



SIERRA LEONE'S INTEGRATED DISEASES SURVEILLANCE AND RESPONSE

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Approval of the Thesis

SIERRA LEONE`S INTEGRATED DISEASES SURVEILLANCE AND RESPONSE

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Doctor of Philosophy (PhD) in Public Health

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Abstract

SIERRA LEONE`S INTEGRATED DISEASES SURVEILLANCE AND RESPONSE

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Background: Sierra Leone adopted the Integrated Disease Surveillance and Response (IDSR) strategy to enhance epidemic detection and control. Despite nationwide electronic reporting, major outbreaks like Ebola and COVID-19 revealed persistent systemic weaknesses, necessitating a comprehensive evaluation to identify gaps and prioritise corrective actions.

Methods: Using a mixed-methods design aligned with the World Health Organisation (WHO) monitoring and evaluation framework, this study collected data in 2021 272 national, district, and health facility respondents visited 93 health facilities. Tools included validated questionnaires (Cronbach's $\alpha = 0.70\text{--}0.80$), key informant interviews, and direct observation. Quantitative data from District Health Information System (DHIS-2) and facility assessments were analysed using regression models to identify predictors of performance, and the qualitative data were thematically analysed using a deductive approach.

Results: Core IDSR functions were inadequately implemented at the health facility level. Only case detection and registration showed a significant association with reporting timeliness ($\beta=108.989$, $p=0.017$), yet just 76% of facilities performed it adequately. Case confirmation was the strongest operational predictor but critically weak, with only 8% of facilities equipped for laboratory confirmation due to resource deficits. Outbreak investigation, preparedness, and feedback were consistently deficient. Among support functions, minimum resource availability was the strongest performance predictor, but severely lacking, only 42% of facilities met basic

standards. Training and guideline availability significantly predicted district-level performance, but coverage was suboptimal. DHIS-2 data showed strong timeliness (85%) and completeness (90%), exceeding national targets and indicating high system acceptance, though data quality and private facility engagement remained concerns. Structurally, IDSR is integrated into the health system but suffers from insecure funding and a lack of legal mandate.

Conclusion: IDSR performance in Sierra Leone is hindered not by the strategy's design but by uneven implementation. Prioritising laboratory-based case confirmation, and outbreak investigation ensuring minimum operational resources at facilities, and strengthening district-level training and guidelines constitute the most strategic pathway to improve epidemic preparedness and response outcomes.

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I want to affirm that this thesis has been composed solely by me and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where stated otherwise by reference or acknowledgment, the work presented is entirely my own.

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In accordance with Unicaf University Zambia's guidelines on the use of generative artificial intelligence(AI), I hereby disclose the use of the following AI-based tools during the preparation and analysis phases of this dissertation:

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Dedication

I want to dedicate this thesis to Almighty Allah for given me the grace and resilience to complete this work. During these years of study my family and I had endured great difficulties but we stood together. I want to appreciate my wife, Yam Mbalu Mbalia Conteh for her patience and for taken care of the family. My children Abibatu Lucy Sulaiman Conteh and Mankapri Gifty Sulaiman Conteh have been very good and for believing and supporting daddy and mummy. Finally, I want to thank my supervisor Professor Victor E. Adamu for his guidance throughout this period of conceptualizing and writing of my thesis.

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Finally, I acknowledge my own dedication, perseverance, and commitment to advancing public health knowledge. This dissertation represents not only an academic achievement but also a contribution towards strengthening disease surveillance and response systems in Sierra Leone and similar settings.

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List of Abbreviations

CBS	Case based surveillance
CDC US	Centres for Disease Control and Prevention
CDSS	Communicable disease surveillance system
EPI	Expanded programme on immunisation
EWARS	Early warning alert and response system
FETP	Field epidemiology training program
IDS	Integrated disease surveillance
IDSR	Integrated disease surveillance and response strategy
IHR (2005)	International Health Regulations (2005)
LDC	Least developed countries
LMIC	Low- and middle-income countries
M&E	Monitoring and Evaluation
MoHS	Ministry of Health and Sanitation
MDS	Multiple disease surveillance
PHSS	Public health surveillance system
SSA	Sub-Saharan Africa
USA/US	United States of America
UNICEF	United Nations Children's Fund
WHO	World Health Organization
WHO AFRO	World Health Organization – African Regional Office

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CHAPTER 1: INTRODUCTION

The world has become a global village where people are closer to each other due to the ease of transportation and communication. These phenomena mean infectious diseases in one part of the globe can reach the most distant site within hours rather than months. This has led to the rapid spread of infectious disease epidemic globally, like what happened with the COVID-19 epidemic that commenced in China on the 8TH of December 2019, and by 30TH March 2020, Sierra Leone announced that the country had recorded its first case of COVID-19 (Couch et al., 2020; Zhu et al., 2020). Humans have evolved and found strategies to combat the spread of infectious diseases. There is enormous evidence that integrated disease surveillance and response (IDSR) is effective in preventing and responding to epidemics, thereby preventing developmental retardation and global spread of the epidemic to the rest of the world (Mremi et al., 2021; Rumunu et al., 2022; WHO Ebola Response Team, 2016; Wilson & Cartwright, 2020; Wolfe et al., 2021). The IDSR strategy had to be effective for it to prevent the next epidemic by ensuring that a public health emergency of international concern is identified as soon as it starts, the structures within the IDSR programme can compile data on the public health emergency, the surveillance team with the clinicians can investigate these probable emergencies so that the possible reason for its occurrence is determined. The data can now be sent to the subsequent authority so that the rest of the global village can be informed and the appropriate response is mounted to the public health emergency of international concern (Fall et al., 2019a).

Establishing the International Health Regulation (IHR) Framework 2005 compelled countries to improve their IDSR strategies and use the IHR 2005 platform to share information internationally on public health emergencies of international concern. However, some countries are still reluctant to share surveillance information. This is because of the geopolitical differences

between countries that consider themselves friends or foes. During the start of COVID-19, there was an allegation by Western countries that China did not notify the rest of the world early enough to give a fighting chance to other countries to prepare themselves to stop the dissemination of the COVID-19 pandemic. It was an allegation that China continues to deny to this day as they believed that the information about the COVID-19 pandemic was shared early enough to give time for countries to prepare. However, some countries with leaders continued to deny the truth about the pandemic until their citizens started dying in huge numbers. It tells the world that surveillance information for public health emergencies of international concerns should be shared quickly so that other countries can have enough time to mobilize more resources like financial and human resources, train clinicians so that they become more aware and ready to look and notify authorities if they see any such illness, use better-triggering systems to alert the rest of the country and the world(Fall et al., 2019a).

The African region has been implementing surveillance programmes for a very long time, and these programmes were decentralized from national, district, health facilities and communities like the national TB surveillance programme, HIV surveillance programme, Neglected Tropical Disease programme and many more. These arrangements put a heavy workload on the health facility workers, making them inefficient. Also, because the surveillance activities were with individual programmes, most of the decisions taken on their results were specific to the programmes, leaving out the complementarity of each programme's effect on the health systems ('Analytical Challenges for Emerging Public Health Surveillance | Request PDF', 2024). These challenges prompted the establishment of the Integrated Disease Surveillance and Response (IDSR) programme, launched in 1998 by the World Health Organization (WHO) in the African region. IDSR aimed to unify countries' surveillance efforts into a single, integrated programme

decentralized from the national level to districts, health facilities, and communities. By consolidating multiple disease-specific programmes, IDSR reduced overall implementation costs and provided a comprehensive view of national public health issues. Additionally, the IDSR strategy enhanced the capacity of local authorities to detect and report public health emergencies of international concern rapidly.

The local IDSR stakeholders are trained to investigate epidemic-prone diseases as this requires specialization based on the epidemic that has been monitored. A clear example was if there was an epidemic of healthcare-associated infection occurring with patients that are catheterized, the stakeholders that would be trained for the investigations of the epidemic would be infection prevention and control stakeholders(*National Infection Prevention and Control (IPC) Guidelines, May 2022 - Sierra Leone | ReliefWeb, 2022*). The technical stakeholders would work with the epidemiologist to ensure that the investigation was done in line with the technical guidelines for IDSR and that the data recorded was collated to be accepted at the next level. The local stakeholders and the epidemiologist can now analyse and present them to make public health decisions on these data. The stakeholders are also trained to report the IDSR data to the next level. IDSR responses are planned and implemented at the community, health facilities, districts and the national levels. The stakeholders have responded to the challenges identified by the IDSR strategy at all levels. The laboratories identify disease processes. The stakeholders at the local level are trained on coordinating the IDSR alerts and when and how to implement alert and response thresholds. The stakeholders working in IDSR must master the IDSR information workflow so that they know how to identify public health emergencies of international concerns, when to alert, how to send the alert, and at what level the alert should be sent. This strategy is thinking globally

but acting locally to protect the world(Fall et al., 2019a; Haffajee & Mello, 2020; Mremi et al., 2021).

Like most strategies, the implementation usually encounters many challenges; this was the same for the IDSR strategy of countries in Sub-Saharan Africa. Most countries only implemented the strategy at the national level without much decentralization. It led to the establishment of the international health regulation framework in 2005. This framework aims to make sure that countries work towards effective management of public health emergencies of international concern without obstructing international traffic and trade. This framework has led to the acceleration of the implementation of the IDSR strategy in most countries, including Sierra Leone(Baker & Fidler, 2006; Wilson & Cartwright, 2020). Sierra Leone launched the IDSR strategy in 1998, but the implementation was abysmal, just like many other African countries. In 2004, the first IDSR guideline was developed for the country, but the implementation was mostly done at the national level. It was what led to the occurrence of public health emergencies like Ebola viral disease in 2014 and COVID-19 in 2019 due to the inefficient implementation mostly at community levels(Fall et al., 2019a; Njuguna et al., 2019a).

Sierra Leone lies on the West coast of Africa; it is 72,000 Km² in area. This area consists of land, which takes 71,880 Km² and the rest is water, 120 km². It occupies latitude 70 North, 100 North of the equator, and longitude 100 West, 140 West of the equator. The Republic of Guinea borders it on the North and Northeast, and the Republic of Liberia borders it on the East and Southeast regions. The Atlantic Ocean borders Sierra Leone on the West and Southwest. The country is divided into West, Northwest, North, South and Eastern regions. Within these regions, there are sixteen districts, namely: Western Area Urban, Western Area Rural, Port Loko District, Kambia, Karene, Falaba, Koinadugu, Bombali, Tonkolili, Bo, Bonthe, Moyamba Pujehun, Kono,

Kailahun, and Kenema districts. These districts are divided into one hundred and ninety (190) chiefdoms. Sierra Leone has a tropical climate that is hot, dry and humid. There are two seasons in Sierra Leone: the dry season, starting from December to April, and the rainy season, starting from May to December. The estimated population of Sierra Leone as of 2022 was 7,976,983, with 51% females and 49% males. Sierra Leone's population was primarily young, with two-thirds under 25. The total fertility rate for Sierra Leone was 4.2% children and a crude birth rate of 36 children per 1,000 inhabitants from the recently published demographic health survey(*Sierra Leone 2015 Population and Housing Census National Analytical Report*, 2018), 2018).

There are three levels of the health sector in Sierra Leone. The first is the national level, where the political, administrative, and technical leadership seats. The political leaders are the Minister and the deputy Ministers of Health and Sanitation. Mostly, the government can decide to have two deputies or one as it pleases the country's President. The administrative leaders are the permanent secretaries of the Ministry of Health and Sanitation, the deputy permanent secretaries and a host of secretaries to the directors and the programme managers. The technical wing is led by the Chief Medical officer and supported by the Chief Nursing and Midwifery Officer and their deputies. The Chief Medical Officer is assisted by the Deputy Chief Medical Officer of Clinical and Public Health, and the Chief Nursing and Midwifery Officer is assisted by the Deputy Chief Nursing and Midwifery Officers for Clinical and Public Health.

The second level is the district level, which is led by the District Medical Officer and his district health management team. There are sixteen district health management teams because there are sixteen districts in Sierra Leone. The district medical officer is assisted by the medical superintendent in the district hospitals and the district health sisters who sit within the district health management teams. The last level is the health facility level, which contains the peripheral

health facilities and some secondary health facilities. The district health management teams do not manage the tertiary hospitals. They are under the supervision of the Director of Hospitals(Barrett et al., 1994).

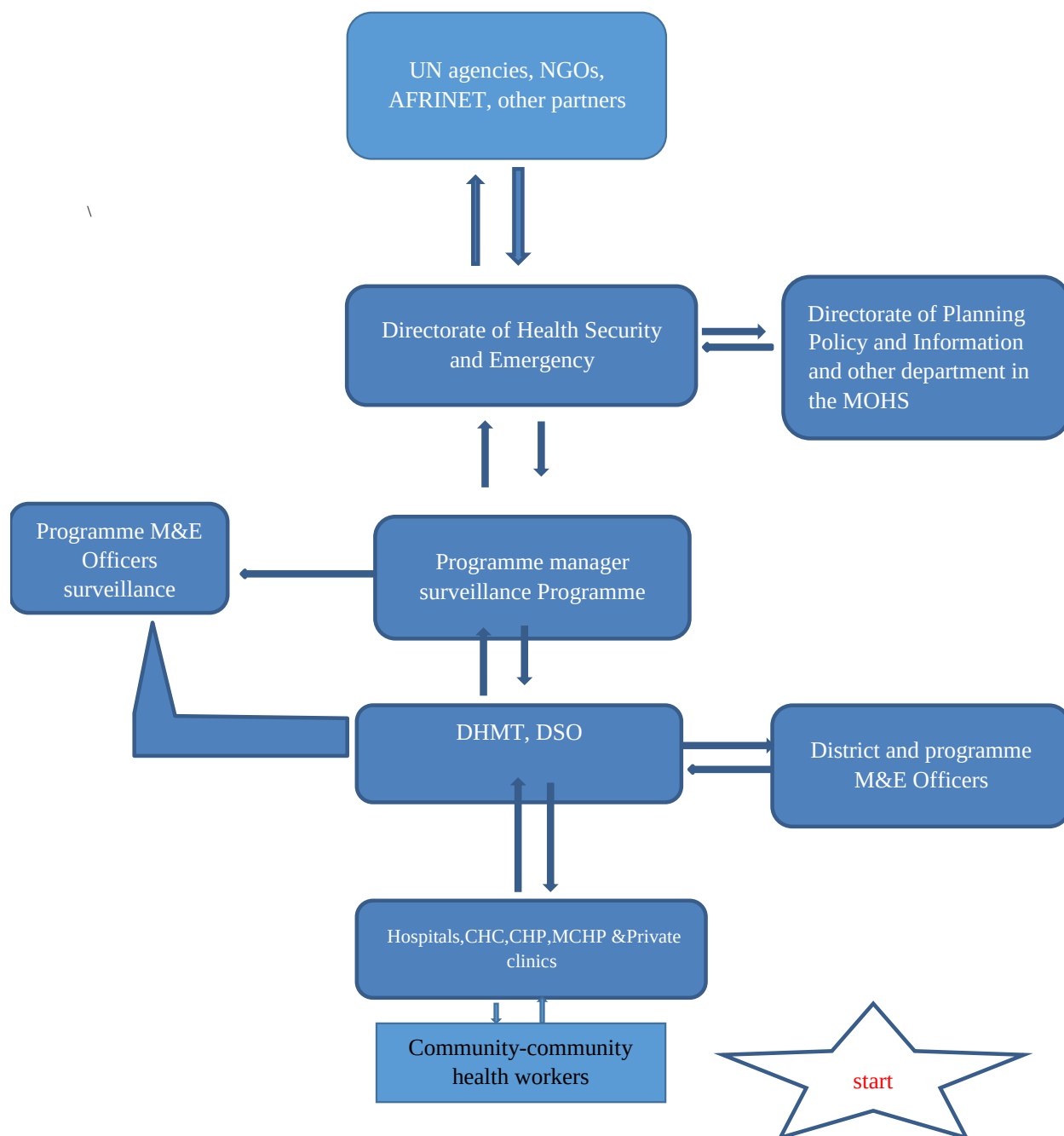
In the IDSR technical guideline 2020, the national stakeholders and the district stakeholders working in IDSR should form a public health emergency management team that should hold the sole responsibility of running the IDSR implementation at all levels, ensuring that all public health emergency strategies, action plans, implementations procedures are followed. These teams include both health and non-health actors. The national team contains the Public Health National Emergency Operation Centre (PHNEOC), which acts as a command-and-control centre and is responsible for the coordination and emergency response. The health security and emergency department director heads the Public Health National Operation Centre. The director reports directly to the chief medical officer at the national level. The Directorate of Health Security and Emergency is in charge of incident management systems at the national level. The director usually coordinates other government agencies, non-governmental organizations, the private sector, partners like UN agencies, and other international partners like CDC Atlanta and China. The district medical officer leads the district's incident management systems, and the district partners, NGOs, and private facilities will work together to respond to emergencies(Njuguna et al., 2019a).

The information is shared with international community organizations like The International Health Regulations (2005), The World Health Organization, the Centre For Disease Control Atlanta, the Centre For Disease Control China, and the African Centre For Disease Control. Information is also being shared with international non-governmental organizations like Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) from the directorate of health

security and emergency from the IDSR weekly, quarterly and yearly bulletins. This information gives the current status of the diseases, events, and conditions that are the priority in the country. The Directorate of Health Security and Emergencies also provides IDSR information to other departments, programmes and directorates within the Ministry of Health and Sanitation (MOHS). The director receives this information from the programme manager surveillance after the programme has sat with its partners to validate the weekly, quarterly and yearly reports. After receiving the IDSR report from the health facilities through the DHIS-2 software, the districts verify the report, allowing the national level to access the data. The community-based surveillance workers (CHWs) in the community also send data to the health facility, and they review the data for duplications and missing data before they enter it into the tablet using the DHIS-2 software. The data that the health facilities send to the district and the national level are sent back through the same route to the health facilities and communities, making sure that they can respond to the challenges that are identified during the process of data collection, analysis and presentation(Njuguna et al., 2019a). It is shown in Figure 1 below:

Figure:1

Sierra Leone's IDRS's information flow (Njuguna et al., 2019a)



This figure illustrates the hierarchical information flow within Sierra Leone's IDSR programme, starting from community-level health workers and facilities. The data ascends through District Health Management Teams (DHMTs), Programme Managers, and the Directorate of Health

Security and Emergency, eventually reaching the Ministry of Health and Sanitation and international partners such as WHO and AFRINET. This structure reflects the integrated and multi-level approach to public health surveillance and response coordination in the country (Njuguna et al., 2019a).

The information flow we have just discussed should have been the ideal situation considering that the IDSR programme works effectively if the stakeholders fully engage it in Sierra Leone. This IDSR programme should have been able to prevent the recent 2019 COVID-19 pandemic from reaching the shores of Sierra Leone. It should have been able to prevent the Ebola epidemic that the Mano River Union countries had in 2014 and 2015. However, due to the ineffectiveness of the programme at those times, we had a huge development challenge that is still haunting our economy today(AlMossawi et al., 2019a; Grieco et al., 2020; Njuguna et al., 2019a, 2019a).

Statement of the Problem

The establishment of the IDSR programme in Sierra Leone in 1998 was to prevent the occurrence of public health emergencies of international concern. However, this does not prevent the occurrence of the epidemic. Since then, many challenges have been met by the strategy, causing the occurrence of public health emergencies, like the one that occurred in 2014 and 2015 and the current one that started in 2020. These public health emergencies of international concerns will continue to happen and retard Sierra Leone's developmental successes if they are not prevented or stopped as soon as they start(AlMossawi et al., 2019a; Njuguna et al., 2019a). The reason for these failures has been shown by some studies with a focus on the implementation challenges of the core and support functions of IDSR(Dureab et al., 2020; Hamalaw et al., 2022a; Ibrahim et al., 2020a; Njuguna et al., 2019a; Saleh et al., 2021; texila american university. & HakwiaKooma, 2019). Two

recent studies in Zanzibar and Zambia use a cross-sectional descriptive study design to present the current state of the core and support functions of IDSR in these countries(Saleh et al., 2021). In Sierra Leone, some studies have been done to identify the challenges of IDSR implementation and to improve its implementation. A study was done in 2019 on revitalizing the IDSR programme in Sierra Leone by a group of researchers led by Njuguna. These researchers examined the process of revitalizing the IDSR programme after failures in the system to prevent the occurrence of the Ebola viral disease epidemic in 2014 and 2015. They found out that the IDSR programme had been revitalized by the Ministry of Health and Sanitation and its numerous partners as the indicators of the quality of the IDSR programme have increased during this revitalization process. The indicators that were reviewed showed that capacity building of the training of health facility was done for 2300 in-charges at the peripheral health level, and 418 health workers were trained on IDSR from hospitals, faith-based organization health facilities, and private health facilities and clinics for one year. This training made clinicians aware of the importance of producing high-quality clinical data to make informed decisions at all levels(Njuguna et al., 2019a). The IDSR data was reported by hard copies using the reporting forms from the health facilities. The in-charges will send the report to the district by noon every Monday by phone, text, WhatsApp, e-mail, or someone who travels to the district surveillance officer's office to drop the report. The districts will verify the report and enter it into the district health information systems two software (DHIS-2) so that the national level can access the data for decision-making at all levels. In 2017, there was a massive training and distribution of tablets to the health facilities so that Sierra Leone could start electronic IDSR. This training was completed in 2019, and the whole country started electronic IDSR, which saw a massive improvement in the timeliness and completeness of reports at district and national levels, with completeness increasing from 78% to 96%.

The team assessed the quality indicator of the sensitivity of the IDSR programme, and they found that the percentage of outbreaks detected increased from 98% to 100% in 2017. The laboratory confirmations of patient samples increased from 16% in 2016 to 72% in 2017. However, the timeliness of reporting outbreaks decreased from 92% in 2016 to 81% in 2017. The researchers suggest that the WHO posted district support staff during the Ebola epidemic in 2014 and 2015, but the staff was withdrawn in 2017 during the post-Ebola recovery period. It led to a decline in the sensitivity of the IDSR programme in Sierra Leone. It demonstrates that the IDSR programme is unstable because it does not have government financial support to fund relevant activities that can prevent the next epidemic (Martin, Sloan, Gleason, De Wit, et al., 2020; Njuguna et al., 2019a). This research could not investigate the challenges at all levels of the health systems. The data did not show which health facilities were used for the information. Most of the indicators were focused on the national and some district-level data about the steps, achievements and gaps in revitalizing IDSR. The IDSR programme is divided into subthemes that must work effectively for the whole programme to prevent the next epidemic. This research did not investigate these subthemes of core, support, quality and structure functions of the IDSR programme at all levels. The research did not compare how much impact each subtheme will have on the effectiveness of the IDSR programme in Sierra Leone. It means that an implementing agency cannot prioritize the subthemes of IDSR to reduce costs and maximize the impact on the effectiveness of the IDSR programme in preventing the next epidemic.

The reason for the failure of the IDSR programme was seen in another research by Kardas-Nelson and Frankfurter in their paper in 2018. These researchers visited a health post in the Eastern region of Sierra Leone in the Kono district. There, they observed the activities of the community health officer in charge, Tengbeh. Mr Tengbeh is also the focal point for integrated disease

surveillance and response in the chiefdom. He is responsible for the IDSR reporting to the Kono district health management team and sends the report every Monday before noon to the district surveillance team. The researchers reported that Mr Tengbeh will travel miles on his bicycle to find mobile network coverage so that he can text the report with his mobile phone to the district. According to the researchers, a community health officer in Freetown from Mabala Community Health Centre said the IDSR programme focuses more on counting the priority diseases, conditions and events than solving the health systems challenges.

The patients are left unattended, but the health facility staff want to report the figures every Monday morning. The health facility was left stuck out of drugs. The researchers also interviewed the person in charge of the IDSR programme at WHO, Charles Njuguna, who confirmed that, for now, they are focused on making sure that the data is flowing. Later, they will work on the quality of the IDSR programme. The researchers also interviewed the deputy chief medical officer, Dr Amara Jambai. He confirmed that the Ministry of Health and Sanitation is currently working on ensuring that the data from the health facilities reach the nation through the district health management teams; he said health system strengthening is a high-cost activity and requires a high commitment by the government of Sierra Leone and its partners. Most partners are unwilling to support these activities, and the government does not have funds to support them. This is why health facilities and district health management teams have health system challenges even though the health facilities are reporting them (Kardas-Nelson & Frankfurter, 2018). This research is more of a documentary of what was happening in one health facility, and we cannot use it to generalize the situation in the whole country. It did not examine the functions of the IDSR programme in Sierra Leone.

In November 2019, two Lassa fever viral infection cases were exported from Sierra Leone to the Netherlands. The IDSR programme was notified of these cases after they reached the Netherlands, and a real-time polymerase chain reaction test was performed on the cases at the Erasmus Medical Center. The index case was a pregnant woman from Makonthandae Maternity Health Post that presented with vaginal bleeding, vomiting and fever. She was referred to The Masanga Hospital for care, and a caesarean section was done on the patient due to a threatening abortion. Two foreign doctors from the Netherlands did the surgery, and a Sierra Leonean anaesthetist assisted them. The patient later developed complications and died despite several efforts to resuscitate her just after the surgery on the 4TH of November 2019. The same surgeons operated on another case that day, but that patient was admitted to the ward for recovery. On the 10TH of November 2019, one of the foreign doctors from the Netherlands developed fever, generalized body pain, cough and vomiting while attending an international meeting in Freetown, the capital city of Sierra Leone. He was tested for malaria and typhoid but was negative. The medical team in Freetown, who should know the case definitions for priority diseases in Sierra Leone, insisted that he must be treated for malaria and typhoid as usual. He had the treatment for eight days but did not improve on the 19TH of November 2019; a commercial airline evacuated the doctor to the Netherlands, transiting through Morocco, Casablanca. No infection prevention control steps were taken during the flight, putting the crew at risk of transmission for Lassa viral infection. The patient was transported straight to the Amsterdam University Medical Hospital, where only methicillin-resistant *Staphylococcus aureus* (MRSA) prevention control was taken. Again, this was a significant risk for international transmission if the ground crew at Casablanca or the flight crew in the commercial private jet were infected while transferring the patient

(Njuguna et al., 2019a; Overbosch et al., 2020). This study lacks evidence of the failure of the functions of IDSR and framework. It is because this study is a case study report.

A study by a group of researchers found that the laboratory systems in Sierra Leone have improved in the molecular biology diagnostic capacity during the Ebola epidemic. However, the laboratory systems need massive government and partner investment. These investments should focus on regulatory capacity, material support, and capacity building. These areas will fill the gaps in quality assurance, supply chain management, specimen collection storage and transportation, maintenance of equipment and systems and waste management (Vernooij et al., 2022). This study did not investigate how this laboratory capacity will impact the effective prevention of epidemics in Sierra Leone.

In all these studies, however, they did not prioritise the gaps of the IDSR functions that were identified at all levels. So that limited resources would be spent on the IDSR functions that had the most impact on the outcome indicator to prevent the next epidemic. It would be good for the government and its partners to know that they do not need to spend huge funds on all the IDSR functions activities before they could see an improvement in the case fatality in an outbreak or performance indicator like timeliness and completeness in reporting.

They did not investigate the effect poor integration of digital tools and real-time analytics has on timely response to epidemics. The effect inconsistent community engagement and feedback loops has on community trust and the risk of delayed identification of epidemics. The effect underutilisation of surveillance data has in policymaking and outbreak forecasting. The effect insufficient focus on equity, particularly rural-urban disparities have on the site that the epidemic starts. Finally, the effect lack of sustained investment in work force development and infrastructure has on epidemic prevention and response.

All health systems must have nine core and six support IDSR subfunctions working for the IDSR strategy to be effective. Examining the impact of implementing the IDSR subtheme would prioritize where more limited resources would be spent to prevent the next epidemic effectively. Our study looked at the effectiveness of the current status of the core and support functions of IDSR at all levels and the thirteen quality functions and support structures for the IDSR programme in preventing the next epidemic.

Purpose of the Study, Research Aims, and Objectives

Purpose of the Study

In response to the continuous occurrence of epidemics in Sierra Leone, even after the IDSR program was revitalized several times after it was launched in 1998 and much money was spent on it, this research is a cross-sectional quantitative study that evaluated the effectiveness of the core and support functions of IDSR programme implementation by stakeholders in preventing the next epidemic.

This evaluation was done at all levels, including the national, district, and health facilities. The current status of the functions was examined to determine if the stakeholders working in the IDSR programme had fully and effectively engaged them to prevent the next epidemic. The gap identified was prioritised based on the data from the study for stakeholders to spend resources in an effective means. This means spend less money but have the maximum impact in IDSR effectiveness in preventing the next epidemic.

The panopticon theory by Jeremy Bentham and the IDSR conceptual framework was used to inform the formation of the research questions, support the method of investigation, analyze the data, and present the results and conclusions for the study.

The WHO structure questionnaire was divided into national, district, intermediate, and health facility levels. The questions are quantitative and qualitative and structured to assess the functions of the IDSR programme: the core, support, quality, and structural functions.

The quantitative and qualitative questions in the WHO-adopted questionnaire will answer the specific objectives of the research.

Aim of the Study

To evaluate the core and support functions of the IDSR programme in Sierra Leone and strengthen them at the national, district, and health facilities levels to prevent or manage future epidemics.

Specific Objectives of the study

1. To evaluate the Nine core functions of Sierra Leone's IDSR programme at all levels
2. To evaluate the six support functions of Sierra Leone's IDSR programme at all levels
3. To assess the current thirteen qualities of Sierra Leone's IDSR programme
4. To assess the current state of the support structures of Sierra Leone's IDSR programme

Nature and Significance of the Study

Nature of the study

Health workers and non-health workers implement the IDSR program. This study examines a few IDSR programme workers because they work in health facilities, districts, and national offices. The WHO questionnaires were used to ask direct face-to-face questions to the selected health workers managing these stations.

The structured questionnaire adopted from the WHO Assessment of Infectious Disease programmes contained questions that needed numerical responses and written responses from the

face-to-face filling of the reactions. It means that the research method is quantitative but needs more clarification of the figures found, and the stakeholders will provide their opinions about their implementation. Although this method gives a closer detail of the problems, they are primarily challenging to analyse and report as the response will be many and complex(*Joint External Evaluation of IHR Core Capacities of the Republic of Sierra Leone, 2016*).

The WHO questionnaire had a generic structure, so we had to change the context to suit the situation in Sierra Leone. For example, the intermediate level was called the district level. The answers from this questionnaire were used to answer the objectives. However, because we needed more clarification, some data was taken from the DHIS-2 database at the planning policy and information directorate.

The study was conducted across all levels, involving highly engaged stakeholders in various roles within the Ministry of Health and Sanitation. To secure their participation, Sulaiman contacted them and invited to participate. Most stakeholders could participate directly, while those unavailable sent representatives to contribute.

The sample included all the national and district-level stakeholders if they meet the eligibility criteria. A purposive multistage randomized sampling method was used at the health facility and laboratory level. It was done to ensure that all the different types of health facilities and laboratories at the chiefdom levels were included in the study. The data was collected for almost a month, cleaned by us, and discussed with the supervisor. It was entered into an Excel database, and the tables generated from the questions. The number of stakeholders that answered yes and the ones that answered no were indicated. The sum and averages of the answers were used to prepare a table in the SPSS IBM statistical package, which was used to estimate if the stakeholders of the IDSR programme did not effectively engage the IDSR programme in Sierra

Leone. It was done by calculating the p values, and based on the p-value, the null hypothesis was accepted or rejected. The tables from the Excel database were used to calculate the indicators at national district and health facility levels using the four objectives: core, support, quality, and structural functions.

Significance of the Study

The study aimed to assess the challenges facing the IDSR program in Sierra Leone, which hinder stakeholders' ability to prevent or control future epidemics effectively. We hypothesize that if the IDSR program is effectively implemented and supported by stakeholders in Sierra Leone, it would enable the prevention or containment of the next epidemic or public health emergency of international concern.

The data that comes from this study would be used for the following:

World: The data from this study would be used by many other countries to address their challenges, similar to those found in Sierra Leone. Some challenges recorded in the Sierra Leone IDSR programme have been identified in the earlier session. The challenges for most of the African IDSR programmes are framed into four main functions: core, support, quality and structural. The data from our study would provide practical solutions with local context for other countries, especially those in Africa, to use and solve their challenges (Jayatilleke, 2020; Mremi et al., 2021; Njuguna et al., 2019a, 2022).

Subregion: The narratives of most African countries are similar, especially in public health. This study's results will help address similar challenges in the subregion in prioritising what IDSR function to spend more funds on and which ones can wait based on the data collection in the locality.

Nationally:

Government: In 2014, during Sierra Leone's Ebola epidemic, the Ministry of Health and Sanitation managed the response and prevention efforts. However, due to shortcomings in handling the epidemic, the government was compelled to establish the National Ebola Response Center (NERC)(Richards et al., 2020). A similar situation occurred during the COVID-19 pandemic, which reached Sierra Leone in March 2020. The Ministry of Health and Sanitation, through the Directorate of Health Security and Emergency, could not effectively respond to or contain the outbreak. Consequently, the National COVID-19 Emergency Response Center (NaCOVERC) was established, a politically appointed body created by the President with significant political alignment to the ruling party. These appointees often receive high salaries, resulting in financial burdens for the country. Such expenditures could have been avoided if the Ministry of Health and Sanitation had effectively utilized the IDSR program to prevent and manage epidemics(''(PDF) Hu et al 2022 Circulating Trends of Influenza and Other Seasonal Respiratory Viruses Ijerp-19-05942'', 2025). The data from this study will ensure that there is a policy change that will allow public health emergencies to be a top priority and that can make sure that the government can provide adequate resources to finance the activities for the implementations that will prevent the next epidemic(*Shock-Responsive Social Protection Systems (SRSP) | Oxford Policy Management*, 2018).

Population: The previous epidemics that happened in Sierra Leone have been killing Sierra Leoneans. In May 2014, the Ebola viral disease epidemic started, and it infected 8,704 and killed 3,851 people in Sierra Leone(Jalloh et al., 2020). The COVID-19 pandemic began in March 2020 and has infected 7,751 people and killed 125(Jalloh et al., 2020). These deaths could have been avoided if those two epidemics had been prevented from happening in the country. This study

will strengthen the IDSR programme so that the next public health emergency of international concern can be prevented, or if it ever happens, it will ensure that the response is swift enough to stop it.

Education: Public health emergencies have been shown to disrupt developmental activities in 2014 and 2015 during the Ebola viral disease epidemic and the 2019 COVID-19 pandemic. These disruptions have led to the closure of cities, resulting in the closing of schools and colleges. Most students had to stay home and study. It led to much abuse of students, especially girls leading to high teenage pregnancy and gender-based violence like rape. Preventing the next epidemic will reduce these incidences and avoid death and developmental loss to education(Grieco et al., 2020; Smela et al., 2023).

Economy and trade: In 2014 and 2015, during the Ebola viral disease epidemic in Sierra Leone, the country lost a GDP of about \$1.9 billion. The cost of illness study showed that Sierra Leone lost \$30 million, which comprised the cost of the Ebola viral disease treatment and loss of productivity. The data from this study will prevent the economic and trade losses identified in this chapter(Kellerborg et al., 2020).

MOHS stakeholders: The Ministry of Health and Sanitation stakeholders will use this study data to advocate for resources and solve the challenges they are currently facing so that they can effectively engage the specific function of the IDSR Programme to prevent the next public health emergency. It would be cost-effective because instead of spending too much on all the functions, they would know which would lead to the most significant impact in preventing and controlling epidemics.

MOHS Partners: The Ministry of Health and Sanitation partners will use the data from this study to advocate for and mobilize scarce resources. Funding would be easier for specific

costed activities in a function than for whole or multiple programmes. They can also use it to report the impact of their activities in Sierra Leone on health security and emergencies, showing convincing success in public health surveillance.

Health Security and Emergencies Staff: The selected staff will form the sample for this study and complete the questionnaire face-to-face. This approach will help identify the strengths and weaknesses of implementing the IDSR program in the country. By engaging in this process, the staff will have the opportunity to self-correct and improve their practices. The data collected from this study will be instrumental for advocacy efforts and ensuring the accurate execution of their responsibilities.

Other MOHS staff: During epidemics, it is the frontline health workers who will mostly lose their lives in fighting the epidemic. These frontline workers are mostly clinical staff like the nurses, doctors, cleaners, and laboratory staff in the health facilities; in 2014 and 2015 of the Ebola viral epidemic, Sierra Leone lost 6.87% of its health workforce compared to 0.06% of the general population was lost (Jalloh et al., 2020). The study will help the IDSR stakeholders know how to prevent the next epidemic and, hence, prevent the loss of lives of health workers. The clinicians will know how important it is to identify epidemic-prone diseases of international concern and report quickly to take speedy action (Jalloh et al., 2020)

Laboratory Staff: The data will show the challenges faced by laboratory systems and solutions to these challenges. The study data will help the laboratory staff correct themselves, like a quality improvement process.

Private Health Facilities: Private health facilities and clinics are integral components of the healthcare system in Sierra Leone. Cases involving infectious diseases of public health significance can arise in these facilities, highlighting the importance of their full participation in

implementing the IDSR program. This study's data will reveal the challenges faced by private health facilities, providing valuable insights to address and resolve these issues effectively('PDF) An Appraisal', 2024).

Research Questions and Research Hypothesis

The Integrated Disease Surveillance and Response (IDSR) WHO Monitoring and Evaluation Framework for Communicable Diseases comprises core functions and support functions that collectively strengthen early detection, reporting, analysis, and response to priority diseases and public health events. The core functions represent the operational surveillance activities. They include case detection and registration, case confirmation (laboratory diagnosis), case reporting, data analysis and interpretation, outbreak preparedness, outbreak response, feedback, monitoring and evaluation, and coordination of epidemic preparedness and response. The support functions enable and sustain the effective operation of core functions. They include the availability and use of standards and guidelines, training, supervision, resource availability (financial, logistical, and ICT), coordination and stakeholders' satisfaction. These were used to develop the research questions, hypotheses and sub-hypotheses below:

Research Questions

The research questions are as follows: What is the state of the;

RQ1. Nine core functions of Sierra Leone's IDSR programme at all levels?

RQ2. Six support functions of Sierra Leone's IDSR programme at all levels?

RQ3. Thirteen qualities of Sierra Leone's IDSR programme?

RQ4. support structures of Sierra Leone's IDSR programme?

Hypotheses

H1o The nine core functions of the IDSR programme in Sierra Leone are Not significantly engaged by the stakeholders to effectively address the nation's disease surveillance and response. Based on the stated null hypothesis (H1o), the following sub-hypotheses can be formulated by disaggregating the nine IDSR core functions. Each sub-hypothesis tests stakeholder engagement with a specific core function.

H1oa: Case detection and registration are not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1ob: Case confirmation (laboratory diagnosis) is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1oc: Case reporting is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1od: Data analysis are not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1oe: Data interpretation are not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1of: Outbreak preparedness is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1og: Outbreak response is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1oh: Feedback is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1*oi*: Epidemic preparedness and response coordination is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

These sub-hypotheses allow each IDSR core function to be tested independently, supporting a granular assessment of implementation gaps and enabling prioritisation based on empirical evidence.

H2*o*: The six support functions of the IDSR programme are Not significantly engaged by the stakeholders to effectively address the nation's disease surveillance and response.

Based on H2*o*, the following null sub-hypotheses can be stated by disaggregating the six IDSR support functions:

H2*oa*: Standards and guidelines for IDSR implementation are not significantly engaged by stakeholders in Sierra Leone.

H2*ob*: Training and capacity building for IDSR implementation are not significantly engaged by stakeholders in Sierra Leone.

H2*oc*: Supervision of IDSR activities is not significantly engaged by stakeholders in Sierra Leone.

H2*od*: Availability of minimum resources (human, financial, logistical, and ICT) for IDSR implementation is not significantly engaged by stakeholders in Sierra Leone.

H2*oe*: Coordination and partnership among relevant stakeholders for IDSR implementation are not significantly engaged by stakeholders in Sierra Leone.

H2*of*: Stakeholders satisfaction of the IDSR implementation are not significantly engaged by stakeholders in Sierra Leone.

These sub-hypotheses permit independent testing of each support function, enabling identification of specific systemic weaknesses and evidence-based prioritisation for strengthening the IDSR programme.

CHAPTER TWO: LITERATURE

Introduction

The world's population continues to increase so much that its space can no longer hold its numbers. It has led to the development of innovative ways of creating more space. In most countries, citizens are clearing the forest to build new homes and cities. Some cities are moving into the shores of the seas to create more space as more people are born. When humans had no place to live, cities were built in deep forests, and the general population came to live very close to the forest and the wild animals. This arrangement made humans interact with animals by using them as pets and food. Some researchers believe this recent population arrangement is dynamic and is causing the emergence and re-emergence of infectious disease epidemics worldwide. Most of these infectious disease epidemics come from zoonotic origins, and most have crossed over from animals that are in the wild or have been used by people as domestic animals. These innovations to feed and create space for the growing population have led to antibiotics being used in the rearing of animals to prevent death and make them grow healthy and fast. These activities have led to antimicrobial resistance like vancomycin-resistant *Staphylococcus aureus* and *Candida auris*, which can be a public health emergency of international concern if it is not controlled (Spernovasilis et al., 2022). Some studies have shown that integrated disease surveillance and response interventions can only prevent or stop these epidemics. The IDSR programme can only prevent the next epidemic if the stakeholders can solve the challenges plaguing the country's surveillance programme. It means that public health officials should use the data from the IDSR programme to develop decision-making strategies. Public health officials should be able to solve the challenges faced by the IDSR programme effectiveness for emergency preparedness. This process is not a one-time cross-sectional issue; it should be continuous

monitoring and one in which the politicians should show high commitment, and they should partner with the funders so that practical actions can be taken to make the public health surveillance programme prepared for any emergency(Fenollar & Mediannikov, 2018).

The data from this study should be used by stakeholders for public health responses, ensuring that the IDSR programme is prepared for public health emergencies. The study evaluated the core, support, quality, and structural functions at national, district, and health facility levels to identify challenges and propose solutions(Khan et al., 2018).

The review of this study was done scientifically using the terms integrated disease surveillance and response, panopticon theory and evaluation in Sierra Leone. The following search engines were used to identify scientific papers: Google Search, Google Scholar, African Journal Online, Incorporated Research Institutions for Seismology (IRIS), Pub Med, Global Health Database, Cochrane Database and UNICAF Virtual Learning Environment. The search produced 3,790 peer-reviewed scientific papers. The search was from 1ST January 2019 to 2022.

Theoretical and Conceptual Framework for this study

The study is a cross-sectional one which uses the panopticon theoretical framework that Jeremy Bentham stated in his inspection house theory that was published in the eighteenth century. Jeremy Bentham was an English man born on the 15TH of February 1748 in Spitalfields, London, United Kingdom. He was a Jurish, a philosopher and a reformer of the English law in the eighteenth century. He was also considered the inventor of utilitarianism, which involved legal positivism and welfare economics. He was a firm critic of traditional law and contract theory.

Why the Panopticon Theory was originally Proposed

In the eighteenth century, Jeremy Bentham travelled to the East, specifically the Russian empire, to visit his brother. While staying with his brother, he developed the panopticon theory of surveillance using a prison-setting approach. Jeremy Bentham showed that in a prison setting where the inmates are constantly watched by a supervisor who can punish them if they do the wrong thing and reward them if they do the right thing, they will always try to be good. This theory will work if the inmates cannot see the supervisor, but the supervisor can see them. The belief is that prison inmates can change their evil ways and take good behaviours before they are integrated into the general public again. It was later called surveillance. The etymological description of surveillance when is divided into two parts: sur, which means from above, and veillance, which means to watch (Galič et al., 2017; Timan et al., 2017).

The panopticon theory would not succeed as a theory for surveillance in the prison setting, so Bentham proposed more similar theories in support of panopticonism. From 1797 to 1798, Bentham's work was edited by Foucault, who worked on and proposed the Pauper panopticon theory. He stated that the Bentham theory should not be limited to the prison setting alone but should be used by all disciplines and that the Panopticon should be seen as an apparatus of power and care (Safaei & Saliminezhad, 2022). The Chrestomatic panopticonism was focused on the relationship between a school teacher and the students. The teacher will observe the student and is taught to replace corporal punishments with visual aids, which are used for children who find it hard to understand lessons. Children are divided into groups of similarity. Children who are slow to understand the lessons are grouped as one, and those who are quick to understand are placed in one group. It makes the teachers provide better tuition for the students, and the students will be assessed based on their levels rather than in a mixed-up class with various intelligences. The third

panopticonism was the constitutional code in which Bentham proposed the utilitarian democracy in 1830. Jeremy Bentham proposed the equal vote, the principle of no taxation without consent and personal secret ballot in democratic processes(Galič et al., 2017).

Tenets of the Theory

Five principles are used to describe surveillance in panopticonism. They are mentioned as follows:

In Jeremy Bentham's theory of the Panopticon, the first principle is that a supervisor at the tower with disciplinary power should be watching the inmates who cannot see him. The prison panopticon demonstrated the use of discipline as a tool for power. This principle has been used in many disciplines, such as politics, education, health, etc. It shows the disciplinary power of modern institutions. The second principle is that the head of the institution is the supervisor for the rest of the employed staff(Safaei & Saliminezhad, 2022). The guards watch the inmates, and the supervisors watch the employees. The third principle is that the inmates or employees do not see the supervisors. In the fourth principle, the inmates and the employees also watch each other to scan for rewarded good behaviours and avoid destructive ones. The fifth principle is that systems or structures will be watched by the general public and evaluated for good outcomes(Galič et al., 2017).

Jeremy Bentham's prison theory has changed to incorporate several disciplines, and it has changed from prison settings to innovative technologies. These technologies include closed circuit television (CCTV) to monitor cities, supermarkets, and hallways, and drones are used in spy activities by the military and intelligence agencies. Panopticonism is no longer a prison structure affair. However, it is still practised in some settings like schools, intensive care units, and

parliamentary sessions as it brings discipline to institutions and the rest of society, as discussed by Foucault in his paper (Galič et al., 2017).

The evolution of the surveillance strategy has led to its usage in multidisciplinary interventions, including health and education. During public health emergencies like the COVID-19 pandemic, several innovations were introduced to identify suspected, probable and confirmed COVID-19 cases in the general population so that the public health emergency can be stopped or prevented from escalating (Couch et al., 2020). Surveillance has been used to do seroprevalence studies like HIV in pregnant women in most African countries. It has been used in identifying cases for nasopharyngeal swabs of cases so that the patients have COVID-19 (Bobrovitz et al., 2023; Mallapaty, 2020; *Operational Guide for Engaging Communities in Contact Tracing*, 2021). During the COVID-19 pandemic, Foucault's panopticonism was used by many countries to implement innovative means of identifying and treating cases and suspects. Several strategies were used to control the spread of COVID-19 by using technology as a means of innovation. In the United Kingdom, United States and Canada, real-time software was used to screen the general population for symptoms and signs of COVID-19. Kings College University in London, Zoe Global Limited and Massachusetts Hospital developed this software application. Health workers use it in the United Kingdom, United States, and Canada to screen the general population. In the United Kingdom alone, the software application was used to screen 2,618,862 for one month. In the United States of America, 168,293 people were screened for one month in 2020. This screening of the general population led to the identification of suspects who answered yes to the symptoms; about 18,401 people screened positive for COVID-19 and were requested to do a polymerase Chain Reaction (PCR) for the identification of COVID-19 as a confirmation of the cases. 65.03%

were confirmed by the PCR test as being positive, while 21.71% were tested negative using a PCR test with positive screening for loss of smell and taste(Menni et al., 2020).

In the capital city of Australia, called Canberra, a population-based software called Beat COVID-19 Now was used to screen for COVID-19. The government analyses and uses the data to determine where the positive cases screened are concentrated. The government will now organise tests and treat all campaigns to reduce the burden of the disease and stop the epidemic. This application was developed by Professor Bailes, an astronomer working in one of the Telescope programs using supercomputers to analyse vast amounts of data. He worked with Professor Richard Osborn from Swinburne, who had previously worked with the World Health Organization and the Australian Bureau of Statistics on disease-tracking surveys. According to Professor Bailes, this application will allow the government to predict the occurrence of the COVID-19 epidemic before it starts. We want to know where and when the next COVID-19 epidemic will emerge and prepare for adequate response(Regan, 2019; Sweney & Hern, 2020).

The Australian and New Zealand governments used a website to track and test the general population for flu symptoms. When the COVID-19 pandemic struck the world, they were able to successively convert this website for use in the COVID-19 pandemic for tracking the general population with positive symptoms of COVID-19('How an Australian Online Survey Joined the Global Fight against Flu and COVID', 2022; Regan, 2019). Singapore used the Trace Together contact tracing software tool to identify those who had positive symptoms screening. They were then sent to the referral laboratory for a PCR test and confirmation of the disease. Those who were confirmed were sent for treatment and isolation. It was done to protect the rest of the community, especially their loved ones and the community's people(*Broken Promises*, 2021). The Israeli government used a mobile data system from the general public to scan for people with COVID-19

symptoms. Those who were positive were sent a text message and requested a PCR test for COVID-19 from a government laboratory. This system was led by the Shin Bet internal security company('Coronavirus', 2020; Yadlin & Marciano, 2022).

The government of Taiwan was able to use an electronic fencing strategy to prevent quarantined people from leaving their homes. The authorities use mobile phone geographic information systems to quarantine people. These mobile phones were used as a geofencing technique. The police were used to punish defaulters by arresting them and putting them back in their geofenced quarantined homes. Critics of the government of Taiwan said that this was an infringement of the human rights of the general population(Lee, 2020; Shang-Su, 2021).The Taiwanese government also introduced social distancing application software that uses the Apple/Google Bluetooth exposure closure notification software in Android and Apple phones. This application needs the general population to accept it on their phones so that if the social distance is violated, a signal is sent to their phone to avoid the person close to them(Garrett et al., 2022).

The government of Hong Kong uses wristbands connected to a smartphone application for people who have been asked to self-quarantine. It monitors their movement and tells them if they leave the quarantine border without an excuse or authority(Saiidi, 2020). An ankle bracelet developed by Goodman, Coyne, and Devereaux in the United States and Canada was used for people on self-quarantine and those in quarantine homes. A person who violates the quarantine borders will make the ankle bracelet to send an alert to the government staff monitoring the devices so that actions can be taken to let the person return to quarantine(Garrett et al., 2022; Goodman et al., 2021; Tom-Aba et al., 2020; *WA to Electronically Track COVID-19 Patients Who Defy Isolation Orders*, 2020). The monitoring of the general population using the Foucault panopticism

by many countries and with innovations like what happened in China as they modify drones to monitor the general population and identify and refer the COVID-19-infected ones for test and treatment.

The Chinese government modified drones to use loudspeakers to give public health messages on prevention, warning on social distancing and calling on people who fault the rules. These drones also had high-definition zoom lenses to detect people so that they could be identified for treatment. This drone also had disinfection chemical spray jets to disinfect suspected COVID-19-infected places, especially in control of mass gatherings and institution of corrective strategies. Thermal sensory cameras identify the suspected cases. People at risk were asked to wear masks, wash their hands regularly, and do social distancing(3 Ways China Is Using Drones to Fight Coronavirus, 2020).Almost all countries have closed-circuit television (CCTV) cameras, which are used primarily in airports, seaports, and land border ports to check people's temperature and other vital rates, like heart rate and respiratory rate. The CCTV can also tell if someone in the crowd is sneezing or coughing(3 Ways China Is Using Drones to Fight Coronavirus, 2020; UniSA Working on 'Pandemic Drone' to Detect('Coronavirus', 2020; Couch et al., 2020; Zhu et al., 2020). Every study should have a conceptual framework on which the objectives will be constructed and the results analysed so that it is readily reproducible by others and its results can be validated. Our study uses the panopticon theory, integrated disease surveillance and a conceptual response framework. This framework was derived from the international health regulation, which was started in 1969 and revisited in 2005. After establishing the international health regulation and the implementation of the IDSR in 1998, the implementation of the IDRS was slowly implemented by countries, which led to its revision in 2005. Using the Bentham panopticonism theory, the IHR (2005) focal points act as supervisors at the tower watching the inmates, who, in this case, are the

country's IDSR stakeholders implementing the IDSR programme. The countries are directed on how to implement the IDSR programme using the technical guidelines that are revised regularly based on the challenges that the IDSR faced and the solutions that are proposed to solve these challenges. While implementing the IDSR programme, the countries should alert the focal points of the IHR at the national, regional and global offices so that a local and international response can be mounted(Masiira et al., 2019).

Origin of the Panopticon Theoretical Framework

The origin of the panopticon theory was framed by an English philosopher and jurist, Jeremy Bentham, who was born on 15 February 1748. He postulated the surveillance theory in 1787 while on a trip to Russia. Mr Jeremy Bentham travelled to the Russian Federation in 1785 to visit his brother, Samuel Bentham; while in Russia, he was opportune to witness the naval engineers working for Prince Grigorii Aleksandrovis Potemkin in Krichev. Samuel was one of the supervisor engineers in the manufacturing company. Bentham noticed that his brother, Samuel, was using the circular prison structure to monitor the peasants of Russia to manufacture goods for the prince. Jeremy Bentham was drawn to his brother's intelligence to observe and write down his findings. In his letter sent to Middlesex, he explained the prison structure panopticonism to the stakeholders in London, saying that it can work to reform the prison systems and socially monitor children in schools and hospitals, especially in the wards like the intensive care units and factories. He suggested that the reform should make the monitoring of subjects in a semi-circular structure with a supervisor sitting at the watch tower who can see the subjects working, but they should not be able to see him(Girlando, 2017).

Proposing a theory while away was very challenging for Jeremy Bentham as the British people criticised his theory, saying it was barbaric and could not fit into the common British law

and society. He was able to return from the East in 1791 to England and wrote two letters to the British people calling on them to entrust him with the contract to build prisons and reform them so that the inmates get corrected before they leave the prison (Girlando, 2017).

This research aims to identify challenges in the integrated disease surveillance programme in Sierra Leone so that the country is at the highest peak of public health emergency preparedness. The study, therefore, used the WHO strategic framework for public health emergency preparedness. This framework comprises eleven elements, the first of which is the most important and usually supports the ten other elements, which is why it is said to be a cross-cutting element. The rest of the other ten are interlinked with each other. The governance and leadership element establishes the entire public health emergency preparedness. The governance of an emergency response is not the same as leadership, although these are both related and are the bedrock of the public health emergency response. Leadership in public health emergencies involves the roles and responsibilities of public health departments and their partners in collaboration with the government. The government coordinates emergency management, which needs to be done well. If there are challenges in the emergency response coordination, this may lead to inconsistency and incoordination of emergency actions and responses. The terms of reference of public health actors as leaders of emergency at times can be challenging, mainly when a non-health emergency occurs.

Everyone is willing for public health actors to take the lead during infectious disease emergencies. In the case of disasters occurring in the communities, there is a challenge as to who takes the lead, and it can cause a delay in the initial response of the emergency, causing deaths(Khan et al., 2018).

Emergency planning is a continuous process that needs to be reviewed constantly. Planning at all emergency response levels is important to give rapid response team members and their

associates specific roles and responsibilities. The organisational structure of the response can also be planned, and staff will be educated on reporting structures. Planning for emergency response should not be viewed as a paper or book prepared to sit on the shelves. It should be implemented and reviewed in real-time, as well as the challenges met during the implementation. This is why when developing the plan, the stakeholders should bring along the communities that will use it and the partners that will take activities from the plans for their implementation. A plan ready for public health emergencies must be flexible and adapt to changes quickly, so it must be updated in real time (Khan et al., 2018).

The third element is building collaboration with partners, ensuring a strong, trustworthy relationship with technical experts. Collaborative networks at all levels can be used to support readiness, response, and recovery. A public health emergency system must be resilient, and working together and knowing the roles and responsibilities of each other's strengths and weaknesses will make the system resilient (Khan et al., 2018).

The fourth element of public health emergency preparedness is community engagement. Community involvement in preparedness will allow the readiness for community risk, cultural challenges and community experiences. Engaging the community will promote inclusiveness and understanding of the community risk, as well as the expertise and other assets and values present in the communities that can be used to make the health system resilient to epidemics. Public health resilience can only happen in a community where the community is involved in the preparation of the system, so resilience is built on the past experiences of the communities. Building truth between public health agencies and the communities will be fundamental. Transparency and integrity can continue to build that truth between public health emergency leaders and their

communities so that risk communication messages and other public health interventions can be trusted in the community (Khan et al., 2018).

Excellence in analysing community risks and hazards is the fifth element of public health emergency preparedness. Community risk before a disaster is important to analyse so that the social risk factors like poverty, disabilities, and mental health in persons can be known so that when the disaster happens, and the person starts to present with these factors, it will be associated with the disaster. Risk analysis should be conducted in real-time as it keeps changing with person, place and time. Risk analysis requires a strong partnership between the public health agencies and the community. Knowing that the community should be involved in the risk analysis is essential to know the issues and how important it is to address them during a public emergency. Risk analysis of the community will allow the public health agency to understand the environmental and contextual influences in the community so that the public health agency can better prepare itself to solve them before and after a public emergency (Khan et al., 2018).

The sixth element of public health emergency preparedness is surveillance and monitoring. Intense surveillance and monitoring can lead to effective early detection and warning systems for public health emergencies. Since the start of the integrated disease surveillance and response, the system has been strengthened with laboratory diagnostic capacity and surveillance intelligence. The surveillance element works with all the other elements to effectively manage emergency preparedness. Early information about public health emergencies needs to be sent to other people so that they can take quick action to prevent developmental, financial and trade losses to countries(Khan et al., 2018).

The practical experience of public health emergency responders is the seventh element of public health emergency preparedness. The responders' experience can be achieved by facing

public health emergencies or through simulation exercises. It will allow the worker to use the training skills given to them to correct their weakness and change their approach to essential workflow processes. These staff should always practise so that they do not lose their skills. They should do simulations and after-action reviews to correct the identified challenges. Analysing these challenges can tell if the surveillance system is ready and resilient to epidemics(Khan et al., 2018).

The eighth element of public health emergency preparedness is available and dedicated resources. Resources are divided into two main types. The first ones are the structural, financial and physical resources. The second set of resources is the human and workforce resources. All of these resources are needed for the public health emergency preparedness. Financial resources usually support the other resources, especially the physical and structural resources. Financial resources also support human and workforce assets, but other elements are required for them to work. Organisation and availability of human resources are also required to support human resources. The organisation must be committed to the support of public health emergency preparedness. The working staff must create time off their busy schedules to support public health emergency preparedness (Khan et al., 2018).

The ninth element of public health preparedness is workforce capacity and skills. A health system that is effectively prepared for emergencies must have a highly trained and specialised workforce. Most staff need to be trained so that the attrition of the workforce will not affect the operations of the services. The new staff should be able to start work immediately because they should have been taught in school before they leave for service. The public health system needs to be resilient (Khan et al., 2018).

The tenth element of public health emergency preparedness is strategic communication, a critical tool for informing the public about necessary actions to prevent infection transmission and

counter misinformation. Strategic communication ensures that the public is promptly updated about situation changes, how they might impact them, and the appropriate responses. Public health emergency staff are responsible for delivering these messages and must clearly understand the content before addressing the public. While communication is vital to public health emergency preparedness, it must remain adaptable, with mechanisms in place to effectively receive and respond to feedback (Khan et al., 2018).

The eleventh element for resilience and public health emergency preparedness in the health sector is having staff learn to improve their skills and continuously evaluate the programme's implementation. When there is a public health emergency, the staff working will learn from their mistakes or from a person who has made a mistake and learnt from it. The staff will take this education into future epidemics so that the same mistakes cannot be repeated. It is why strategies like after-action and post-incidence reviews are done so that these learning processes can be documented and presented to future epidemic workers. It will tell what was done correctly, what was done wrongly, what the implications for the wrong things were, and how corrective measures were taken to reduce the impact of these deeds. It would help in the implementation of responses to future epidemics. Looking at the things learnt over a long period is the evaluation process, which is important for future public health emergency preparedness and resilience.

Why are we using The Panopticon Framework to evaluate Sierra Leone's Integrated Diseases Surveillance and Response?

The Panopticon theory, conceptualised by philosopher Jeremy Bentham and later expanded upon by Michel Foucault in *Discipline and Punish*, is centred on the idea of surveillance, control, and self-regulation within systems of power (Clemens, 2017; Jalloh et al., 2020). Its principles can be linked to emergency public health preparedness in several ways:

Surveillance and Monitoring

Public Health Context: In emergency preparedness, surveillance systems are central in monitoring diseases, identifying outbreaks, and responding promptly. The Panopticon's concept of constant observation mirrors modern surveillance tools, such as Integrated Disease Surveillance and Response (IDSR) systems, electronic health records, and other real-time monitoring technologies(World Health Organization, 2001).

Self-Regulation: As in the Panopticon, where individuals self-regulate behaviour due to perceived surveillance, communities may adopt preventive health behaviours when they know they are being monitored. It would push the stakeholders to put more effort into implementing the IDSR activities so that their communities would do better (e.g., adherence to quarantine measures and vaccination tracking) (Clemens, 2017).

Data-Driven Decision Making

Emergency public health relies heavily on data collection and analysis to predict and mitigate threats. The Panopticon emphasises a centralised view where all data is gathered, interpreted, and used to influence action, reflecting how public health agencies aggregate surveillance data for strategic communication and interventions(Galič et al., 2017; Timan et al., 2017).

Behavioural Influence

Foucault's interpretation of the Panopticon highlights how surveillance is about observing and influencing behaviour. Public health campaigns use strategic communication to encourage behaviours like social distancing, handwashing, or vaccination during emergencies. It aligns with the Panopticon's mechanism of inducing conformity through perceived oversight(Clemens, 2017).

Accountability and Preparedness

Emergency preparedness systems often involve clear roles, responsibilities, and accountability frameworks. The Panopticon's model of visible authority ensures that individuals and organisations are aware of being held accountable for their actions, fostering discipline and readiness in public health responses (Clemens, 2017).

Ethical Considerations and Resistance

The Panopticon also raises concerns about power dynamics and potential overreach. In public health, extensive surveillance (e.g., contact tracing or digital monitoring) must balance effectiveness with privacy and ethical considerations. Resistance to perceived over-surveillance (e.g., scepticism about government-mandated health measures) can challenge public health efforts, reflecting a key tension within the Panopticon framework (Galič et al., 2017; Timan et al., 2017).

The Panopticon theory provides a valuable lens for understanding the dynamics of observation, control, and behavioural influence in emergency public health preparedness. It highlights the critical role of surveillance systems, communication strategies, and ethical governance in fostering effective responses to public health emergencies while emphasising the need to balance authority with public trust and autonomy.

Challenges that are encountered using the Panopticon Framework in the evaluation of the Integrated Disease Surveillance and Response

Bentham's theory of panopticonism was praised for reforming many sectors of sociology. Starting with the inspection house design by Bentham, this theory has been used as an application in people's lives, for example, in law, education, health, and politics. However, critics like Foucault said that panopticonism infringes on the rights of people and makes disciplinary measures as a means of control. Foucault said the power should be guided by politicians who have seen and

verified what they can do. He said that Bentham's theory of inspection house brought about punishment as a tool to control the inmates in prison settings. It led to the prison masters using torture as a tool to reform the inmates. Torture was interpreted as absolute control of power with intimidation by societal leaders in all facets of life, such as governments, schools, colleges, and industries. Some governments use surveillance of their opposition with modern technologies, followed by arrest and detention if anything comes from the opposition that does not favour them. Schools and colleges use surveillance to monitor students, and punishment is given to those who do poorly. Sometimes, rewards are given to those who follow institutional policies.

The theory of panopticism has been criticised for its lack of privacy for the inmates in inspection houses or prisons. The same thing is seen for recent panopticonism, which is seen with surveillance in schools, colleges, industries, and offices. During the recent epidemics seen with Ebola and COVID-19, methods of surveillance used with recent technologies using big data have also been criticised because of the lack of privacy for the general population's data and the means used to punish people. The Panopticon framework primarily focuses on monitoring and control mechanisms, potentially overshadowing collaborative and participatory approaches needed for effective IDSR implementation. Public health systems require trust and cooperation among stakeholders, but excessive reliance on surveillance can lead to resistance or distrust among healthcare workers and communities(Aniwada & Obionu, 2016).

The Panopticon theory of surveillance raised the challenge of privacy and data security in the eyes of the public when it is fully implemented. As mentioned earlier in this dissertation, during the COVID-19 pandemic, several calls for breach of privacy and data security were made in several countries like Israel, Taiwan and China. People were tracked using geospatial data for mobile phones; some were fenced using software triangulation systems of their mobile phones. In

China, CCTV cameras were used to surveillance people under 14 days of quarantine so that they do not mix with the unquarantined people(Couch et al., 2020; Shang-Su, 2021; Wu et al., 2020; Yadlin & Marciano, 2022).

The Panopticon theory supports a hierarchical power structure, where the watch tower master can discipline or reward the people being watched. It endorses a top-to-bottom approach to IDSR evaluation. This method marginalises frontline workers like the facility and community staff, who are doing so much to ensure the success of the IDSR programme.

The Panopticon Theory is a structured system where the watch tower stands above the centre to observe the frontline workers. However, public health systems must be dynamic in response to public health emergencies. The Panopticon theory needs to be adaptive, with quick decision-making and can be equally distributed in response to public health emergencies. It is what the Panopticon framework cannot provide (Couch et al., 2020a). The Panopticon Theory was built on content monitoring and visibility of the implementation. When this approach is used in the public health sector, health workers become tired and burnt out due to the heavy workload and the demands of pleasing their supervisors. This may lead to psychological and behavioural issues among the health staff, leading to ineffectiveness in implementing IDSRs(Kaplan, 2006).

The Panopticon Theory, which focuses on observation and measurable outcomes, favours quantitative rather than qualitative research methods. This could result in overlooking contextual factors that influence the implementation and effectiveness of IDSR systems(Richards et al., 2020).

The world continues to experience emergency and re-emergence of infectious disease epidemics, and the most effective means of combating them has been implementing IDSR programmes. An effective IDSR programme can detect public health emergencies early by using

indicators called early warning signs and preparing the country to respond effectively to these public health emergencies before they spread far and wide.

The early warning indicators are there to give countries a chance to prepare themselves to prevent or stop the beginning of an infectious disease epidemic. Countries need to know what to do and have the capacity to prevent the next epidemic. It could be a challenge in some countries, resulting in an infectious disease epidemic even though they have enough time and knowledge to prevent themselves from starting it. The implementation of integrated disease surveillance and response has been ongoing for several. Countries like Malawi, Uganda and Tanzania, but due to several challenges that these countries' implementations face, still experience public health emergencies that have led to international concerns (Joseph Wu et al., 2018; Masiira et al., 2019).

Studies that have used this Theoretical Framework

The panopticon theory supports the background of surveillance; for this reason, any study that wants to evaluate the implementation of surveillance uses the panopticon theory as its background theory. Several studies have used panopticonism as their theory. These are some of the recent studies that have used the panopticons theory:

In Uganda, panopticonism was used to evaluate a surveillance programme that worked in the camps set up for people displaced by the civil wars that occurred in the Great Lakes region. The surveillance programme was set up to detect and respond to any diseases in real-time. The evaluation uses the core, support, quality and structural indicators of integrated disease surveillance and response framework through the WHO and the CDC questionnaire tools. The research also did key informant interviews and focused group discussions to discuss the challenges and get answers. The questionnaire was used in 53 health facilities, and 224 village health teams and 12 key personnel were interviewed. The villages covered were 112. The result shows that the

integrated disease surveillance and response programme in the refugee camps works, but many attribute challenges exist(Ario et al., 2022).

A study on the core and support functions of surveillance regarding neglected tropical diseases was done in Kenya in 2021. The theory of panopticonism was used in the surveillance and response to neglected tropical diseases in Kenya. The implementation was evaluated using core, support, quality, and structural function. A mixed method research was done using semi-structured questionnaires by the adopted World Health Organisation generic interviewing 192 health facilities. The result showed that many indicators were underperforming and require urgent improvement to prevent the next epidemic(Ng'etich, Voyi, & Mutero, 2021).

Sierra Leone has experienced several infectious disease epidemics, and they continue to happen in the country. A study was done in 2019 by Njuguna et al. on how the integrated disease surveillance and response has changed since the 2014 Ebola epidemic in the Mano River Union. The study designed used panopticonism as its backbone theory for this research. The results showed that since the 2014 Ebola epidemic, the integrated disease surveillance and response programme has improved tremendously. With proper planning, supervision and resources, an effective integrated disease surveillance and response programme can be developed in Sierra Leone(Njuguna et al., 2019a).

What is the connection between the panopticonism Theoretical framework and the study design?

Panopticonism theory is one in which the person believes he is constantly watched for good behaviours. Similarly, the IHR framework watches the IDSR implementations in countries for exemplary implementations, and rewards or corrections may follow. For exemplary

implementations to be assessed, the IDSR framework must be assessed by indicators with targets set to meet. This study is assessing the implementation of the IDSR programme in Sierra Leone.

It needs to know if Sierra Leone's IDSR programme is meeting the targets set by the IDSR programme, which are monitored by the IHR framework. This research, therefore, uses the IDSR frame indicators to set up its research questions. From these research questions, theoretical Hypotheses were created and used. The methodology also uses this theoretical Hypothesis to develop the methods for selecting a sample of health facilities to visit and persons to fill out the questionnaires adopted from the generic WHO communicable disease programme evaluation. The analysis plan was based on the theoretical framework for IDSR, and the results, discussions, conclusions, and recommendations were also based on this IDSR framework.

The first study objective and Hypothesis were formed from the core functions of the IDSR framework. These core function indicators provide the basics of the information from surveillance and laboratory data that can be used for decision-making in public health. The nine core functions start with the identification of the public health emergency. The detection of other cases of public health emergencies should come with its identification. The laboratories are used to confirm public health emergencies, especially infectious ones. These confirmed public health emergencies are registered in a system and reported to the next level. The data that was collected will be sent to the next level for analysis and management by the stakeholders of the public health emergency department. This will allow the public health stakeholders to determine whether a threshold for an outbreak has been achieved. This feedback is sent to the lower cadre staff and the rest of the world so appropriate responses can be prepared and taken(Saleh et al., 2021; Wolfe et al., 2021).

The support functions help the integrated disease surveillance and response core functions. Coordinating the IDSR programme is a key system support that should be effective if we want to

prevent the next epidemic. The next is staff capacity for the IDSR programme workers. They need to be trained in emergency response and surveillance. The laboratory staff needs to be trained to support the IDSR programme in identifying infectious diseases. The process of surveillance needs standards that all who implement it must use. These are the standards and guidelines which the World Health Organization produces for countries implementing IDSR. Supervision is a function that checks the quality of IDSR programme implementation (Saleh et al., 2021; Wolfe et al., 2021b).

The third objective and Hypothesis were the quality indicators for the surveillance programme. These cross-cutting issues affect all the surveillance indicators (Erundu, 2016; Saleh et al., 2021; Wolfe et al., 2021b).

The fourth objective and Hypothesis were about the structures that were set up for the integrated disease surveillance and response programme.

Several studies have been done on the IDSR framework in the past, and they used the indicators as their objectives and Hypotheses to find challenges and resolve means of solving these problems at the national and subnational levels.

Field/Industry Description

The field of this study was in Sierra Leone, a country on the West Coast of Africa. Sierra Leone is bounded by the Republic of Liberia in the southeast, the northwest by the Republic of Guinea, and the West by the Atlantic Ocean. The land surface area for Sierra Leone is 72,180 KM², starting from latitude 7° North and going to 10° North, with longitude 10° West and spreading to 14° West. The country inhabits about 8,400,851 people as of the 28TH of December 2022(Sierra Leone 2015 Population and Housing Census National Analytical Report, 2018). This population is estimated to be 0.1% of the global population. The population density is 111 per

KM2. 43.3% of the population lives in urban areas, leaving rural areas with less development and more people. Sierra Leone has a huge potential of having a young population with an average age of 19.4 years. In 2015, a national census was conducted to determine the size of Sierra Leone's population. After that census, the borders of the regions, districts and chiefdoms were delineated. It divided Sierra Leone's regions into five (5) regions with sixteen (16) districts and one hundred and Ninety chiefdoms(*Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search, 2022*).

Sierra Leone's health system is decentralised from the top to the sub-national levels. The national level is the government's agenda and hosts the political, technical and administrative leads of the government's agenda for health. The Minister is the head of the political section of the Ministry of Health and Sanitation, supported by the deputy minister of health. Some governments can have two deputy ministers, while some do one. The technical section is led by the Chief Medical Officer and supported by the deputy chief medical officer of clinical and public health. The nursing sector is led by the chief nursing and midwifery officer, who is also a deputy to the chief medical officer. The chief nursing and midwifery officer reports to the chief medical officer. The Ministry of Health and Sanitation has sixteen (16) directorates under the supervision of the deputies of the chief medical officers. The deputy chief public health medical officer supervises eight (8) directorates. They are as follows: The Food and Nutrition, directorate of Planning Policies and Information, Directorate of Health Security and Emergencies, directorate of Primary Health Care, directorate of Reproductive and Child Health Care Disease Prevention and Control, Environmental Health and Sanitation and Non-communicable Disease and Mental Health Service.

The deputy chief medical officer clinical supervises the directorate of training and research, national emergency medical services, and hospital and laboratory. The chief nursing and

midwifery officer supervises the directorate of nursing and midwifery. The administrative section is led by the senior permanent secretary and deputised by the deputy permanent secretaries. He supervised support services, internal audits, and human resources for health and financial services. The national level also supervises the six (6) tertiary hospitals under the deputy chief medical officer clinical (Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search, 2022).

The subnational level is divided into three levels: the regions, districts, and chiefdoms in the provincial areas and wards in the Western area. There is no administration at the regional level, but there is one at the district level.

The district health management team (DHMT) administers the district level. The DHMT is composed of the following positions:

The district medical officer leads the district health sector response in consultation with the chairman of the health committee in the district council. The district council is a decentralised structure of the political sector of the seating government. The district medical officer serves as the implementer for all health activities. The medical superintendent stationed at the district hospital assists the district medical officer. The hospital's district health sisters and matrons also help support district health implementation. The districts have other staff members who support implementing health programmes like integrated disease surveillance and response. The monitoring and evaluation officers are an important staff member. They are responsible for the management of data in the districts. Environmental and health education officers are also important. The district pharmacist and store officers manage the district medical stores and are there to support the pharmacist. The hospital secretary supports the district hospital with administration and reports to the permanent secretary of the Ministry of Health and Sanitation. The

water and Sanitation programme is a decentralised programme with coordinators in the districts; similarly, the community health programme is decentralised with a focal point. The administrative offices, like the finance and operations offices, are represented. The other decentralised offices are the social mobilisation office, births and deaths office surveillance office and MCH aide's office(*Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search*, 2022).

Secondary hospitals exist in the provincial region and western areas. These are supervised by the district councils(*Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search*, 2022).

In the chiefdoms of the districts, there are health units called peripheral health centres. They can be one of the following:

A maternal and child health post (MCH post). These are the lowest health units in the entire health system of Sierra Leone that link the community to the health systems. They usually serve 500 to 5000 people within a radius of 5 KM. They provide surveillance of basic public health emergencies, antenatal clinics, safe delivery of children in the maternity ward without complications, post-natal services, child health and immunisation, nutrition and IMNCI, national health campaigns like national immunisation, and distribution of malaria bed nets. MCH posts do not usually have a laboratory or pharmacy; the nurses prescribe tests or drug prescriptions so that the patient can buy from other facilities. Free health drugs are dispensed by MCH AIDES in MCH post(*Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search*, 2022).

The Community Health post is the next level of health facility in chiefdom. It covers an 8 km area and usually serves small towns with a population density of 5,000 to 10,000 people. The

person in charge is usually a community health assistant or a state-enrolled community health nurse. The post provides all the services and curative services provided by the MCH post. A midwife also staffs it and can manage complicated deliveries.

Community health centres usually serve 10,000 to 30,000 people in an area of 15 km. Community health officers staff them and provide all the services in community health posts, including preventive and curative functions. They provide complex services within the primary health care systems and all the services provided by CHP and MCHP(*Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search*, 2022).

There are four primary objectives for IDSR strategy:

The first is to respond to priority diseases, events and conditions by ensuring that WHO member states can provide early detection, complete recording, timely reporting, excellent analysis and feedback within and outside the country(Buback et al., 2025; *Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019).

The second is strengthening national laboratories to confirm suspected priority diseases, events and conditions(Buback et al., 2025; *Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019).

The third is to strengthen health emergency epidemic preparedness in WHO member states(Buback et al., 2025; *Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019).

The last is to monitor and evaluate IDSR implementation at the national and sub-national levels(Buback et al., 2025; *Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019).

In developed countries, where health and social systems are better, these countries better manage the effects of these health emergencies. However, we have seen in the recent past that even in these highly developed countries with all their good structure, if the political will is absent, epidemics can strive to address these weaknesses. In developing countries, the case is different because of the poor health systems, lack of technologies and the inability of the governments to prevent or respond to these epidemics. This was seen during the 2014 Ebola epidemic in West Africa. Where due to the poor health systems, Ebola-infected and killed more people in Africa than in the United States of America (Erondy, 2016).

Successes in public health surveillance have benefited the Sub-Saharan African region by teaching us how to combat and respond to epidemic-prone diseases. For example, the fight to eliminate smallpox viral infection, poliomyelitis, dracunculus medinensis, measles viral infection, and leprosy. Public health surveillance for both clinical and laboratory and implementing routine and supplementary vaccination have helped us reduce the effects of infectious disease emergencies (Erondy, 2016).

In 1998, the world decided to launch the Global Polio Eradication Programme Initiative (GPEI). It has led to the eradication of polio in most parts of the world, confining it to Afghanistan and Pakistan. 2018 only 22 polio cases were identified in these two countries(*GPEI-Polio Endgame Strategy*, 2019; *Polio Eradication Strategy 2022–2026*, 2021). In 2011, forty-six (46) World Health Organisation countries pledged to eliminate measles viral infection using the following strategies. Greater than or equal to 95% of the targeted population are immunised with measles-related vaccines and supplements, and less than one (1) per cent of incident cases of measles are reported per million population(Jean Baptiste et al., 2021).

The incidence of measles viral disease was reduced by 60% from 2013 to 2016 in most African countries due to the elimination strategy that has been implemented. The mortality of children due to measles has decreased by 88% because of surveillance and vaccination (Jean Baptiste et al., 2021). More success stories of surveillance and immunisation in the Sub-Saharan African countries show the importance of surveillance and why it is important to strengthen it. The surveillance of the serotype of organisms causing meningitis is active so that appropriate vaccines can be developed for the population (Erondy, 2016).

Despite all these developments in communicable disease surveillance, Sub-Saharan African countries still have significant challenges in combating new and re-emerging health emergencies like communicable diseases causing repeated epidemics (Erondy, 2016; Fenollar & Mediannikov, 2018). The challenges are as follows; limited commitment by low-income countries and their governments to provide adequate domestic resources to integrated disease surveillance and response (IDSR); Inadequate training of healthcare care personnel and the high attrition rates of those healthcare care personnel that have been trained on IDSR resulting in break in continuation of implementation of this strategy when those new ones that are trained are re-deployed; late and limited sharing of surveillance data and information between and within countries leading to late response; limited resources can lead to inadequate supervision and mentoring of the field staffs; weak laboratory capacities and limited networking of the available laboratories; limited and inadequate transfer of information to the peripheral health units(Fall et al., 2019).

Using the International Health Regulation (IHR), which was revised in 2005, countries must learn to work together to prevent, control, and respond to health emergencies and events, including infectious diseases. Countries must achieve public health emergency epidemic

preparedness to respond early to public health priority diseases, conditions, and events(Agbo et al., 2019; Simen-Kapeu et al., 2021).

To build public health emergency epidemic preparedness, countries must employ high-level advocacy so that their governments and multilateral and bilateral donor partners can support IDSR. The IDSR programme needs to be acceptable to the country by making it flexible and suitable to the local context of the country (Agbo et al., 2019; Fall et al., 2019; Simen-Kapeu et al., 2021). It needs to have good leadership and accountability so that it can show value for money. Monitoring and evaluating key performance indicators of IDSR to show the progress of the process will provide accountability. Training health workers on IDSR will ensure that highly competent staff are maintained at the health facilities. Institutionalising the training curriculum with health service training institutions will solve the problem of workforce capacity. Scaling up Event Based and Case-Based surveillance will increase the sensitivity of the surveillance process in the communities. The IHR guideline stipulates that countries must ensure that epidemiological and laboratory information feedback is shared within and outside the country. IDSR must be integrated into the national information systems like District Health Information Systems – 2 (DHIS-2) used by most Sub-Saharan African countries (Fall et al., 2019; Simen-Kapeu et al., 2021).

How does IDSR use Indicator-based surveillance and Event-Based surveillance in its framework?

Event-based surveillance (EBS) and indicator-based surveillance (IBS) are used in IDSR to detect outbreaks in communities, and the information flow system is used to inform the national level. They are used as early warning systems and intelligence-driven approaches to detect epidemics(Clara et al., 2018). EBS is used to detect and report small outbreaks early in the communities. Community health workers or volunteers report these outbreaks to the nearest health

facilities. This system can report outbreaks in remote areas with limited or no health facilities (Clara et al., 2018).

On the other hand, IBS data needs to be analysed by senior health system staff so that trends in infections, conditions, or events can be interpreted over time and epidemic threshold signals can be used to indicate the start of an outbreak. This usually occurs when diseases are endemic and a seasonal outbreak starts, like a seasonal influenza viral outbreak(Clara et al., 2018). The information flow for both EBS and IBS uses the same system. The information starts from the communities and flows to the health facilities, later to the districts, regions, and the nation, and then to partners and the rest of the international community (Clara et al., 2018).

Core Functions Used in Integrated Disease Surveillance and Response

The implementation of IDSR involves core functions performed at all levels. These core functions are divided into eight steps as follows:

The first step involves identifying and registering cases, conditions and events. Health workers in health facilities and community health workers in the communities will identify cases using the standard case definitions. Usually, the standard case definition for health workers in health facilities is more advanced than the standard case definition for community health workers in the community. The case definitions bring up alert and response thresholds for action. Whether these alerts prove cases or not, they are registered in a line listing book(Saleh et al., 2021; Wolfe et al., 2021).

The second step is for the case, Event, or condition to be reported to the next health system level. In the case of epidemic-prone priority infectious diseases, the worker must determine if the case is targeted for eradication or elimination or has reached the public health emergency of global interest. Events and conditions need to be assessed to know if they have reached the level of public

health emergency that can cause a global epidemic. A decision instrument form provided by the International Health Regulation (IHR) must be used to report the Event condition to the international community by the IHR focal point(Saleh et al., 2021; Wolfe et al., 2021b).

The third step is to analyse the data, considering the person involved in the case, Event, or condition, the time it happened, and the geographic location of the case, Event, or condition. The data is then interpreted, and trend analysis is done to compare the data from now and those recorded in previous periods. The data should be interpreted for decision-making at all levels(Saleh et al., 2021; Wolfe et al., 2021b).

The fourth step is to investigate the suspected case, Event or condition using an investigation form. It will involve epidemiological data collection and the possibility of laboratory tests to confirm the case, Event or condition. This process of laboratory confirmation is enhanced by the collaboration with networks of partners that focus on strengthening the laboratory. This process can explain the origin of the cases, events or conditions. This data can now be used to formulate prevention and control strategies for the cases, events or conditions. The local context of the outbreak of cases, events or conditions should be used to modify risk communications and community response. These local contexts should involve the social, behavioural and gender factors (Saleh et al., 2021; Wolfe et al., 2021b).

The fifth step is response preparedness to the cases, events or conditions. Preparedness involves implementing a public health emergency preparedness plan for epidemics of international concern. It could involve stocking commodities like vaccines, drugs, infection prevention materials, laboratory reagents and medical supplies. Isolation, community care, and treatment centres can be built at this stage. The assessment of laboratories to ascertain their readiness to

confirm cases of diseases, events or conditions that may lead to public health emergencies with global interest will be done(Saleh et al., 2021; Wolfe et al., 2021).

Domestic and foreign resources should be mobilised during this period, and training on surveillance, treatment and care, laboratory, IPC measures, and psychosocial counselling can also be done. A coordination team is set up to manage the response to the epidemic before it starts. A memorandum of understanding was signed between United Nations agencies, the government and partners, especially non-government organisations that may want to be part of the network to manage logistics for the epidemic. Vulnerabilities in the epidemic are identified using existing data from other sources. Like the metrological data, risks are determined, and plans are implemented to mitigate these risks. Mathematic models can estimate the risk using pre-existing data(Saleh et al., 2021; Wolfe et al., 2021).

The sixth step is to respond to the outbreak, Event or condition. During the start of an outbreak or Event or condition of public health emergency with global interest, the investigation is done to identify gaps and vulnerabilities. Resources are mobilised, and a coordination team is set up to manage the situation. The public health emergency operation centre should be set up. A government official with authority and the ability to make things move within the country should take full responsibility for the response. These structures should be repeated at the sub-national levels, with government officials and authorities placed in the driving seat to move things quickly without any obstacles. Within this structure, there should be a spokesman from the government at the national level who can move things forward(Saleh et al., 2021; Wolfe et al., 2021).

A risk communication plan should be set up, and a risk communication lead should be appointed to coordinate all communication partners. For the response to be successful, political,

religious, and community leaders must be fully on board, especially at the community level(Wolfe et al., 2021).

The seventh step is risk communication. It is an important process in response to epidemic preparedness, events, and conditions that cause public health emergencies. It involves exchanging information between technical experts, community leaders, the coordination team members and the people at risk of the epidemic, disaster or condition. This platform is used to communicate with the communities about the outcome of the case investigation and the events and conditions. It is also used to explain the response to the epidemic and the response to the epidemic(*Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019).

The eighth step is the last and involves monitoring, evaluating and supervising the epidemic and response. It also involves sending feedback to all levels to improve the timeliness and completeness of reporting. It will improve the quality of information in the IDSR programme. The feedback will give health workers confidence and faith in the IDSR programme, giving them a reason to continue reporting. The IDSR programme should be evaluated with partners and NGOs to give it credibility. The evaluations are as follows: Action Reviews, Joint External Evaluation, Simulation exercises and Operational Reviews(Wolfe et al., 2021).

These core functions should be performed at the national, regional district, health facilities and community level.

International Health Regulation in 2005 and International Disease Surveillance and Response

International Health Regulation (IHR) is a legally binding regulation to WHO member states in the African region, allowing all states to maintain a minimum core public health surveillance capacity (Wilson & Cartwright, 2020).

IHR was revised in 2005 to move from just monitoring cholera, yellow fever, and plague to public health emergencies of international concern (PHEICs). These PHEICs include communicable and non-communicable diseases, radioactive substance exposure, natural disasters, chemical agents and contaminated food(*Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019). IDSR provides the platform for implementing the IHR (2005) by ensuring minimum public health activities are done in WHO member states in the African region (Couch et al., 2020b). The platform that IDSR provides offers the following activities:

Highly capacitated human resource for IHR

Implement structural processes to perform minimum surveillance activities, such as case identification, investigation, confirmation of case conditions or events, and reporting.

Description of implementation processes on sensitisation, action plan, assessment, monitoring and evaluation.

They also give guidelines for technical people, assessment, training materials and standard operating procedures.

In a nutshell, IDSR provides information about PHEIC at the national level so that that information is sent to the international community for quick response(Wilson & Cartwright, 2020).

One Health and IDSR

One health strategy responds to health emergencies from humans, animals, and the environment by ensuring that all the responsible sectors collaborate, communicate, and coordinate information to solve these health emergencies in humans and animals. The one health approach starts with communities and extends to districts and regional, national, and global communities(Connolly & Organization, 2005).

The frequent occurrence of novel and re-emerging infectious disease epidemics has been associated with humans being closer to animals and the wild forest than before. The rapid globalisation and expansion of the world population have led to clearing the wild forests for humans to build homes and new cities, hunting wild animals for food, and using the forest for economic activities like timber logging. It has reduced the distance between man and wild animals, causing more interaction and crossing over of new organisms that infect man and home animals. That is why monitoring animal organisms that tend to cross over to humans is important. One health approach uses the IHR and the IDSR strategies to strengthen the monitoring of health emergencies using early warning signs and indicator- or event-based surveillance. One health strategy offers a comprehensive framework for implementing the IHR (2005) for PHEICs(Hemingway-Foday et al., 2020).

Cross Border activities can be implemented using IDSR in the context of IHR (2005) The spread of infectious diseases from one country to another can be caused mainly by humans and animals moving from one country to another and crossing the border. This is why it is important to implement IDSR activities at border crossing points to monitor, prevent, and control the spread of infectious diseases(Buback et al., 2025).

Countries should be able to develop and implement a cross-border framework that includes active surveillance, epidemic preparedness, and control of infectious diseases. Working with WHO, countries should develop joint surveillance systems between their borders and share vital information to ensure they can prevent, control, or respond to any infectious disease outbreak between them. The districts close to the borders should be actively surveillance and hold cross-border meetings with the districts from other countries(Buback et al., 2025).

Sierra Leone's Public Health Surveillance Programme

Sierra Leone's public health surveillance before introducing IDSR was mostly disease-specific surveillance programmes. Disease-specific programmes like malaria, HIV, and Nutrition existed; NGOs also had surveillance programmes that collected separate data from the same health facilities. The health sector was fragmented in structure, funding, and engagement in most of Sub-Saharan Africa, including Sierra Leone(*World Health Organization Sierra Leone Annual Report 2017 | WHO | Regional Office for Africa*, 2025). This compelled countries to implement vertical programs driven by the requirements of funding agencies and partners. Vertical surveillance programmes posed many challenges, like duplication of efforts and putting pressure on human and financial resources. Health workers were made to fill out numerous forms for each of the implemented vertical surveillance programmes, and little financial resources were wasted because of duplication of efforts. This can also lead to weak coordination of the vertical surveillance data from the health facilities and communities(Barr et al., 2019). These challenges of collecting, reporting and analysing data from vertical surveillance programmes for decision-making present an opportunity for the MOHS Sierra Leone to change its strategy from disease-specific surveillance programmes to integrated disease surveillance and response(Organization & Fund (UNICEF), 2020).

Integrated Disease Surveillance and Response in Sierra Leone

Integrated disease surveillance and response was born when the World Health Organisation for the African region met in Harare in 1998 and adopted this conceptual framework to support the forty-seven (47) member states improves the early detection and efficient response to communicable diseases, events and other condition in their countries(*Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019). Sierra Leone, as

one of the WHO members states in the African region, joined the bandwagon to implement the IDSR strategy in the country in 2004. After four (4) years, the first national technical guideline on IDSR was developed to support the implementation of IDSR in Sierra Leone after the first guideline was published by WHO and CDC in 2001(Njuguna et al., 2019a). The second IDSR technical guideline was done in 2015 after the WHO revision of the Technical guideline in 2010(Njuguna et al., 2019a), and the Third guideline was done in 2020 after the WHO revision of its guideline in 2019(Njuguna et al., 2019a).

In 2005, during the fifty-eighth (58) World Health Assembly in Geneva, the International Health Regulation (IHR) called WHA 58.3 was adopted. However, it was in 2007 that this regulation came into force, and all member states to abide by its regulations. These regulations force member states to report public health emergencies and international concerns through their IHR focal points in the countries to the information centres provided by WHO(Rourke et al., 2020). The recent recurrence and novel occurrence of infectious diseases can only be stopped by using correct and timely surveillance data and responding to these epidemics' challenges. The response can prevent future infectious diseases, antimicrobial resistance and other conditions(Jayatilleke, 2020).

The aim of IDSR in Sierra Leone is to effectively respond to emergencies caused by diseases, conditions and events using data from the health facilities and communities(Njuguna et al., 2019a).

Sierra Leone has been able to implement IDSR on paper since 2004. The country has since incorporated Event- and Indicator-based surveillance into the IDSR programme. Sierra Leone was one of the first countries in Africa to start electronic IDSR in 2019(Martin, Sloan, Gleason, De Wit, et al., 2020).

In order to be able to prevent or control epidemics due to diseases, conditions and events, the information collected must reach decision-making authorities so that accurate and précised decisions are made on public health challenges.

Structure of IDSR and Information Flow in Sierra Leone

The Ministry of Health and Sanitation in Sierra Leone incorporated IDSR into the national health systems structure for the national district, health facilities and communities. The IDSR program is a combination of Event-based surveillance and Indicator-based surveillance. Event-based surveillance starts in the communities where things that happen in the communities are reported to the health facilities(Njuguna et al., 2019a).

The indicator-based surveillance starts at the health facilities, where aggregated data on the patients who received treatment from the clinics in the health facilities are analysed, and decisions are made based on the data received at the health facilities. This aggregated data is then forwarded to the district health management teams and later to the national level. At the national level, the IHR focal point reports to the country's WHO team, and later, the IHR focal point is at the WHO regional office. The data flow is shown in Figure one(Njuguna et al., 2019a).

In Sierra Leone, the health facility staff records data about the patients who visit the clinic in the routine registers. Priority diseases are reported every Monday by the IDSR focal point in the health facilities to the district IDSR focal point in the district health management team (DHMT). The epidemiological week starts on Monday and ends on Sunday every week. The data from the districts are aggregated and sent through the district health information systems 2 (DHIS-2) to the national level. Sierra Leone is using the electronic IDSR systems that started in 2019. The health facilities had an Android tablet with an application allowing them to enter data directly into the DHIS 2, which the district focal point must verify before it reaches the national-level server. It

allows the IDSR system to remove the challenges of timeliness, completeness and reporting analysis(Sloan et al., 2020).

Priority diseases must be reported immediately to the national level. A case-based notification form is filled out and sent to the next level so that a response plan can be put together to prevent the next epidemic(Njuguna et al., 2019a). The priority disease must sometimes be sent to the WHO team for international response. This report is put together at the Directorate of Health Security and Emergencies and sent to the WHO focal point for IHR (Njuguna et al., 2019a).

Data analysis starts from the communities and health facilities and goes up to the national level, where complex analyses are done. The community should be able to tell the burden of diseases, conditions or events that are common in their area. The health facilities should be able to tell the distribution of diseases disaggregated by sex, age and geographic location affecting their communities. The district should be able to do complex analyses, such as trends of diseases disaggregated by age, sex, and location. Public health decisions at the district level should be made based on data from the IDSR programme. At the national level, complex analyses are expected to show disease trends, conditions, and events in all regions and districts. The districts should be able to prepare a district epidemiological bulletin to send feedback to the health facilities and communities. It can also be done by holding the monthly in-charge meeting every last week or, in some areas, the first week of the month. The national level should be able to prepare weekly epidemiological bulletins and send them as feedback to the districts, health facilities and communities. After preparation, the national bulletin should be discussed with partners in the emergency preparedness resilient and response group meeting so mistakes can be corrected and responses can be mounted (Njuguna et al., 2019a).

Functions of the levels of the health system in responding to the core IDSR functions

The IDSR's core function is to provide information to the IHR so that public health emergencies of international concern can be prevented or controlled (Jayatilleke, 2020). The IHR's core functions require three levels of health systems: national, district, and community.

The communities or the public health response has two primary responsibilities. Using community-based surveillance (CBS) workers, the community can detect diseases, events, and conditions in their local environment at a particular time (Clara et al., 2018).

The detected diseases, events, and conditions should be reported to the appropriate health facilities within their locality no later than 24 hours after the identified disease, Event, or condition. The CBS focal point in the community will send the report to the health facility, and the health facility IDSR focal point will send the report to the district focal point. This report that is sent to the district should contain a clinical description of the emergencies, the laboratory results, the sources of the risk of getting the disease event or condition, the number of cases that have been identified or are dead from this emergency and the factors favouring the spread of the disease event or condition and how it can be mitigated (Guerra et al., 2019; Njuguna et al., 2019a).

The district level is there to do the following responsibilities:

They confirm the emergency disease event or condition and devise better methods of preventing and controlling the emergency (Guerra et al., 2019).

Districts usually take 24 to 48 hours to confirm the emergency and send the report to the national level (Njuguna et al., 2019a).

The National level is responsible for the notification and assessment of emergencies, and they do the following:

They ensure the assessment and notification of the Event by coordinating with other partners like WHO, the International Food Safety focal point, and CDC (Atlanta, Africa & China) (Clara et al., 2018).

Within 48Hrs all urgent reports must have been assessed and action taken to inform partners(Njuguna et al., 2019a).

The national government will decide whether to notify WHO based on the assessment and classification of the disease, Event, and condition if it is a public health emergency of international concern (PHEIC)(Njuguna et al., 2019a).

The capacity that is required by the Health systems levels to perform the core functions of IDSR National Level:

The national level will establish the coordinating unit at the central level, called the Public Health Emergency Operation Centre (EOC), where the team sits. The same structure is established at the subnational level, called the district, and it is called the district Public Health Emergency Operation Centre (DEOC)(Njuguna et al., 2019a).

The EOC team will determine how to prevent and control the public health emergency from spreading nationally and internationally(Njuguna et al., 2019a).

The coordination team will bring specialists into the team, such as clinical specialists on the potential emergency and laboratory specialists who can diagnose the emergency. They are responsible for mobilising resources like financial, laboratory equipment and reagents, transportation, and so on(Njuguna et al., 2019a).

The co-opted specialists will support local offices in investigating the emergency(Njuguna et al., 2019a).

The EOC team will have direct access to the country's technical and political leadership. This link will help them provide information to the leadership and advocate for resources to be allocated to the response(Njuguna et al., 2019a).

The EOC will implement containment and prevention measures, such as lockdowns and quarantines, to stop the spread of the epidemic(Njuguna et al., 2019a).

The national level will provide a communication link between WHO information systems and public and private hospitals, peripheral health units, border crossings, points of entry, restaurants and bars, the general public, and important areas. The information concerning the containment of the emergency coming from WHO in Sierra Leone will be disseminated to these facilities in a reverse sequence(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019b*).

A national public health emergency response plan should be developed using a one-health approach, with affiliating ministries like the Ministry of Agriculture, Environment, and Health involved in its development(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The roles and responsibilities of the Ministry of Health and Sanitation at the national level The MOHS national level forms the EOC and the DEOC at the subnational level to coordinate health emergencies. The MOHS will develop an incident management unit with an incident manager and his team, as well as a plan and procedures(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019a*).

The MOHS will identify a risk communication manager who is responsible for developing and implementing a risk communication plan and providing a risk communication procedure for media units regarding how they produce news about emergencies before they arrive in Sierra Leone, during their stay in the country, and after the emergency has ended(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019b*).

The MOHS will conduct simulation exercises when preparing for an emergency and conduct after-action reviews after these simulations. The lessons learnt during these procedures will be used to review the procedures and processes in IDSR guidelines and policies to improve the system(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019b*).

The MOHS can hire surge capacity specialists to assist in implementing the emergency response plan(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019b*).

The MOHS can mobilise domestic and international resources to implement the IDSR plan (*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*). MOHS monitors and supervises the IDSR programme(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019a*).

Preparing and disseminating the epidemiological bulletin is important for providing feedback to the district and health facilities(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019a*).

MOHS monitors and evaluates the implementation of intercountry, regional and international protocols(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019a*).

They support the development, entry and analysis of the national database on IDSR(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019a*).

They identify, record and investigate potential epidemics in Sierra Leone(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019a*).

The roles and responsibilities of WHO and other partners, such as CDC Africa, CDC Atlanta, CDC China, e Africa, Medicines San Frontier, and others.

Partners support the government of Sierra Leone's agenda and help develop standard technical and training guidelines for IDSR(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019a*).

They support the government by providing technical assistance and expertise in surveillance, laboratory support, and information systems(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

They support the MOHS in mobilising resources to support surveillance and response activities(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*)

They support technical experts and provide financial assistance to the MOHS for supervision, monitoring, and evaluation(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

They assist in writing grant proposals and other management activities, preparation of activity reports like supervision(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The partners support the development of a training manual, training of health care personnel, and procurement and installation of medical equipment(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019b*).

They can even send surge personnel as expert in the field to support the health worker. They can procure and install portal laboratories and equipment.

WHO can help mobilise other UN agencies to support IDSR activities.

The roles and responsibilities of District political leaders

These leaders are responsible for moving the agenda of the district surveillance activities, making the local communities accept the surveillance interventions, and giving access to health officials(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019b*).

They can be the chiefs, village headmen, town criers, mama queens, and district officers.

Their roles and responsibilities are as follows:

The district leader helps strengthen public emergency declarations, making the local population understand and accept them(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2022*).

Local mobilisation of human, financial, and logistical support is important to prevent the spread of infection. The district political leaders will help in these processes(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019b*). They will propagate the principles of health emergency prevention and control interventions, such as hand washing, personal hygiene, proper latrine use, wearing a face mask, environmental cleanliness, and advocacy for clean drinking water.

They also can report clusters of unexplained illnesses and deaths to the nearest health facility.

District leaders support the implementation of the by-laws to enhance response interventions like limited gathering of people, hand washing and the rest.

They can be health promoters in the communities, ensuring important information on health hygiene, sanitation and education.

They facilitate community planning, implementation, supervision, monitoring, and evaluation of health programmes such as IDSR, malaria programmes, HIV, and so on.

They follow the outbreak procedures and mobilise health and community health workers.

They can support health workers in administrative work at the chiefdom and ward levels.

They support the implementation of legislation to prevent and control epidemics.

They can set up public healthcare community meetings so that health workers are sensitive to the communities' needs for health prevention information.

They can discuss disease trends and how to respond to stop its propagation in the communities with the district health management team (DHMT)

They can ensure various committees are established and resourced.

Respond to disaster by advocating for resources.

Join various campaigns conducted in the districts to support health(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The roles and responsibilities of The District Health Management Teams (DHMT)

The DHMTs are the leaders of health issues in the districts. It is headed by the district medical officer (DMO) assisted by the hospital's medical superintendent (MS). The district health

sisters support the DMO, while the matron in the government hospital supports the MS. The DHMT will be responsible for the following:

The team will work with the district council health team on implementing IDSR plans and activities(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The rest of the DHMT will support the surveillance officer in implementing IDSR activities(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The DHMT will support the inclusion of IDSR activities into the district health plan(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

At the district level, the DHMT will advocate with the district council authorities to provide funds for IDSR.

The DHMT will work with the district council to ensure the timely release of funds for IDSR activities.

They monitor the district's IDSR performance indicators and output data analysis(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

This will allow the DHMT to use the performance indicators in decision-making processes, such as mapping the emergency risk and making action plans.

The DHMT assists in response by forming and operating the public health emergency management committee and public health emergency rapid response teams during an outbreak or epidemic.

The DHMT sends the reports of the investigations in the district of an outbreak to the national level(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The DHMT participates in risk mapping for emergencies and community assessments(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

They design, train, and implement health education in the communities in collaboration with the community leaders.

The DHMT participate in and leads the training of health workers in the district on IDSR. DHMT works nationally to choose and implement responses to district emergencies. They are also responsible for documenting and monitoring response activities.

They prepare and disseminate district epidemiological bulletins and send reports to the national level(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

Surveillance officer's roles and responsibilities in IDSR

They are in charge of investigating outbreaks, preparing outbreak reports, collecting samples for diagnosis, and providing advice on treatment protocols(Nagbe, Yealue, et al., 2019). They prepare weekly surveillance reports and send them to the appropriate authorities(Nagbe, Yealue, et al., 2019).

During their monitoring and supervision, they ensure health facilities maintain their log books and registers for line listing(Nagbe, Yealue, et al., 2019; *National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The surveillance officers should maintain a list of health facilities offering IDSR(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

Health workers and community health workers who are trained to implement IDSR are recorded in a list maintained at the DHMT.

The surveillance officers maintain the supply and review of the IDSR reporting forms to the health facilities.

They monitor health workers' use of standard case definitions for priority diseases and provide mentorship if the need arises.

Take the lead in monitoring the quality performance indicators of IDSR, such as timeliness and completeness of reporting.

They use the data from IDSR to analyse weekly, monthly, quarterly, and yearly trends using line graphs, correlation and regression, pie charts, and seasonal changes in diseases, events, and conditions. They can use this data to make recommendations in the response plan(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019b*).

They provide weekly and monthly epidemiological bulletins as feedback to the health facilities (Nagbe, Yealue, et al., 2019).

The surveillance officers should ensure that health facilities report on time(Nagbe, Yealue, et al., 2019).

Supervised health facilities, border posts, and communities, correcting their mistakes on the registers and reporting forms. They also sign their visitors' books and proffer recommendations they will follow up with on the next visit(Nagbe, Yealue, et al., 2019).

They work with the health facilities to verify the IDSR alerts coming from the communities(Nagbe, Yealue, et al., 2019).

The surveillance officer and the healthcare worker at the facility will investigate the verified cases from the communities(Nagbe, Yealue, et al., 2019).

They can assist the health facility staff in collecting, storing, and transporting suspected samples to the laboratory to confirm the priority diseases(Nagbe, Yealue, et al., 2019) .

The laboratory test results from the test sites are sent to the surveillance officers, who in turn will urgently send the results to the health facilities.

They conduct on-site training for new staff at the health facilities.

They review the quality-of-care performance indicators for IDSR by doing a data quality audit, and they will propose recommendations that can be implemented and monitored by them.

They keep a rumoured book for the health facilities to record their events(Nagbe, Yealue, et al., 2019).

The surveillance officers coordinate cross-border activities, collaborate with other authorities in neighbouring districts and countries on IDSR activities, and notify of any priority diseases.

They can evaluate and conduct research on IDSR performance in the districts.

Roles and responsibilities of health facility staffs

The health workers at the health facilities identify priority diseases, events and conditions using the standard case definitions.

Report these cases, events or conditions to the next level within the stipulated time frame after recording them in the line listing register and case notification forms.

The healthcare worker can collect samples for suspected priority diseases in collaboration with the surveillance officer at the district level.

Manage patients with priority diseases using the treatment protocols prepared at the national level.

Participate in case investigation, diagnosis, treatment and response of priority disease events and conditions(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

They analyse data at health facilities or communities using graphs, frequency distribution tables, and chartsGilbert & Cliffe, 2016; *National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018; Njuguna et al., 2019a*).

The health facilities staff are responsible for communicating laboratory results to the communities and districts(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*) (Ministry of Health and Sanitation Sierra Leone, 2020c).

They are part of the district's rapid response team for outbreaks.

The health facility staff can use the community management teams to advocate for community resources.

Provide community monitoring and supervisory roles(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The roles and responsibilities of community health workers are as follows:

Conducts household visits regularly(Clara et al., 2018).

There are people in the communities who will report any event that the CHWs get a regular audience within a meeting. They should report these events and help the community to mount an

adequate response at their level (Clara et al., 2018; Guerra et al., 2019; Organization & Fund (UNICEF), 2020).

Document priority diseases, events and conditions in the reporting forms and tools for immediate reporting within 24 hours.

The health facilities will take the lead in preparing the CHW's questions while doing the verbal autopsy.

Sends a quick description of the situation to the nearest health facility and other relevant sectors regarding unexpected or unusual cases of disease or death in humans and animals for immediate verification and investigation according to the International Health Regulations and in line with the IDSR strategy (within 24 hours)(Clara et al., 2018; Guerra et al., 2019; Organization & Fund (UNICEF), 2020).

Involves local authorities in describing diseases, events, conditions and trends in the community.

Increases the knowledge of the communities on how to report and find responses for priority diseases, events and conditions which are unusual(Clara et al., 2018; Guerra et al., 2019; Organization & Fund (UNICEF), 2020).

Helping health workers find contacts for priority diseases, events, and condition cases and investigating them(Clara et al., 2018; Guerra et al., 2019).

The chiefs, headmen or women in the communities must be part of the response of IDSR and they need to be organised and supported to make a response in the communities happen(Clara et al., 2018; Guerra et al., 2019; Organization & Fund (UNICEF), 2020).

Identifying the probable dangers in the communities is very important, and they are very good at helping with it. They also help in the simulation exercises conducted by the districts and the training of the community staff(Clara et al., 2018; Guerra et al., 2019).

Help the districts coordinate responses that can stop the epidemic.

Works in the response package of integrated disease surveillance and response, which includes taking care of patients in the communities like home-based care, community waiting for centres for pregnant women, using the social behavioural change module to serve the communities, and distributing commodities in the communities. They also work in social mobilisation and advocacy.

Can also work within the health systems, supporting the sending and reporting of feedback to the communities based on the compiled and verified data on the priority diseases, events, and conditions from the national and district levels.

They can also act as monitoring and evaluation officers in the communities. They are contacted to verify whether the planned health interventions have been implemented and whether the implementation was successful. They take part in community meetings organised by all levels(Clara et al., 2018; Guerra et al., 2019; Organization & Fund (UNICEF), 2020).

Priority Diseases Events and Conditions in Sierra Leone

The government of Sierra Leone, like other countries, has identified priority communicable and non-communicable diseases, events, and conditions to be monitored through the integrated disease surveillance and response system. The government of Sierra Leone, like any other country, has selected priority diseases, events, and conditions that are communicable and non-communicable, and the integrated disease surveillance and response will monitor them. The selection was made based on the following criteria:

Priority diseases were selected based on the requirements of the International Health Regulations, for example, smallpox, poliomyelitis due to wild-type poliovirus, and human influenza caused by a new subtype, SARS(Njuguna et al., 2019b).

Diseases with epidemic potential tend to become pandemics, such as cholera, plague, yellow fever, and viral haemorrhagic fever.

Priority diseases that are significant causes of morbidity and mortality in Africa, like malaria, pneumonia, diarrhoeal diseases, tuberculosis, HIV/AIDS, and maternal deaths and injuries.

Priority non-communicable diseases or conditions in the African region include high blood pressure, diabetes mellitus, mental health issues, and malnutrition.

Table 1:

The priority diseases, conditions and events for integrated surveillance and response in Sierra Leone (National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018)

Epidemic prone diseases, conditions and events which require immediate reporting	Diseases targeted for eradication or Elimination	Other major disease, conditions and events of public health importance
1. Acute haemorrhagic fever syndrome	1. Buruli ulcer	1. Adverse drug reaction
2. Acute jaundice syndrome	2. Dracunculiasis (Guinea Worm)	2. Diabetes mellitus (New)
3. Adverse events following immunization (AEFI)	3. Leprosy	3. Diarrhoea with dehydration less than 5 years age
4. Animal Bites (Dog and snake bites)	4. Lymphatic filariasis	4. Epilepsy
5. Anthrax	5. Measles	5. HIV/AIDS (new cases)
6. Bacterial Meningitis	6. Neonatal tetanus	6. Hypertension (new cases)
7. Chikungunya	7. Poliomyelitis***	7. Injuries (road traffic accidents)
8. Cholera	8. Onchocerciasis	8. Malaria
9. Dengue Fever		9. Non-neonatal tetanus
10. Diarrhoea with blood(Shigella)	Diseases or events of international concern	10. Perinatal deaths
11. Human Rabies	1. Human influenza due to a new subtype***	11. Severe Malnutrition in children under 5 years of age
12. Maternal deaths	2. SARS***	12. Severe pneumonia less than 5 years of age
13. Monkey pox	3. Smallpox***	13. STIs
14. Plague		14. Schistosomiasis
15. SARIs**	Any public health event of international or national concern (infectious, zoonotic, food borne, chemical, radio nuclear, or due to unknown condition.	15 Soil transmitted helminths
16. Typhoid fever		16. Tuberculosis (new cases)
17. Yellow fever		17. MDR/XDR Tuberculosis
18. Zika virus disease		
Also:		
A cluster of deaths in the community (animal or human deaths)	*** Disease specific by IHR (2005) for immediate notification	

A cluster of unwell people or animals with similar symptoms		
*Ebola, Marburg, Rift valley, Lassa, Crimean Congo, West Nile Fever		
** National programmes may wish to add Influenza-like illnesses to their priority disease list.		

The priority diseases, conditions and events for integrated surveillance and response in Sierra Leone

Surveillance Systems Evaluation

The surveillance system is a critical public health intervention for preventing, monitoring, and managing epidemics related to infectious diseases, events, and conditions. The effectiveness of these systems plays a pivotal role in determining how well a country can respond to such outbreaks. Regular and continuous evaluations are essential to maintain efficiency (Groseclose & Buckeridge, 2017; Ibrahim et al., 2020a; Masiira et al., 2019).

Surveillance programmes differ by social, economic, and epidemiological characteristics. It makes them difficult to evaluate, as so many tools are used to capture the programme's performance in evaluation (Nuvey et al., 2019).

The main objectives for doing the evaluation are as follows:

The country needs baseline data that the programme can use to assess progress in integrated disease surveillance and response.

The country needs to assess the need for integrated disease surveillance and response so that adequate efforts can be made to meet the needs.

The country must assess the gaps in the integrated disease surveillance and response programme's core and support functions.

The country needs to use the gaps identified and do a prioritised action plan that will be implemented using a monitoring framework(Nagbe, Yealue, et al., 2019).

The components that are to be assessed by the evaluation of the Integrated Disease Surveillance and Response

Evaluation of an integrated disease surveillance and response programme should focus on the following:

The structure on which the programme is implemented. For example, in Sierra Leone, the programme is implemented using the national health systems, which are divided into three levels: the national, districts, primary health units, and communities(Masiira et al., 2019).

The second is the core functions of integrated disease surveillance and response, which are case identification, notification, registration, confirmation by the laboratory, reporting to the next level, data analysis to support public health decision-making, data management, feedback, and prioritised monitored health emergency preparedness and response at all levels(Ng'etich, Voyi, & Mutero, 2021).

The third is the programme's support functions, which include training health workers and community workers on IDSR, supervision, standards and guidelines, laboratory capacity, resource mobilisation, and coordination. These functions guide the implementation of the core functions of integrated disease surveillance and response(A. Alemu et al., 2019).

The fourth and last one is the quality of the IDSR programme, which looks at the usefulness of the data, simplicity, flexibility, acceptability, representativeness, data accuracy, timeliness,

completeness, consultancy, sensitivity, positive predictive value, and stability (Texila American University. & Hakwika Kooma, 2019).

Assessment of the Integrated Disease Surveillance and Response Parameters

The structure on which the integrated disease surveillance programme is implemented has already been described, but new changes during the data collection time will be described.

The core functions will be assessed by doing the following:

The case identification and registration process will be examined in all the sampled health facilities in Sierra Leone. The register, reporting forms and case investigations for all the reported cases must be verified (Erondy, 2016).

The core functions will be defined as follows:

Case identification and Notification: We will examine the availability of standard case definitions to identify priority diseases, standard registers to record possible cases, reporting forms, and the inspection of the software on the Android phones used by health workers in the facilities. It will highlight the challenges they have been dealing with using the tablets and the software (Martin, Sloan, Gleason, De Wit, et al., 2020).

Case confirmation: The confirmation of priority diseases depends on the capacity of available laboratories in Sierra Leone. The district list of referral laboratories will be examined. A timely mechanism by which referrals are made within district laboratories. The capacity of the district laboratories to confirm priority diseases will be examined. The referral pathway from districts to the higher level will also be investigated. The use of private laboratories, if possible in emergencies, should be examined. The transport of specific samples should be examined. Blood, sputum, urine and cerebrospinal fluid should be reviewed. Health facilities should show they have

the correct sample transport medium and know how to collect and store them(A. Alemu et al., 2019).

Case notification: The various methods by which possible priority disease cases are sent to the next level should be examined. The integrated disease surveillance and response programme in Sierra Leone is now electronic. The transfer of cases should be documented, and records used to document these transfers should be observed at the health facilities, usually called reporting forms. How have the reporting forms been designed and printed, and how do they reach the health facilities(Martin, Sloan, Gleason, De Wit, et al., 2020)?

Data analysis: We will investigate how all levels of the health systems in Sierra Leone analyse their data from IDSR programmes. Do they analyse their data showing person, place and time from the health facilities to the districts and national level? We will conduct a trend analysis of the IDSR data and examine how it has been utilised in decision-making processes. We will investigate the appropriate use of the denominators at all levels. At the health facility levels, we will investigate if they use alert and action thresholds and the recommended actions for each priority disease.

Outbreak detection: The health facilities with a standard case management protocol for epidemic-prone diseases have been used. Most districts and health facilities use the syndromic data and compare it with the presumptive data to detect high clusters of priority diseases so that they can detect outbreaks. It is using indicator-based surveillance. The team should look for rumour registers at the health facilities. Health facilities should maintain a rumour register for all outbreaks reported to the next level(Saleh et al., 2021).

Outbreak/Epidemic preparedness and response: The districts and health facilities should be checked to see if they have rapid response teams (RRT) and how quickly the team can

be assembled to respond to an outbreak. The districts and health facilities should have epidemic management committees. They should have an epidemic response plan with a monitoring and evaluation component. The minutes of the meetings regularly held by the epidemic management committee should be on record (Saleh et al., 2021).

Feedback: The team should investigate whether the health facilities receive feedback on the data they have produced in the last three months. Primary health facilities like community health centres, community health posts, and maternal and child health posts should receive feedback from the district health management team's epidemiological bulletin. Public and private hospitals should receive feedback from their district health management team. The districts should receive feedback from the directorate of health security and emergencies at the national level every week through an epidemiological bulletin (Saleh et al., 2021).

The support functions will be defined as follows:

Standards and Guidelines: The most recent IDSR guidelines for Sierra Leone should be present in all health facilities, both private and public. The team should investigate the presence and use of the IDSR guideline in the health facilities. The supervisory visit to the health facilities should be examined. The district health management teams should conduct several supervisory visits to the health facilities. There should be a fixed number of supervisory visits that the national level should make to the districts per quarter. The challenges and successes of the supervisory visits will be investigated (Saleh et al., 2021).

Training and coordination: The number and percentage of the health workforce trained in surveillance and epidemic management. The person who trained them, the place where they were trained, the duration of the training, and the qualifications given to them. The coordination systems are at the national, district, health facility, and community levels. The existence of a

coordinating body at the national and district level must be investigated. This can be done by looking at the meeting minutes regularly held by this coordinating team (Saleh et al., 2021).

Laboratory capacity: Laboratory confirmation of priority diseases is important. We assess each health facility's laboratory capacity and how they communicate to allow for the transport of samples for further testing. We also assess the laboratory infrastructure, personnel, and equipment for testing (A. Alemu et al., 2019; Vernooij et al., 2020).

The following parameters define the quality of the surveillance programme:

Acceptability of the surveillance programme: The willingness of the surveillance stakeholders to accept the integrated disease surveillance and response. This is measured by their active participation in detecting, notifying, reporting and responding to potential outbreaks in the field. This can be measured by the timeliness and completeness of the reporting to the next level in the past 12 months. The evaluation will check if private health facilities and private laboratories are willing to send their report to the integrated diseases surveillance and response programme so that their priority disease events or conditions can be part of the public health decision-making of the country. For example, the condition called maternal mortality can happen in public and private health facilities. It is extremely important to report the ones that happen in private health facilities and those that happen in public health facilities (A. Alemu et al., 2019; Noreen et al., 2018; Simusika et al., 2020).

Completeness of reporting: This is the number of health facilities that send their IDSR report to the next higher level regardless of the reporting time. It usually shows the health workers' acceptance of integrated disease surveillance and response (A. Alemu et al., 2019).

Timeliness of reporting: This is the number of health facilities that could send their report to the next higher level within the stipulated time agreed upon by the technical guideline of the integrated diseases surveillance and response programme(A. Alemu et al., 2019).

Data quality: The data for the surveillance programme was believed to be of high quality if the reporting was complete and the data validity was also good. The levels at which data is analysed and used for public health decision-making are important(Noreen et al., 2018).

Positive predictive value: This is the number of priority disease cases, events or conditions identified by the surveillance programme using the case definition that turned out to be actual cases of that specific priority disease (Alemu et al., 2019). The positive predictive value has two effects on the surveillance programme; firstly, positive predictive value for outbreak detection affects the use of resources. Suppose every case the surveillance team identified turns out to be true, and an appropriate intervention is given. The positive predictive value and the number of resources used will be high in that case. On the other hand, if the positive predictive value is low because the cases investigated are false positive cases, the resources spent will be missed, wasting limited resources. Secondly, the positive predictive value might be analysed by checking all the cases in an outbreak and investigating them thoroughly(Azofeifa et al., 2018).

Flexibility: This is the ability of the surveillance programme to adapt to changing needs. It involves adding new priority diseases, events and conditions as the need arises in the country. The integrated disease surveillance and response (IDSR) system must allow for a change in the reporting time. For example, all health facilities in Sierra Leone report IDSR every Monday morning before noon. This can be changed to every Friday before 2 P.M. if the stakeholders in IDSR believe it would improve the timeliness and completeness of reporting(A. Alemu et al., 2019; Noreen et al., 2018).

Representativeness: The surveillance system must be able to use epidemiological variables like person, place, and time to describe the occurrence of priority diseases, events, and conditions(A. Alemu et al., 2019; Noreen et al., 2018).

Simplicity: The structure in which the integrated disease surveillance and response are implemented should be easy to use while meeting the programme's stated objectives. Some countries have one case definition for health facilities used by health workers, while the communities where the community health workers are operating work use a simpler case definition. The surveillance systems should be easily integrated with other information systems (A. Alemu et al., 2019; Noreen et al., 2018).

Stability: This will check the surveillance programme's ability to provide reliable data, which means the data system will not fail. The data should also be available when stakeholders need it to make important public health decisions(A. Alemu et al., 2019; Njuguna et al., 2019b, 2022).

Usefulness: This refers to whether stakeholders use the integrated disease surveillance and response information to make important public health decisions. The evaluation will check if this data from surveillance is used to determine the magnitude of the morbidity and mortality of priority disease events and conditions. Does the surveillance programme provide a trend of disease, events or conditions that signal changes in the occurrence of these conditions, events or diseases? We will investigate whether the programme evaluates prevention, treatment, and control. It will investigate if the integrated disease surveillance and response programme supports clinical, social, psychological or behavioural improvement in the health system. Does the system stimulate research into preventing, treating and controlling priority diseases, events and conditions? The number or percentage of districts that use the data from integrated disease surveillance and

response to make decisions on the prevention and management of an outbreak of a priority disease event or condition (A. Alemu et al., 2019; Azofeifa et al., 2018; Njuguna et al., 2019b; Noreen et al., 2018).

Sensitivity of the surveillance programme: This is the ability of the integrated disease surveillance and response programme to detect the actual priority disease events or conditions.

Sensitivity = $\frac{\text{positive cases}}{\text{Expected cases}} \times 100\%$ (Azofeifa et al., 2018; Njuguna et al., 2019b, 2022; Noreen et al., 2018). The probability that the following will happen will affect the sensitivity of the surveillance programme:

Health-related events, policies, and risk factors occur in the same population.

Priority diseases, events and conditions occurring are sent to central systems for decision-making (Azofeifa et al., 2018; Njuguna et al., 2019b, 2022).

Strengthening Community-Based surveillance

Community Base Surveillance is a simple, adaptable, cost-effective public health intervention designed to be owned by the community so that they can detect, report and respond to any public health emergency by protecting themselves (Clara et al., 2018; Guerra et al., 2019; Kuehne et al., 2019; Organization & Fund (UNICEF), 2020).

Implementing integrated disease surveillance and response involves detecting priority diseases, events and conditions, mainly at the outpatient and inpatient services at health facilities. These patients must come to the health facilities for the diseases, events, or conditions to be seen. However, this patient hardly reaches the health facilities, especially in the Sub-Saharan regions. Cases are not identified in the community; the integrated disease surveillance and response will miss them. Community-based surveillance is extremely important, especially in the Sub-Saharan African region, where many communities are located where Health is limited. Even in areas where

people have health facilities because of their traditional beliefs, the community prefer the traditional healer to the health facilities(Byrne & Nichol, 2020; Guerra et al., 2019; Kuehne et al., 2019; Simen-Kapeu et al., 2021).

Many outbreaks begin with a cluster of diseases or deaths in the community. Community members will usually be made aware of these occurrences because they are the ones who are living them. However, they cannot take this information to those supposed to provide resources and response to this outbreak before it becomes an epidemic or pandemic. This is why community-based surveillance is essential in countries where community members can identify outbreaks of priority diseases, events and conditions and mount some response to them(Byrne & Nichol, 2020; Guerra et al., 2019; Organization & Fund (UNICEF), 2020).

Establishing community-based surveillance in a country is key to improving early detection and response to priority disease events and conditions. A community-based Surveillance programme should complement the efforts of integrated disease surveillance and response in the country(Simen-Kapeu et al., 2021). Early detection and response to priority diseases, events, and conditions that can cause public health emergencies can save lives and property or eventually prevent huge economic and social losses(Evans et al., 2015; Kirigia et al., 2015; Umuhoza et al., 2021).

Empirical Studies on the implementation of the IDSR

This sub-theme explores empirical studies that have evaluated the effectiveness and implementation of integrated disease surveillance and response (IDSR) programmes from several countries. The objective is to understand how different health systems have adopted, operationalised and sustained the IDSR programme, especially during recent epidemics.

A search was done using the words "*evaluation of integrated disease surveillance and response*" in Google and Google Scholar. The search was limited from January 2015 to May 2024 and had the following eligibility and exclusion criteria.

Eligibility criteria:

- The timeline of study should be 2015 to the present day, May 2024
- Papers that evaluated national disease surveillance
- Papers with integrated and single disease surveillance systems
- The study should evaluate the IDSR programme
- The study should use the WHO protocol to evaluate communicable disease programmes

Exclusion criteria:

- Abstracts, systematic reviews, and conference papers or grey literature lacking empirical evaluation.

A Google search with the prescribed words provided 17,200 papers. However, none of the papers met the inclusion criteria. A Google Scholar search with the same words provided 10,900,000, but only nine papers met the eligibility criteria. Abstracts and conference papers constitute 10,830 papers, and 61 papers were systematic reviews.

The Integrated Disease Surveillance and Response (IDSR) strategy, developed by the World Health Organization (WHO) for Africa, aims to strengthen national public health surveillance systems by integrating and streamlining data collection, reporting, and response efforts for priority diseases. Empirical studies on the implementation of the IDSR strategy often focus on assessing the system's effectiveness, challenges, and outcomes in improving disease surveillance and

outbreak response in various settings. These studies typically examine core components of IDSR, including data collection, analysis, reporting, and response mechanisms, while addressing the contextual factors that influence implementation. The review examined data from multiple countries from 2015 to 2024.

Below are key findings from empirical research on IDSR implementation:

First study: Sierra Leone: Post-Ebola IDSR Revitalization (2015–2017).

(Njuguna et al., 2019a)

The revitalisation of Integrated Disease Surveillance and Response (IDSR) in Sierra Leone following the Ebola virus outbreak underscores the critical need to strengthen public health systems in post-crisis settings (Njuguna et al., 2019b). The outbreak revealed significant weaknesses in surveillance, reporting, and response mechanisms, prompting reforms to build a more robust system.

Key focus areas included capacity-building for health workers, improved data collection and analysis tools, enhanced laboratory networks, and stronger community-based surveillance. Despite these efforts, challenges such as limited resources, inadequate infrastructure, and gaps in inter-agency coordination persisted, impacting the system's overall effectiveness (Njuguna et al., 2019b).

The revitalised IDSR aims to prevent similar outbreaks by fostering early detection, timely alerts, and rapid responses. Continued investment in health system resilience and sustained political commitment are essential to consolidate these gains and ensure long-term public health security in Sierra Leone (Njuguna et al., 2019b).

Gap: The Ebola virus disease (EVD) outbreak in Sierra Leone highlighted critical weaknesses in the country's public health surveillance and response systems. The post-EVD era

saw efforts to revitalise the Integrated Disease Surveillance and Response (IDSR) system to improve epidemic preparedness and response. However, significant research gaps must be addressed to optimise the system's effectiveness. This was because the data collected for this study does not comprehensively look at the core and support functions of IDSR at all levels in the health sector. It mainly focuses on data from the national and district levels. The research gaps identified critical areas overlooked in the current evaluations but essential for building a resilient, equitable and adaptive surveillance system in a post-Ebola resource-constrained setting.

Key Research Gaps

- The gaps identified in this study were not prioritised using the quantitative and qualitative data. This would not allow the stakeholders to spend money on IDSR functions with the greatest impact in the outcome indicator.
- The study did not evaluate the role of private health facilities, pharmacies, and traditional healers in implementing IDSR. It also did not explore community-based surveillance and the engagement of traditional leaders in the early detection of priority disease outbreaks.
- The study did not provide insight into the infrastructure of the laboratories in Sierra Leone and their capacity to perform confirmatory tests for the priority diseases in the IDSR guidelines. It also did not discuss the reliance on external laboratory diagnostics and its impact on the response time for epidemics.
- The study did not evaluate the use and benefits of digital health surveillance technologies, explore the integration of health tools, electronic surveillance systems, and real-time data, or evaluate the challenges usually faced by this system, such as internet connectivity, data security, cyber-attacks, and interoperability with other information systems like the DHIS-2.

- The study did not explore the completeness, accuracy, and timeliness of disease reporting from health facilities to national levels. The one evaluated in the study was at the national level from the districts. Also, the study did not explore the use of these data for decision-making, outbreak predictions, and policy formulation.
- The study did not evaluate the staffing shortages, skill gaps, and retention challenges in the implementation of IDSR, nor did it evaluate the effectiveness and frequency of training programmes on IDSR.
- The study failed to explore the use of community awareness and risk communication in IDSR response to epidemics. It did not explore the role of community awareness campaigns and risk communication in improving reporting and responding to disease outbreaks, and it did not explore how misinformation and cultural beliefs impact disease surveillance efforts.
- The study did not examine government budget allocation for disease surveillance and response impact. However, it was able to state the lack of government budget allocation and explain that it needed to be explored in detail.
- The study did not examine how IDSR functions during disease outbreaks and health crises. It did not examine preparedness and response strategies like stockpiling of medical commodities and response by the rapid response teams.
- The study did not compare the effectiveness of the IDSR functions subtheme in preventing the next epidemic.

Conclusion

Addressing these research gaps is critical to ensuring that the revitalised IDSR system in Sierra Leone can effectively prevent, detect, and respond to public health threats. Prioritising these

gaps can inform policy, guide resource allocation, and strengthen Sierra Leone's overall health security framework in the post-EVD era. This PhD would address these critical gaps (Njuguna et al., 2019b).

Second study: Uganda: Evaluation of IDSR Core and Support Functions (2012–2016)

(Masiira et al., 2019).

"The Evaluation of Integrated Disease Surveillance and Response (IDSR) Core and Support Functions after its Revitalization in Uganda from 2012 to 2016" explores the effectiveness of Uganda's IDSR system five years post-revitalisation (Masiira et al., 2019). Uganda is a low-income country that c/ as Cholera, meningococcal meningitis, typhoid and viral haemorrhagic fevers. The Integrated Disease Surveillance and Response (IDSR) strategy was adopted by WHO-AFRO in 1998 as a comprehensive strategy to improve disease surveillance and response in WHO Member States in Africa. It was adopted in Uganda in 2000. To address persistent inconsistencies and inadequacies in the core and support functions of IDSR, Uganda initiated an IDSR revitalisation programme in 2012(Masiira et al., 2019).

Objectives

1. Evaluate Core Functions:

The study assessed core surveillance functions, including case detection, reporting, data analysis, outbreak detection, and response to public health events at various health system levels.

2. Evaluate Support Functions:

The study also examined support functions such as training, supervision, resource allocation, and data management systems that facilitate the effective implementation of IDSR.

3. Identify Gaps and Challenges:

A key focus was to identify gaps in the operationalisation of IDSR and provide recommendations for further strengthening the surveillance system.

Methodology

The study used a mixed-methods approach, combining qualitative and quantitative data collection techniques:

- **Quantitative Analysis:** Data were collected from routine surveillance reports, including data on disease trends and response times for outbreaks.
- **Qualitative Interviews:** In-depth interviews with health workers and stakeholders provided insights into implementation challenges and system performance.
- **Site Assessments:** Selected health facilities were assessed to determine their capacity to detect, report, and respond to disease outbreaks. 202 health facilities were selected based on the purposive sampling method and later the Random method. The health centre (1) was excluded even though it has the village health teams in the communities (Masiira et al., 2019).

Key Findings

1. Improvements in Core Functions:

The study found significant improvements in disease reporting and response times after revitalising the IDSR system. However, challenges persisted in case detection and data analysis due to inadequate training and resource constraints.

2. Strengthened Support Functions:

Training and supervisory visits were scaled up, improving disease surveillance and outbreak response performance. Nonetheless, funding and logistical support gaps were identified as barriers to sustained improvements.

3. Integration of New Tools:

The integration of electronic tools, such as mobile reporting platforms, enhanced data collection and reporting accuracy, although some health facilities faced challenges with adoption due to technological and infrastructural limitations.

Recommendations

1. Scale up training for health workers to improve case detection and data analysis capabilities.
2. Ensure consistent funding and resource allocation to sustain IDSR activities.
3. Enhance community-level engagement to support early outbreak detection and reporting.
4. Expand the use of electronic surveillance tools to improve data quality and timeliness.

This evaluation highlighted the progress made in revitalising IDSR in Uganda and the remaining gaps that must be addressed to ensure a robust and sustainable surveillance system.

The first research gap is on the sustainability of IDSR gains made in Uganda during and after the 2012 to 2016 revitalisation of the programme. Uganda's IDSR system remains dependent on external partners like WHO and PEPFAR, raising sustainability concerns(Bakiika et al., 2023). This study showed an improvement in the reporting of priority diseases in the IDSR implementation from 60% to 85% during the revitalisation programme. However, the study did not explore whether the improvement in reporting priority diseases was sustained after the withdrawal of donor funding.

The second research gap is on equity in surveillance coverage in Uganda. Rural facilities face chronic shortages of diagnostic tools and trained staff(Dowhaniuk, 2021). This study could not explore the disparities in IDSR performance indicators between Urban regions like Kampala and rural areas like Karamoja.

The third research gap is the study's exclusion of private health facilities. The study focused on public health facilities, excluding private clinics that serve 60% of Uganda's population, creating surveillance "blind spots"(Medard et al., 2023).

The fourth research gap identified is that the study did not explore community perceptions during outbreaks, particularly in post-conflict regions like Northern Uganda, where distrust in government systems delayed outbreak reporting.

The study identified that only 28% of rural health facilities had reliable internet in 2016(Masiira et al., 2019). The research did not explore this barrier to implementing mTrac in rural health facilities.

In Uganda, the Agricultural sector contributes 24% of the GDP, which means that many agricultural activities occur in the country(Medard et al., 2023).

The fifth research gap is that this study in Uganda did not compare the effectiveness of the IDSR subthemes or prioritised them in preventing the next epidemic.

Third study: Tanzania (Zanzibar): IDSR System Assessment (2021)

(Saleh et al., 2021)

The Assessment of the Core and Support Functions of the Integrated Disease Surveillance and Response (IDSR) System in Zanzibar, Tanzania, reveals critical insights into the functionality and effectiveness of the IDSR system (Saleh et al., 2021). The study uses a mixed-method approach using the health infrastructure of the 10 districts to highlight the following:

1. Evaluate Core Functions:

The study assessed core surveillance functions, including case detection, reporting, data analysis, outbreak detection, and response to public health events at various health system levels.

2. Evaluate Support Functions:

The study also examined support functions such as training, supervision, resource allocation, and data management systems that facilitate the effective implementation of IDSR.

3. Identify Gaps and Challenges:

A key focus was to identify gaps in the operationalisation of IDSR and provide recommendations for further strengthening the surveillance system.

Methodology

The study used a mixed-methods approach, combining qualitative and quantitative data collection techniques:

- **Quantitative Analysis:** Data were collected from routine surveillance reports, including data on disease trends and response times for outbreaks.
- **Qualitative Interviews:** In-depth interviews with health workers and stakeholders provided insights into implementation challenges and system performance.
- **Site Assessments:** Selected health facilities were assessed to determine their capacity to detect, report, and respond to disease outbreaks.

Key Findings

1. Improvements in Core Functions:

The study found significant improvements in disease reporting and response times after revitalising the IDSR system. This was shown in the high reporting rates for malaria (95%) and Cholera (88%), which were shown to be due to community engagement. However, challenges persisted in case detection due to late reporting and poor data analysis due to inadequate training and resource constraints, making analysis at the district level unreliable.

2. Strengthened Support Functions:

Training primarily took place at public health facilities, with 45% of them receiving training, while no private facilities were trained. Only two districts received training on IDSR, despite most district and national-level officers having a Master's degree or other postgraduate training in IDSR. Laboratory capacity was limited, primarily conducting microscopy tests, and definitive diagnoses for most priority diseases (e.g., dengue, Rift Valley fever) outlined in the IDSR guidelines were not performed (Saleh et al., 2021).

Training and supervisory visits were scaled up, improving disease surveillance and outbreak response performance. Nonetheless, funding and logistical support gaps were identified as barriers to sustained improvements.

3. Integration of New Tools:

The integration of electronic tools, such as mobile reporting platforms, enhanced data collection and reporting accuracy, although some health facilities faced challenges with adoption due to technological and infrastructural limitations.

The recommendations are to strengthen health worker training, especially at private health facilities, upgrade the laboratory infrastructures to meet the diagnostic needs of priority diseases, establish digital platform systems to improve efficiency in reporting and responding to epidemics, and enhance multiagency collaboration in response to epidemics.

In essence, the study underscores the importance of a well-functioning IDSR system. It highlights gaps that, if addressed, could significantly improve Zanzibar's capacity to prevent, detect, and respond to public health threats (Saleh et al., 2021).

However, there are some major areas that may not have been covered by this research. We would make sure that our own research covers these areas.

The first one is the private sector and community engagement. This study has not explored the involvement of private healthcare facilities, pharmacies, and traditional healers in disease surveillance.

The second is community-based surveillance, and this study has not explored community health workers' involvement in the early identification and response of epidemics.

The third is that this study has not evaluated the capacity and ability of laboratories to confirm priority diseases at all levels. This is important for the core functions of the IDSR programme implementation, especially during outbreaks. This study does not explore the reliance on external reference laboratories and the turnaround time for the results.

The fourth research gap concerns the adoption and use of digital and real-time surveillance tools and their integration into national and regional information systems. The study has not evaluated the effectiveness of data-sharing platforms at all levels.

The fifth gap is the use of surveillance data and the use of these data in decision-making by the stakeholders' top management in preventing and responding to epidemics of international concern. The study did not assess the feedback mechanisms between data collectors, decision-makers, and frontline health workers.

The sixth research gap is that the study has not explored the rural-urban disparities in IDSR implementation and disease reporting. It has focused mostly on what is happening at the national and district levels.

The seventh research gap is that the study has not provided a detailed analysis of delays in reporting suspected cases and how that impacts response times. The reason for the delayed analysis and reporting of the suspected cases was underreporting and gaps in the data collection (Saleh et al., 2021). The study did not fully examine this.

The eighth research gap identified in this study was cross-border disease surveillance and coordination with Zanzibar's neighbour, Tanzania. This study did not examine port-of-entry screening and disease monitoring for travellers.

The ninth research gap identified that was not examined by this study is the long-term financial sustainability of IDSR activities, and it is reliance on donor funding. The study did not analyse government budget allocations for IDSR implementation at all levels.

The tenth research gap that this study did not evaluate was the training and capacity building for health workers at all levels. The study was unable to evaluate whether the trained staff had the capacity to apply IDSR principles correctly in practice.

The eleventh research gap not evaluated by this study was the effectiveness in detecting and responding to outbreaks like COVID-19, Dengue fever, Ebola fever and Black plague. The study has not evaluated the coordination of emergency response teams and rapid containment measures.

The twelve research gaps were caused by the study's failure to evaluate the effectiveness of the IDSR subthemes in preventing the next epidemic.

Fourth study: Iraq (Baghdad): Communicable Disease Surveillance in PHC Centres (2019)
(Kadhum, 2019)

The fourth study, "The Assessment of Communicable Disease Surveillance System Activities in Primary Healthcare (PHC) Centres in Baghdad", highlights the critical role these centres play in detecting, reporting, and managing communicable diseases (Kadhum, 2019). This evaluation likely examines the existing surveillance infrastructure's efficiency, challenges, and gaps, including data collection, reporting mechanisms, staff training, and resource availability. It

may also identify systemic barriers such as delays in reporting, inadequate technology, or a lack of integration with national health strategies.

Such an assessment aims to provide actionable insights to strengthen surveillance systems, enhance disease prevention and control measures, and improve public health outcomes in Baghdad. Additionally, it underscores the need for capacity building, policy refinement, and resource allocation to support the sustainability of effective communicable disease surveillance (Kadhum, 2019).

Here are some unexplored research gaps that may not have been addressed in the study on "The Assessment of Communicable Disease Surveillance System Activities in Primary Healthcare While studies in the Kurdistan Region of Iraq revealed political barriers to integrating COVID-19 into existing surveillance systems(Hamalaw et al., 2022a), there is limited data on how Baghdad's PHC centres adapted to the pandemic. The 2019 study by Kadhum predates COVID-19 and does not address whether electronic reporting or real-time data analysis—key weaknesses identified earlier—were improved during the crisis (Kadhum, 2019). Research is needed to evaluate post-pandemic resilience, including adopting digital tools and protocols for novel pathogens.

The Middle East and North African (MENA) region faces challenges in monitoring mobile populations, including refugees and migrants, due to fragmented data-sharing and political instability(Buback et al., 2025). However, Baghdad-specific studies lack analysis of how mobile populations (e.g., internally displaced persons post-conflict) impact disease transmission. For instance, the 2006 epidemiological study in Baghdad focused on static populations (Kadhum, 2019), overlooking dynamic groups that may exacerbate outbreaks. A gap exists in understanding how PHC centres track diseases in transient communities and collaborate with regional networks.

Existing studies highlight the reliance on paper-based reporting and limited use of electronic systems (e.g., only 21% of centres had computers) (Kadhum, 2019). However, there is no exploration of why technological upgrades lag or how artificial intelligence or predictive modelling could enhance outbreak detection. For example, studies in other regions emphasise internet-based surveillance and AI tools(‘Developing Infectious Disease Surveillance Systems’, 2020), but Baghdad's capacity to adopt such innovations remains unexplored.

Only 30% of PHC staff received training in surveillance practices (Kadhum, 2019), yet no studies evaluate the long-term retention of skills or the impact of intermittent training programs. Comparative research from Kurdistan emphasises the need for continuous feedback and motivated staff (Hamalaw et al., 2022a). However, Baghdad-specific strategies for workforce sustainability—such as mentorship or digital learning platforms—are unexplored.

The MENA review underscores the importance of multisectoral approaches (e.g., One Health) for cross-border surveillance (Buback et al., 2025). However, Baghdad's PHC-centered studies lack data on coordination between human, animal, and environmental health sectors. For example, zoonotic diseases like cutaneous leishmaniasis may require integrated reporting mechanisms that are absent in current assessments.

While 95% of PHC centres reported data, only 3.8% conducted regular analysis(Hamalaw et al., 2022a; Kadhum, 2019). The absence of feedback loops (30% received updates) suggests a disconnect between data collection and actionable insights (Kadhum, 2019). Research is needed to evaluate how PHC centres utilise surveillance data for decision-making and whether automated analytics could bridge this gap.

This study did not compare the effectiveness of the IDSR subthemes in preventing the next epidemic.

Fifth study: Malawi: IDSR Implementation and Reporting Gaps (2018)

(Joseph Wu et al., 2018)

The 2014 Ebola Virus Disease (EVD) outbreaks rang the bell to call upon global efforts to assist resource-constrained countries to strengthen public health surveillance systems for early response (Joseph Wu et al., 2018a). Malawi adopted the Integrated Disease Surveillance and Response (IDSR) strategy to develop its national surveillance system in 2002 and revised its guidelines to fulfil the International Health Regulation (IHR) requirements in 2014. This study aimed to understand the state of IDSR implementation and the differences between guidelines and practice for future disease surveillance system strengthening. This was a mixed-method research study. Quantitative data were used to analyse the completeness and timeliness of surveillance system performance from the National District Health Information System 2 (DHIS2) from October 2014 to September 2016. Qualitative data were collected through interviews with 29 frontline health service providers from the selected district and seven key informants of the IDSR system implementation and administration at district and national levels. Findings The current IDSR system showed relatively good completeness (73.1%) but poor timeliness (40.2%) of total expected monthly reports nationwide and zero weekly reports during the study period (Joseph Wu et al., 2018a). Significant implementation gaps were a lack of weekly reports and training. The challenges of IDSR implementation revealed through qualitative data included case identification, compiling reports for timely submission and inadequate resources. Conclusions The differences between IDSR technical guidelines and actual practice were huge. The developing information technology infrastructure in Malawi and emerging mobile Health.

Integrated Disease Surveillance and Response (IDSR) in Malawi: Implementation gaps and challenges for timely alert", "title-short": "Integrated Disease Surveillance and Response (IDSR) in Malawi"(Joseph Wu et al., 2018).

Malawi's adoption of the IDSR strategy has aimed to strengthen its disease surveillance system, yet persistent gaps and emerging challenges highlight critical areas for future research. The study may not have addressed some unexplored research gaps.

Malawi's surveillance landscape is fragmented, with vertical programs (e.g., HIV/AIDS, malaria) operating independently and using uncoordinated reporting systems ((*Insights from Malawi's Deep Dive of the Integrated Disease Surveillance System* | IANPHI | Atlanta GA, 2023; Kambalame et al., 2024). These programs often receive more funding and resources than IDSR, creating parallel workflows and data silos. A key gap lies in understanding how to harmonise these systems to reduce duplication, streamline reporting, and improve interoperability of laboratory data with platforms like DHIS2 or One Health Surveillance Platform (OHSP) (Joseph Wu et al., 2018). Research is needed to evaluate governance structures and collaborative frameworks prioritising integration while addressing donor-driven vertical program dominance (Kambalame et al., 2024).

While mobile health (mHealth) is proposed as a tool to improve timeliness and completeness of reporting(*Insights from Malawi's Deep Dive of the Integrated Disease Surveillance System* | IANPHI | Atlanta GA, 2023; Joseph Wu et al., 2018), empirical evidence on its scalability and impact in Malawi's resource-constrained settings remains sparse. For instance, studies on hybrid two-way texting (2wT) for HIV retention exist(Klabbers et al., 2025), but similar innovations for IDSR-specific case reporting or outbreak alerts are underexplored.

Community engagement is critical for early outbreak detection, yet Malawi's IDSR system lacks robust CBS mechanisms. Only 68% of African countries had implemented CBS by 2017, with minimal integration into national systems(Mremi et al., 2021). Research is needed to evaluate participatory models, such as training community health workers (HSAs) to report events via mobile platforms in Malawi.

Persistent issues include incomplete data, lack of feedback loops, and underutilisation of surveillance data for decision-making (*Insights from Malawi's Deep Dive of the Integrated Disease Surveillance System* | IANPHI | Atlanta GA, 2023; Joseph Wu et al., 2018; Mremi et al., 2021). While studies note these challenges, there is limited exploration of interventions like real-time dashboards, automated validation algorithms, or capacity-building for district-level data analysis.

Malawi's One Health Surveillance Platform (OHSP) exists but struggles with integrating zoonotic disease data into IDSR(*Insights from Malawi's Deep Dive of the Integrated Disease Surveillance System* | IANPHI | Atlanta GA, 2023). Research gaps include evaluating cross-sectoral collaboration (e.g., linking animal health data to human outbreaks) and addressing systemic barriers like funding disparities between human and veterinary sectors.

Vertical disease programs (e.g., PEPFAR, Global Fund) receive significantly more funding than IDSR, leading to resource gaps for core surveillance activities(*Insights from Malawi's Deep Dive of the Integrated Disease Surveillance System* | IANPHI | Atlanta GA, 2023; Kambalame et al., 2024). No studies have quantified how this disparity affects outbreak preparedness or long-term system sustainability.

Frontline health workers face high turnover and inconsistent training on IDSR guidelines(Joseph Wu et al., 2018; Kambalame et al., 2024). Research is needed on cost-effective,

technology-driven training (e.g., e-learning modules) and their long-term impact on case identification and reporting accuracy.

Private facilities account for 36% of Malawi's health infrastructure but are poorly integrated into IDSR due to weak enforcement of reporting mandates (Joseph Wu et al., 2018; Kambalame et al., 2024). Studies on incentivising private-sector participation (e.g., through policy reforms or digital reporting tools) are lacking.

Malawi's IDSR does not systematically incorporate environmental data (e.g., rainfall patterns) to predict outbreaks like Cholera or malaria (Mremi et al., 2021). Research on predictive modelling using geospatial and climate data could enhance proactive surveillance.

Malawi's multilingual context (e.g., Chewa, Yao, Tumbuka) may affect data accuracy, as case definitions and reporting tools are primarily in English (Joseph Wu et al., 2018). No studies have explored localised adaptations of IDSR materials to improve comprehension among frontline workers.

Sixth study: Liberia: Post-Ebola IDSR Reforms (2015–2017)

(Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Chukwudi, et al., 2019)

A study in Liberia that looked at the implementation of integrated disease surveillance and response in Liberia after the Ebola virus disease outbreak 2015-2017 following the devastating 2014–2016 Ebola outbreak reflects a critical effort to rebuild and strengthen the country's public health infrastructure (Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Okeibunor, et al., 2019). The Ebola epidemic exposed systemic weaknesses in Liberia's health system, particularly in surveillance, laboratory capacity, and emergency response. The IDSR strategy, promoted by the

WHO, became a cornerstone for recovery, aiming to integrate fragmented systems and improve early detection and response to outbreaks.

The study found that the key components of the implementation of IDSR were in four sections:

Policy and Governance showed that Liberia could revise its national health policy to incorporate the IDSR guideline. The Ministry of Health, with international partners (e.g., WHO, CDC, NGOs), established emergency operations centres and improved multi-level coordination. Capacity building shows that frontline health workers were trained in case detection, reporting, and data analysis. The research showed that in order to be better prepared, the staff had several simulations and drills on IDSR implementation in an emergency situation. The research also showed that investment in laboratory diagnostic infrastructures reduced diagnostic testing turnaround time and improved response time.

Surveillance systems were transformed from paper-based to electronic-based reporting using the DHIS-2 platform, which enabled real-time data collection. The community-based systems use local volunteers to collect reports on symptoms of priority diseases and use lessons learnt from the Ebola infection outbreak.

Community engagement ensures trust is built between the communities and the health workers by involving the community leaders in health campaigns, addressing stigma, and improving reporting compliance.

The post-Ebola IDSR rollout in Liberia exemplifies how crisis-driven reforms can catalyse the strengthening of the health system. However, long-term success depends on addressing systemic vulnerabilities, maintaining community trust, and securing sustainable investments. Liberia's efforts highlight the interplay of local adaptation and global solidarity in building health

security. However, this research had areas that had not been explored in implementing IDSR in Liberia.

Post-Ebola, Liberia introduced digital tools like the Auto-Visual AFP Detection and Reporting (AVADAR) and eIDSR platforms to improve reporting timeliness and accuracy (Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Okeibunor, et al., 2019; Nagbe, Yealue, et al., 2019). However, the 2017 data quality audit revealed persistent infrastructural barriers: only 23% of health facilities had dedicated reporting phones, and 17% had daily internet access (Nagbe, Yealue, et al., 2019). Research gaps include:

Prioritisation of the research gaps.

Long-term scalability and cost-effectiveness of these tools in rural settings with limited connectivity.

Impact of digital solutions on reducing reporting delays or improving outbreak detection in resource-constrained environments.

Despite achieving 80% reporting completeness post-Ebola (Nyenswah, 2022), data were primarily used for risk communication rather than resource allocation or prioritisation at district levels (Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Chukwudi, et al., 2019). Unexplored areas include:

Interventions to translate surveillance data into actionable policies include predictive modelling for outbreak hotspots.

Effectiveness of real-time dashboards or automated validation algorithms in enhancing decision-making (Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Chukwudi, et al., 2019).

Post-Ebola efforts to pilot community event-based surveillance lacked robust evaluation (Nagbe, Yealue et al., 2019). Key gaps include:

The role of community health workers (CHWs) in improving early outbreak detection.

Barriers to integrating CBS into national systems include linguistic diversity (e.g., local languages like Kpelle and Bassa) and trust deficits between communities and health authorities (Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Chukwudi, et al., 2019; Nyenswah, 2022).

Although 91% of health workers received mentorship on data quality (Nagbe, Yealue, et al., 2019), high staff turnover and inconsistent training protocols undermined IDSR performance. Research gaps include:

Long-term retention of IDSR skills post-training.

Effectiveness of e-learning modules or mobile mentorship in remote areas (Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Chukwudi et al., 2019; Nagbe, Yealue et al., 2019).

Four districts consistently fell below timeliness targets post-Ebola 18. Unexplored factors driving disparities include:

Geographic and socioeconomic barriers, e.g., rural vs. urban access to reporting tools.

Strategies to integrate conflict-affected or marginalised populations into IDSR (Nyenswah, 2022).

Vertical programs (e.g., PEPFAR, Global Fund) received disproportionate funding compared to IDSR, leading to fragmented systems (Nyenswah, 2022; Nyenswah et al., 2023). No studies quantify how funding inequities affect outbreak preparedness or long-term system resilience.

Liberia's One Health Surveillance Platform (OHSP) struggled to integrate animal and environmental health data into IDSR (Nyenswah, 2022). Research gaps include:

Evaluating collaboration between human, animal, and environmental health sectors.

Systemic barriers like funding disparities between sectors (Nyenswah, 2022).

IDSR materials were primarily in English, despite Liberia's multilingual context. No studies explore how localising case definitions or training modules into indigenous languages (e.g., Kpelle, Grebo) could improve data accuracy (Nagbe, Yealue, et al., 2019).

While 65% of facilities received IDSR supervision, community-level feedback was limited (Nagbe, Yealue, et al., 2019; Nyenswah, 2022). Unexplored questions include:

How supervisory frequency correlates with data accuracy.

The role of peer-to-peer learning networks in sustaining quality improvements.

Seventh study: Nigeria: Rapid IDSR Assessment in Northeast States (2017).

(Ibrahim et al., 2020a)

The 2017 rapid assessment of Nigeria's Integrated Disease Surveillance and Response (IDSR) system in three northeastern states (Adamawa, Borno, Yobe) revealed systemic gaps in infrastructure, workforce capacity, and data utilisation, despite progress in adopting standardised frameworks (Ibrahim et al., 2020a).

The study found that health facilities participated poorly. Only 23% of health facilities (606 out of 2,598) actively reported IDSR data, with private facilities significantly underrepresented (Ibrahim et al., 2020a). Documentation gaps in facility registers (e.g., missing patient age, sex, diagnosis, and lab results) compromised data quality (Ibrahim et al., 2020a).

The study also found a deficit in workforce and training. The Local Government Area (LGA) Disease Surveillance and Notification Officers (DSNOs) and clinicians demonstrated limited knowledge of IDSR core indicators beyond timeliness and completeness (Ibrahim et al., 2020a). It also showed that only 63% of LGAs had rapid response teams, and 47.7% lacked epidemic preparedness committees.

The research showed infrastructural and resource constraints in the three investigated regions. The study showed limited access to digital tools, few facilities having dedicated reporting phones, or reliable internet, hindering the scalability of innovations like eIDSR (Ibrahim et al., 2020a). Stockouts of laboratory supplies (e.g., specimen packaging) delayed outbreak confirmation, leading to the delayed response to potential epidemics of international concern (Ibrahim et al., 2020a).

The study showed that the stakeholders did not use surveillance data. Surveillance data were underutilised at subnational levels, primarily serving risk communication rather than guiding resource allocation or outbreak prediction (Ibrahim et al., 2020a).

Studies also showed that private health facilities are excluded from implementing IDSR. Private health facilities lagged in IDSR implementation (40.7% vs. 76.4% in public facilities), with only 16.7% of staff trained in IDSR protocols (Tagurum et al., 2022).

The assessment underscores the vulnerability of IDSR systems in conflict zones, where fragmented infrastructure and workforce turnover amplify outbreak risks. While Nigeria's adoption of eIDSR and standardised case definitions marks progress, systemic inequities persist. Unexplored areas that were identified in the implementation of IDSR were not covered.

The assessment noted that only 23% of health facilities had dedicated reporting phones, and 17% had daily internet access, limiting the scalability of tools like eIDSR (Ibrahim et al., 2020a, 2021). While pilot eIDSR projects improved reporting completeness ($\geq 85\%$) and timeliness (Ibrahim et al., 2021), no studies explore:

Cost-effective hybrid (online/offline) reporting models for areas with intermittent connectivity.

Long-term impact of digital tools on outbreak detection timelines (e.g., Cholera, meningitis) in conflict zones.

Private health facilities accounted for 36% of health infrastructure but lagged in IDSR participation (16.7% trained vs 76.4% in public facilities) (Ibrahim et al., 2020a; Tagurum et al., 2022). Research gaps include:

Effective incentives (e.g., policy mandates, digital reporting tools) to engage private providers.

Trust-building mechanisms between public health authorities and private facilities (Ibrahim et al., 2020a; Tagurum et al., 2022).

The assessment did not evaluate CBS integration despite linguistic diversity (e.g., Hausa, Kanuri) and trust deficits in conflict zones (Ibrahim et al., 2020a). Unexplored areas include:

The role of community health workers (CHWs) in early outbreak detection.

Localised adaptations of IDSR materials into indigenous languages to improve data accuracy (Ibrahim et al., 2020a).

Despite achieving 80% reporting completeness, data were underused for resource allocation or hotspot prediction (Ibrahim et al., 2020a). Research gaps include:

Effectiveness of predictive analytics and real-time dashboards in guiding localised responses.

Barriers to translating surveillance data into actionable district-level policies (Ibrahim et al., 2020a).

High staff turnover and inconsistent training protocols undermined IDSR performance (Ibrahim et al., 2020a). Unaddressed questions include:

Long-term retention of IDSR skills post-training.

Adaptive learning models (e.g., mobile mentorship, e-learning) for remote or insecure areas (Ibrahim et al., 2020a, 2021).

Four districts consistently missed timeliness targets due to geographic and socioeconomic disparities(Ibrahim et al., 2020a). Research gaps include:

Strategies to integrate conflict-affected populations (e.g., mobile clinics, decentralised reporting).

Impact of humanitarian aid fragmentation on surveillance equity (Ibrahim et al., 2020a).

Stockouts of laboratory supplies (40% of facilities) and delays in specimen transport were noted, but gaps persist in:

Cost-benefit analyses of centralised vs. decentralised testing models.

Strategies to strengthen local laboratory networks in resource-poor settings(Ibrahim et al., 2020a).

The assessment excluded facilities in insecure areas, leaving gaps in understanding:
How does conflict compromise a nation's surveillance infrastructure and workforce stability, facilitating epidemics' emergence and contributing to increased mortality?

Conflict-sensitive surveillance strategies to ensure continuity during crises (Ibrahim et al., 2020a).

Eighth study: Ghana: Kassena-Nankana IDSR Evaluation (2015–2016).

(Adokiya et al., 2015)

The 2015 assessment of Ghana's Integrated Disease Surveillance and Response (IDSR) system in the Kassena-Nankana districts of the Upper East Region highlights systemic gaps in both core and support functions, undermining its capacity to detect and respond to outbreaks effectively(Adokiya et al., 2015).

Under the core functions of the IDSR implementation, challenges were found in case detection and confirmation. None of the nine (9) assessed health facilities had copies of IDSR

Technical Guidelines, leading to inconsistent application of case definitions (e.g., Cholera, meningitis) and reliance on simplified, community-level criteria that lacked specificity (Adokiya et al., 2015). Also, the laboratories were ill-equipped, with frequent stockouts of specimen packaging supplies. For diseases like tuberculosis and HIV, diagnostic testing was perceived as unreliable by communities, reducing trust in health facilities (Adokiya et al., 2015).

The study found fragmented reporting systems for data reporting and analysis. While mobile phone reporting improved timeliness, only 23% of facilities had dedicated reporting phones, and paper-based systems dominated. It created delays and inconsistencies, particularly in rural areas with limited connectivity (Adokiya et al., 2015). Surveillance activities ranked low among nurses, doctors, and lab staff, who prioritised clinical duties over data entry and reporting (Adokiya et al., 2015).

In support functions, the challenges found were some of the followings:

Training and supervision had irregular feedback and mentorship. Supervision was largely absent, and feedback from the district and national levels happened sporadically. Only 7/9 facilities had designated surveillance officers, and training programs were inconsistent (Adokiya et al., 2015). Frequent transfers of trained personnel disrupted continuity in surveillance workflows, exacerbating gaps in data quality.

Limited internet access (17% of facilities) and reliance on motorbikes for specimen transport delayed outbreak confirmation. Stockouts of laboratory supplies affected 40% of facilities. Vertical disease programs (e.g., HIV/AIDS) received disproportionate resources compared to IDSR, fragmenting surveillance efforts (Adokiya et al., 2016; Mremi et al., 2021).

Northern Ghana's IDSR system demonstrates both resilience and fragility. While mobile reporting and community engagement offer pathways for improvement, persistent gaps in

infrastructure, training, and resource allocation threaten its effectiveness. Addressing these challenges is critical for aligning IDSR with global health security goals, particularly in light of lessons from recent epidemics like Ebola. Future efforts must prioritise multisectoral collaboration and sustainable funding models to transform IDSR into a proactive, equitable tool for outbreak preparedness (Masiira et al., 2019; I. Mremi et al., 2020).

While the study highlighted critical barriers, several research gaps remain unexplored, particularly in conflict-affected and resource-limited settings.

Although the study focused on northern Ghana, comparative research could examine differences in IDSR performance between northern and southern regions, urban versus rural settings, or among different administrative districts (Adokiya et al., 2015).

Despite mobile phone reporting improving accessibility, 23% of facilities lacked dedicated reporting phones, and 17% had daily internet access, limiting the scalability of tools like the District Health Information Management System II (DHIMS2)(Adokiya et al., 2015). While DHIMS2 improved reporting completeness (e.g., 100% in 2013), timeliness remained suboptimal (61%) (Adokiya et al., 2016). Unexplored areas include:

Cost-effective hybrid (online/offline) reporting models for areas with intermittent connectivity.

Long-term impact of digital tools on outbreak detection timelines (e.g., cholera, meningitis) in remote regions(Adokiya et al., 2015).

Private clinics constituted 36% of health infrastructure but lagged in IDSR participation due to weak enforcement of reporting mandates(Adokiya et al., 2015, 2016).

Research gaps include:

Policy incentives (e.g., tax breaks) to engage private providers.

Trust-building mechanisms between public health authorities and private facilities (Adokiya et al., 2015).

The study did not evaluate CBS integration despite linguistic diversity (e.g., Kasem, Nankam) and community distrust in diagnostic testing (Adokiya et al., 2015). Key gaps include:
Role of community health workers (CHWs) in early outbreak detection.

Localised adaptations of IDSR materials into indigenous languages to improve data accuracy (Adokiya et al., 2015; Wolfe et al., 2021).

Surveillance data were underutilised for resource allocation or hotspot prediction (Adokiya et al., 2015, 2016). Research gaps include:

Effectiveness of predictive analytics and real-time dashboards in guiding localised responses.

Barriers to translating data into actionable district-level policies (Adokiya et al., 2016; Wolfe et al., 2021b).

High staff turnover and inconsistent training protocols undermined IDSR performance. Although 91% of health workers received mentorship, long-term skills retention was not evaluated (Adokiya et al., 2015). Unexplored questions:

Effectiveness of e-learning modules or mobile mentorship in remote areas.

Integrating IDSR training into pre-service health worker curricula (Adokiya et al., 2015; Wolfe et al., 2021b).

No studies have quantitatively measured the long-term effects of refresher training and capacity-building interventions on surveillance performance.

Disparities in reporting performance were noted, with rural areas facing geographic and socioeconomic barriers (Adokiya et al., 2015, 2016). Research gaps include:

Strategies to integrate marginalised populations (e.g., mobile clinics, decentralised reporting).

Impact of humanitarian aid fragmentation on surveillance equity (Adokiya et al., 2015, 2016).

Stockouts of lab supplies affected 40% of facilities, and specimen transport relied on motorbikes, causing delays (Adokiya et al., 2015). Unaddressed gaps:

Cost-benefit analyses of centralised vs. decentralised testing models.

Strategies to strengthen local laboratory networks in resource-poor settings (Kwabla et al., 2025).

IDSR materials were primarily in English, despite multilingual communities. No studies explore how translating case definitions or training modules into local languages (e.g., Kasem) could improve comprehension among frontline workers(Adokiya et al., 2015).

Feedback from district or national levels occurred sporadically, with only 7/9 facilities having designated surveillance officers(Adokiya et al., 2015). Research gaps include:

Correlation between supervisory frequency and data accuracy.

Role of peer-to-peer learning networks in sustaining quality improvements.

The Ninth Study: North Kivu, Democratic Republic of the Congo.

(Kallay et al., 2024)(Kallay et al., 2024)

The assessment of the Integrated Disease Surveillance and Response (IDSR) system in North Kivu, Democratic Republic of the Congo (DRC), conducted in 2021, aimed to evaluate the province's capacity to detect and respond to public health threats following the 2018–2020 Ebola outbreak, the largest in DRC's history. This evaluation was critical given the region's vulnerability

to viral hemorrhagic fevers (VHFs) and ongoing challenges in public health infrastructure. Below is a synthesis of the key findings and implications from the study:

1. Methodology and Scope

The assessment utilised a mixed-methods approach, combining quantitative data from standardised questionnaires and health facility records with qualitative insights from focus groups, observations, and interviews. Data were collected across multiple health system tiers, including provincial offices, five health zones, 66 healthcare facilities, and 15 health areas with community health workers (CDC Science Clips, 2024; Kallay et al., 2024). The focus was on core IDSR functions such as case detection, reporting, and outbreak response.

Key Findings

a. Gaps in Case Identification and Reporting

Documentation shortages: 36% of health facilities lacked case definition guidelines, and 53% had no reporting forms, leading to inconsistent identification and reporting of suspected VHF cases (Kallay et al., 2024).

Data quality issues: At the health facility level, data completeness and timeliness averaged 53% and 75%, respectively, with significant variability across zones. While health zones reported 100% completeness and 97% timeliness, these metrics masked inconsistencies in underlying facility data (Kallay et al., 2024).

b. Limited Adoption of Digital Tools

Electronic IDSR systems were not widely implemented, hindering real-time data sharing and analysis. Manual reporting processes remained dominant, contributing to delays and errors (Kallay et al., 2024).

c. Challenges in Rapid Response

Though rapid response teams (RRTs) were available, their functionality was compromised by:

Lack of guidance documents.

Delayed mobilisation due to logistical constraints (e.g., transportation and communication resources).

Insufficient training for outbreak investigation and containment (Kallay et al., 2024).

3. Contextual Challenges

The assessment highlighted systemic issues exacerbated by the region's unique challenges:

Conflict and insecurity: North Kivu have faced prolonged armed conflict, which has disrupted healthcare access and complicated surveillance efforts (Kallay et al., 2024).

Resource limitations: Health facilities lacked basic supplies, transportation, and trained personnel, particularly in rural areas (Kallay et al., 2024).

Over-reliance on outbreak-specific funding: Post-Ebola investments focused on immediate response rather than strengthening routine surveillance, leading to fragility in long-term preparedness.

4. Recommendations

The study proposed actionable steps to address gaps:

Strengthen lower-tier health systems: Prioritise training, resource allocation, and supervision at the facility and community levels (Kallay et al., 2024).

Expand digital surveillance: Implement electronic IDSR tools to improve data accuracy and timeliness (Kallay et al., 2024).

Enhance RRT capacity by Developing standardised protocols, improving logistics, and conducting simulation exercises (Kallay et al., 2024).

Shift to sustainable funding: Transition from emergency-focused support to investments in routine surveillance and workforce development (Kallay et al., 2024).

Community engagement: Address mistrust through localised health messaging and involvement of community leaders (Kallay et al., 2024).

5. Implications for Future Outbreaks

The assessment underscores the need for a resilient surveillance system capable of detecting outbreaks early while managing routine health threats. The 2021 North Kivu Ebola resurgence (11 cases, six deaths) further demonstrated the consequences of gaps in case detection and delayed response (*Ebola Virus Disease – Democratic Republic of the Congo*, 2022).

Integrating IDSR improvements with broader health system strengthening—such as infection prevention protocols and vaccination campaigns—remains critical to mitigating future crises (*Ebola Outbreak 2021- North Kivu*, 2021; Ousman et al., 2022).

In summary, while progress has been made post-2018, systemic weaknesses in North Kivu's IDSR system highlight the urgency of sustainable reforms to balance outbreak responsiveness with foundational public health capacities.

Here are some potential unexplored research gaps related to the assessment of the Integrated Disease Surveillance and Response (IDSR) system implementation in health zones at risk for viral hemorrhagic fever (VHF) outbreaks in North Kivu, Democratic Republic of the Congo, post-Ebola outbreak (2021):

Effectiveness of IDSR in Early Detection and Response – Limited studies assess how well the IDSR system identified and responded to emerging VHF threats after the Ebola outbreak.

Community Engagement and Reporting: Research gaps exist in understanding the role of community-based surveillance and its effectiveness in strengthening IDSR implementation.

Health Workforce Capacity and Training—Few studies examine whether health workers in high-risk zones received adequate training and resources for effective IDSR execution.

Integration of Laboratory Networks – Limited data on how well laboratory networks were integrated into the IDSR system for early confirmation of VHF cases.

Timeliness and Completeness of Data Reporting: Research is needed to evaluate whether IDSR data reporting in North Kivu met timeliness and completeness standards post-Ebola.

Impact of Conflict and Insecurity on IDSR Functionality – The influence of ongoing conflict on surveillance activities, outbreak response, and data quality remains understudied.

Use of Digital Health Tools in Surveillance—There is little evidence on how digital tools (e.g., mobile reporting and GIS mapping) have improved IDSR performance in the region.

Cross-Border Coordination and Surveillance: Research is needed on how IDSR collaborates with neighbouring countries to prevent transboundary VHF outbreaks.

Sustainability of IDSR Post-Outbreak – The long-term sustainability of strengthened surveillance efforts following the Ebola outbreak remains unclear.

Community Trust and Perception of Surveillance Activities—There are gaps in understanding how public perception and trust influence the effectiveness of IDSR interventions in North Kivu.

Summary

Human-induced environmental changes have significantly altered the spatial dynamics between wildlife and human populations. Increasing encroachment into wildlife habitats has intensified contact between humans and animals, facilitating the spillover of zoonotic pathogens. These cross-species transmissions have been implicated in the emergence of epidemic and pandemic diseases, with profound global economic, social, political, and environmental consequences(Fenollar & Mediannikov, 2018). In response to these threats, the Integrated Disease

Surveillance and Response (IDSR) strategy has emerged as a vital framework for strengthening public health systems, particularly in low- and middle-income countries. However, the effectiveness of IDSR relies heavily on its regular evaluation to identify system weaknesses and implement sustainable corrective actions. This research seeks to uncover systemic gaps to inform durable and contextually relevant interventions.

Jeremy Bentham's panopticon theory informs the theoretical orientation of this study. It was initially conceptualised in the 18th century to reform the British penal system through an architecture of constant visibility and internalised discipline (Girlando, 2017). Though initially designed for prisons, the panopticon has evolved into a metaphor for modern surveillance practices. Technological advancements have replaced the watchtower with data analytics systems, CCTV, drones, and digital tracking tools, which allow continuous observation of populations without overt presence (Couch et al., 2020a).

For example, during the COVID-19 pandemic, ankle bracelets were used in the United States and Australia to monitor quarantine compliance, while drones were deployed to enforce social distancing in public (McNabb, 2020; *UniSA Working on 'Pandemic Drone' to Detect Coronavirus*, 2020).

This research conceptualises the International Health Regulations (IHR) framework through a panoptic lens. The IHR Secretariat is the observer, monitoring WHO member states' compliance with disease surveillance and response standards. Member states must report any potential public health emergency of international concern (PHEIC) within 48 hours of detection (Masiira et al., 2019). Thus, the IHR–IDSR relationship mirrors the panopticon model in which states, aware of being observed, are expected to self-regulate and act promptly.

Although Bentham's theory has been criticised for promoting punitive surveillance and dehumanisation (Clemens, 2017), it offers an applicable framework for understanding how health systems function under international accountability mechanisms. Despite historical controversies, its adaptation to global health governance provides a compelling lens through which surveillance and response systems can be evaluated.

The IDSR strategy, derived from the International Health Regulations (IHR), functions as the conceptual framework for this study. Introduced by WHO in 1998, IDSR was developed to help Sub-Saharan African countries transition from fragmented, disease-specific surveillance systems to a unified platform that integrates data collection, analysis, reporting, and response for both communicable and non-communicable diseases (Ibrahim et al., 2020a; Masiira et al., 2019). Its key aims include the early detection of outbreaks, timely response to priority diseases, and strengthening laboratory and emergency preparedness capacities.

IDSR encompasses Nine core functions, six support functions, and thirteen quality indicators. These components form the operational backbone of epidemic preparedness and response systems. Periodic evaluation of each component is critical to ensuring operational functionality and alignment with evolving needs (Groseclose & Buckeridge, 2017). The evaluation is critical for understanding the system's capacity to monitor endemic conditions and prevent future outbreaks of international concern (Keita et al., 2021).

In Sierra Leone, the IDSR programme was officially adopted in 2004 when its first guideline was published and has since undergone multiple rounds of revision, most notably in 2015 and 2020, in response to lessons learned during the Ebola Virus Disease (EVD) outbreak (Ministry of Health and Sanitation, 2020a). Prior to the adoption of IDSR, disease surveillance in the country

was highly fragmented, with separate reporting systems for HIV, malaria, and tuberculosis, creating inefficiencies and burdens for frontline health workers(Njuguna et al., 2019b).

The public health system in Sierra Leone operates across three levels, national, district, and peripheral health facilities, each with clearly defined roles in IDSR implementation. At the community level, health workers serve as the first point of contact for surveillance, escalating reports to district-level officers, who communicate with the national directorate responsible for health security and emergency response(Njuguna et al., 2019b; Sochas et al., 2017).-

IDSR operationalises various forms of surveillance to optimise outbreak detection and response. These include:

Passive surveillance: routine data collection through established reporting channels, the DHIS-2 and IDSR information flow;

Active surveillance: deliberate outreach by health personnel to collect data from facilities and communities using the rumour book records to initiate outreach;

Sentinel surveillance: focused monitoring through selected health facilities based on disease prevalence;

Enhanced surveillance: intensified data collection for high-risk diseases (e.g., tuberculosis);

Syndromic surveillance: monitoring symptom clusters indicative of specific illnesses(Gilbert & Cliffe, 2016).

Two primary reporting modalities—event-based surveillance (EBS) and indicator-based surveillance (IBS)—underpin IDSR. EBS captures unusual or unexpected health events in real-time, while IBS relies on structured weekly reports. Both use a common information flow channel but differ in the urgency and nature of reporting (Clara et al., 2018).

Although IDSR has proven valuable in strengthening epidemic intelligence, its functionality remains uneven across countries and contexts. For instance, studies in Uganda and Malawi have shown persistent challenges in reporting priority diseases, insufficient digital integration, limited laboratory capacity, and inadequate workforce development (Joseph Wu et al., 2018b; Masiira et al., 2019). Moreover, timely and complete reporting alone cannot prevent future epidemics if health systems are not concurrently strengthened (Kardas-Nelson & Frankfurter, 2018).

In Sierra Leone, the government has designated a list of epidemic-prone diseases—both communicable and non-communicable—monitored through the IDSR framework. These are reported immediately, weekly, or monthly, depending on the risk and severity. However, such a system's effectiveness hinges on its ability to consistently perform its core, support, and quality functions under both routine and emergency conditions (Wolfe et al., 2021).

Given IDSR's importance in epidemic preparedness, assessing its performance comprehensively and contextually is critical. This doctoral research will evaluate IDSR implementation in Sierra Leone, guided by the IDSR's conceptual framework and the panopticon's theoretical lens. The study aims to examine the system's effectiveness in detecting and responding to public health threats, identify gaps across the surveillance continuum, and propose sustainable, locally appropriate strategies to enhance system performance.

Furthermore, this research will respond to identified gaps in the literature, including:

No Prioritisation of the identified gaps after the evaluation of the IDSR programme

No review of the subnational and private sector contributions;

No evaluation of the most effective IDSR subthemes in preventing the next epidemic.

No data on the current state of integration of digital tools and real-time analytics in Sierra Leone.

No assessment of the inconsistency of community engagement and feedback loops, and the root cause.

No assessment of the Underutilisation of surveillance data in policymaking and outbreak forecasting.

No evaluation of the insufficient focus on equity, particularly rural-urban disparities.

A mixed-methods approach aligned with WHO evaluation protocols will be employed to ensure rigour and policy relevance. Ultimately, this study aims to contribute to the global disease surveillance and response discourse by offering actionable insights for national and international health stakeholders.

CHAPTER 3: RESEARCH METHODS

Introduction

The interconnectedness driven by population growth, industrialization, and globalization has accelerated the worldwide transmission of infectious diseases(*Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019). To combat this, the Integrated Disease Surveillance and Response (IDSR) strategy was established as a key method for early infection detection and containment to prevent global spread. This approach requires individual nations to swiftly identify, investigate, and report potential epidemic threats to facilitate a coordinated international response(Fall et al., 2019a). Although global information sharing has improved, particularly after events like the COVID-19 pandemic, greater political commitment and resources are needed to enhance early warning systems. In Africa, the strategy has evolved since 1998 through building local capacities for data analysis and laboratory confirmation, with its adoption becoming mandatory under the International Health Regulations in 2007, as seen in its gradual implementation in countries like Sierra Leone(Njuguna et al., 2019b).

The West coast of Africa inhabits Sierra Leone in 72,000 Km². It is located in a stretch from latitude 7 degrees North to 10 degrees North and longitude 10 degrees West to 14 degrees West. On the North and Northeast, Sierra Leone is bordered by The Republic of Guinea, the East and Southeast by the Republic of Liberia, and the West and Southwest by the Atlantic Ocean. Sierra Leone is divided into five (5) regions, sixteen (16) districts, and 190 chiefdoms. Sierra Leone has an estimated population of 7,976,983 people. Forty (40%) of this population resides in urban areas(*Sierra Leone 2015 Population and Housing Census National Analytical Report*, 2018).

The health system in Sierra Leone is divided into three levels. At the national level, the Minister of Health and his two deputies lead the political wing, the Chief Medical Officer leads

the technical wing, and his Chief Nursing and Midwifery Officer leads the directors and programme managers. The Senior Permanent Secretary heads the administrative wing.

The second level is at the district level, where the district medical officer, his district sisters, and monitoring and evaluation officers are in all sixteen districts. The last level is the health facilities (*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

In the 2015 IDSR technical guideline, the national MOHS staff will be responsible for policy development, resource mobilisation, coordination, and collaboration in IDSR. The districts and health facilities, including the laboratories, provide community services(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*).

The flow of IDSR data comes from the community to the health facilities and then to the districts. The district will collate the data, analyse it, and respond to some challenges. The issues the district cannot deal with are sent to the national level for a more significant response. At the national level, the Directorate of Health Security and Emergency coordinates the response by the MOHS. The information is then sent to the directorate of planning policy and information for onward dissemination to partners like the World Health Organisation (WHO), the Center for Disease Control, the United States of America, China and the Africa Union(*National Action Plan for Health Security (NAPHS), 2018-2022, Sierra Leone. | FAOLEX, 2018*). The data that has been analysed were sent back from the national level to the district, health facilities and communities with recommendations on how to respond to the challenges on time. It is shown in Figure 1 in chapter one.

The system discussed above is expected to work if the IDSR programme optimises. However, this is not the case for the IDSR programme, even after revision three times: in 2004,

2015, and 2019. The last one was done in 2019 but was not completed before the COVID-19 pandemic. In the next session, we will explain what is happening on the ground that led to the Ebola epidemic 2014 and the COVID-19 pandemic in 2020.

Statement of the Problem

The inadequate implementation of the IDSR system contributed to the emergence and escalation of the Ebola Virus Disease outbreak in Sierra Leone, resulting in substantial health and developmental losses, and similar outcomes may persist if the system is not strengthened (AlMossawi et al., 2019a; Njuguna et al., 2019b). A structured literature review of studies published between 2015 and 2024 across diverse geopolitical contexts identified only a limited number of eligible studies ($n = 9$), highlighting a significant gap in empirical evaluations aligned with WHO surveillance protocols. Evidence from countries including Sierra Leone, Uganda, Tanzania, Iraq, Malawi, Liberia, Nigeria, Ghana, and the Democratic Republic of the Congo demonstrated improvements in reporting systems, digital surveillance tools, and workforce training, yet persistent weaknesses remain in laboratory capacity, data utilisation, coordination, and sustainable financing. The literature further revealed reliance on donor funding, disparities in surveillance performance between urban and rural settings, fragmented reporting systems, and inadequate multisectoral collaboration, all of which undermine timely epidemic detection and response. These studies gave a list of gaps and recommendations but they fail to prioritise these gaps so that cost effective recommendations can be implemented. Guided by surveillance theories such as panopticonism and the oversight role of the International Health Regulations, this study evaluates the core, support, and quality functions of the IDSR programme in Sierra Leone to identify priority gaps and inform cost-effective system strengthening.

Purpose of the Study

This cross-sectional study aimed to evaluate the core and support functions of the Integrated Disease Surveillance and Response (IDSR) programme in Sierra Leone at the national, district, and health facility levels to prevent future epidemics. The research focused on the core, support, quality, and surveillance structures influencing IDSR implementation. A structured questionnaire, incorporating both quantitative and qualitative questions, served as the primary data collection instrument. The instrument organized questions under the headings of core, support, quality, and structural components to align with the study's aim and objectives. Data collection targeted the national, district, and facility levels, including health facilities and laboratories. The study then analysed the collected data to identify prioritised IDSR implementation gaps.

Research Approach and Design

The study adopted a cross-sectional design with a mixed-methods approach to evaluate IDSR implementation. A sample of health facilities trained in IDSR was selected to ensure relevant representation. Data were collected using a structured questionnaire comprising both open-ended and closed-ended questions, integrating quantitative and qualitative components administered concurrently. The qualitative questions were used to complement and provide contextual explanations for the quantitative findings. The study utilised the World Health Organization's generic 2017 questionnaire for the assessment of communicable disease programmes in Africa, which was adapted for the study context(Fall et al., 2019b; Kallay et al., 2024; Njuguna et al., 2019b).

This evaluation of the Integrated Disease Surveillance and Response (IDSR) programme in Sierra Leone employed a mixed-methods research design. Several compelling methodological and practical reasons justified this choice. This approach was essential for comprehensively

addressing the complex realities of the health system by integrating the statistical power of quantitative data with the contextual depth of qualitative insights.

Addressing Complexity and Providing a Holistic Understanding

The primary rationale was the need not only to quantify the level of IDSR implementation but also to explain the underlying reasons for observed performance. Quantitative methods were used to measure the extent of engagement with core and support functions, such as the completeness and timeliness of reporting from health facilities to the national level. However, while these indicators could show the magnitude of epidemiological events, they failed to explain the systemic factors behind them. The qualitative component addressed this gap by investigating stakeholder perceptions, institutional dynamics, resource constraints, and operational challenges, thereby providing a nuanced understanding of the mechanisms, barriers, and enablers affecting system performance(Creswell & Clark, 2017).

Enhancing Validity through Triangulation

The design facilitated triangulation of findings, thereby significantly enhancing the credibility and validity of the results. By corroborating evidence from multiple sources, including surveys, routine surveillance data, policy documents, and in-depth interviews, the study was able to compare performance data with stakeholder narratives. This cross-verification process ensured that the findings were robust and accurately reflected on-the-ground reality(Creswell & Clark, 2017; Schoonenboom & Johnson, 2017).

Facilitating Multi-Level Analysis

The research collected data from multiple levels of the health system (national, district, and health facility). A mixed-methods design was the most appropriate way to ensure that this multi-

level data converged into a coherent analysis. It enabled a cross-level assessment, linking national-level objectives with district-level implementation realities and community-level engagement, thereby providing a comprehensive picture of the programme's operations from policy to practice(Schoonenboom & Johnson, 2017).

Ensuring Complementarity of Inquiry

Mixed methods enabled complementarity, allowing different research questions to be answered with the most suitable method. For instance, a quantitative question might have asked about the frequency of supervision visits. At the same time, a qualitative inquiry sought written evidence and narratives to understand the effectiveness and quality of that supervision. This dual approach ensured that the researcher could both identify problems (e.g., low reporting rates) and understand them by engaging directly with those most affected(Creswell & Clark, 2017; Schoonenboom & Johnson, 2017; Stroud et al., 2020).

Contextual Relevance in Sierra Leone

The frequent occurrence of epidemics (Ebola, COVID-19, Mpox) in Sierra Leone made a mixed-methods approach particularly valuable. While quantitative data often showed good reporting rates, it failed to capture systemic vulnerabilities such as coordination breakdowns, workforce shortages, community mistrust, and infrastructural deficits. The qualitative component was critical for capturing these underlying fragilities that quantitative metrics alone could not reveal(Creswell & Clark, 2017; Schoonenboom & Johnson, 2017).

Initiating Further Research and Expanding Knowledge

The design was also chosen to build on and examine previous data, enabling the initiation of new research questions based on the study's findings. For example, the study identified that frontline health workers lacked knowledge on using case definitions for priority diseases. This

finding, generated through the integrated approach, opened avenues for future research to explore the reasons for this gap and develop targeted solutions, thereby expanding the body of knowledge on IDSR implementation(Stroud et al., 2020).

Increasing Credibility for Advocacy

Given the significant economic and public health impact of epidemics in Sierra Leone, the research findings were intended for advocacy to secure financial and human resources. A mixed-methods design, by creating a more complete and trustworthy picture through triangulation, increased the credibility of the evidence, making it more powerful for convincing policymakers and partners and ensuring public trust(Creswell & Clark, 2017).

Illustrating and Clarifying Findings

Finally, the qualitative data illustrated and gave meaning to the quantitative numbers, providing a clearer, more vivid picture of the realities behind the statistics. This helped to translate abstract data points into tangible human experiences and operational challenges.

Challenges and Mitigation

Despite its strengths, the mixed-methods approach presented challenges, primarily the generation of vast amounts of data, which required significant time and experience to manage. To mitigate this, the study was structured around the IDSR conceptual framework, which provided a clear and efficient guide for designing the research questions, data collection, analysis, and presentation(Creswell & Clark, 2017; Schoonenboom & Johnson, 2017; Stroud et al., 2020).

Population and Sample of the Research Study

This study assessed the preparedness of the Integrated Disease Surveillance and Response (IDSR) programme to prevent and control health emergencies and infectious disease epidemics in Sierra Leone by identifying gaps and prioritising them. To achieve this, the research engaged

stakeholders responsible for the programme's day-to-day management and implementation, gathering data that were used to calculate key performance indicators reflecting the country's preparedness status.

The study population comprised the health workforce involved in the daily implementation of the IDSR programme, estimated at 9,910 individuals, of whom 72% (7,107) were directly involved in patient care (Sierra Leone Human Resources for Health Strategic Plan 2017-2021)(*Sierra Leone Human Resources for Health Strategic Plan (2017-2021) | WHO | Regional Office for Africa, 2017*). The healthcare system within which this workforce operated was structured into a two-tier administrative system (national and district levels) and a two-tier facility system (peripheral health units with community extensions, and secondary/tertiary hospitals)(*Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search, 2022*).

At the national level, the Ministry of Health and Sanitation (MOHS) was organised into three wings that made political, administrative, and technical decisions for the IDSR. The Minister of Health and Sanitation led the political wing. The administrative wing, headed by the Senior Permanent Secretary, coordinated key directorates including Finance, Human Resources for Health, and Donor and NGO coordination. The technical wing, under the Chief Medical Officer, oversaw critical directorates, including Disease Prevention and Control, Health Security and Emergencies, and Primary Health Care. These directorates were managed by directors and programme managers who supervised the implementation of health programmes(*Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search, 2022*).

At the district level, the District Health Management Teams (DHMTs), headed by District Medical Officers (DMOs), managed health activities across the sixteen districts. The DHMTs

functioned as a devolved arm of the MOHS, coordinating primary healthcare and reporting to local government councils, while Medical Superintendents oversaw the district hospitals.

Healthcare delivery was structured across three tiers of facilities, as defined by the 2022 Basic Package of Essential Health Services. Tertiary-level care was provided by three specialist hospitals located in the Western Area, which served as referral centres. Secondary-level care was delivered by twenty-three public and thirty private hospitals distributed across all districts. The foundation of the system was the Peripheral Health Units (PHUs), which provided essential services to local communities. These PHUs included 559 Maternal and Child Health Posts (MCHPs) at the village level, 386 Community Health Posts (CHPs) serving small towns, and 229 Community Health Centres (CHCs) at the chiefdom level, with five CHCs designated as basic Emergency Obstetric and Neonatal Care (BEmONC) centres. This multi-layered structure constituted the operational context for the IDSR programme and defined the levels from which data were collected and the stakeholders sampled for this study(*Basic Package of Essential Health Services in Sierra Leone - Service Provider - IATI Datastore Search*, 2022).

This study assessed the preparedness of the Integrated Disease Surveillance and Response (IDSR) to prevent and control health emergencies and infectious disease epidemics in Sierra Leone. This means that those responsible for the day-to-day running of the IDSR programme were interviewed to understand what was happening in the field. These stakeholders gave us access to the data that was used to calculate the indicators which provided the status of the IDSR programme's preparedness in Sierra Leone

Sampling Technique

A purposive multistage random sampling technique was employed to ensure equal representation across the entire country and among all stakeholders involved in the IDSR

programme. This approach enabled the selection of a sample that reflected the diverse levels of the health system and the various categories of health facilities responsible for IDSR implementation.

National Level Sampling

At the national level, participants were purposively selected based on their direct responsibility for the daily management and oversight of the IDSR system. The sample included the Director of Health Security and Emergencies, the Programme Manager, two Monitoring and Evaluation Officers, the Director of Planning Policy and Information, the Health Information Management Coordinator, and two Monitoring and Evaluation Officers from that directorate. In total, eight (8) national-level stakeholders were interviewed.

District and Hospital Level Sampling

All stakeholders at the district health management level were included in the sample. In each of the sixteen (16) districts, the District Medical Officer, the District Health Sister responsible for IDSR, and the Monitoring and Evaluation Officer (who served as the district focal point for IDSR) were interviewed, yielding forty-eight (48) participants from the district level.

All district hospitals that had been trained on IDSR and were expected to report to the programme were included in the sample. In each of these hospitals, the Medical Superintendent, the IDSR focal point, and the Monitoring and Evaluation Officer were interviewed. This applied to fifty-three (53) public and private hospitals, resulting in one hundred and fifty-nine (159) participants at the hospital level.

Primary Health Care Level Sampling

At the primary health care level, the person in charge of IDSR reporting from each selected health facility was interviewed. These were typically Community Health Officers or Community

Health Nurses managing the facilities. To be eligible for inclusion in the study, health workers were required to meet the following criteria:

Had been responsible for IDSR activities at the health facility for at least one year.

Provided voluntary consent to participate in the study.

Health workers were excluded from the study if they:

Were not responsible for IDSR activities.

Had been responsible for IDSR activities for less than one year.

Did not provide voluntary consent.

Facility Selection Procedure

At the district level, a computer-generated random sampling method was used to select 10% of the chiefdoms in all sixteen (16) districts, ensuring that all health facilities had an equal chance of being selected. Within each selected chiefdom, 10% of all health facilities were subsequently chosen. Proportional representation was applied to ensure that all categories of health facilities—Community Health Centres, Community Health Posts, and Maternal and Child Health Posts—were equally represented based on their population in the chiefdom. Only facilities that had been trained and were eligible to report on IDSR were included.

In the Western Area Urban and Western Area Rural, which are administratively divided into zones rather than chiefdoms, the same sampling approach was applied: 10% of the zones were selected by computer-generated random sampling, and all eligible health facilities within those zones were selected using the same random sampling method to ensure equal representation.

Table 2:

The distribution of chiefdoms per district in Sierra Leone

Regions	Districts	Chiefdoms	Number of Chiefdoms selected per district (10%)
Eastern	Kailahun	14	1
	Kenema	16	2
	Kono	14	1
Subtotal			4
Northern	Bombali	13	1
	Kambia	7	1
	Koinadugu	11	1
	Port Loko	11	1
	Tonkolili	11	1
Subtotal			5
Southern	Bo	15	2
	Bonthe	11	1
	Moyamba	14	1
	Pujehun	12	1
	Subtotal		5
	Grand Total		14

The distribution of chiefdoms per district in all the sixteen districts of Sierra Leone

Three eligible staff were questioned per health facility, making it a total of forty-two (42) from the CHC, CHP and MCHP in the provinces.

Western area urban has twenty zones. Each zone had an average of four health facilities excluding the hospitals. 10% of these zones gave two zones that were randomly selected. All of the health facilities selected were distributed by CHCs, CHPs and MCHPs making it a total of six (6) health facilities and six people in total to be questioned in Western Area Urban.

Western area rural had sixty-three peripheral health facilities. There are 20 zones also in Western area rural. Each zone had an average of three (3) health facilities in the zone. All the health facilities were represented by equal proportion which summed to a total of three (3) health facilities and three people were questioned.

Table 3:

The distribution of number of interviewees

Level at which the staff are working	Number of staff that were requested for interviewed	Number of staff that were requested but declined interviewed	Number of staff that were interviewed
National	12	4	8
District Health management Team	60	12	48
Hospitals	201	42	159
Peripheral Health Units (Provincial)	50	8	42
Peripheral Health Units (Western Area Urban)	15	9	6
Peripheral Health Units (Western Area Rural)	10	1	9
Grand Total	348	76	272
Grand Total in Percentages	100	21.83908046	78.16091954

The distribution of number of interviewees

The sample size of the study is 272 people were questioned.

How were participants recruited to this Study

The study involved voluntarily convincing stakeholders of the IDSR programme to participate in interviews. 348 staff were approached to take part in the study but 272(78.2%) stakeholders gave consent to be interviewed. The main reason for decline to take part in the study was because they were busy with COVID-19 activities. Meetings were set up with top management of the Ministry of Health and Sanitation who were involved in the daily implementation of IDSR. During these meetings, appointments were arranged at times convenient to their work schedules. They were also asked to assign liaisons within their offices to assist in rescheduling missed appointments. During the meetings with these stakeholders, they were asked to voluntarily sign a consent form if they agreed to participate in the study. The same process took place at the district level and in health facilities, where participants also signed a consent form to voluntarily take part in the study

Materials/Instrumentation of Research Tools

This study was done using the generic WHO questionnaire on evaluating communicable disease programmes in Africa (Hamalaw et al., 2022b).

Origin

Historically, disease surveillance in Sierra Leone was conducted vertically by individual programmes, each utilising the same systems, personnel, and activities to implement their functions. This fragmented approach placed considerable strain on the health system and its workforce, ultimately limiting the success of the individual programmes (*Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019). In response to these inefficiencies, the World Health Organisation introduced the Integrated Disease Surveillance and Response (IDSR) strategy in 1998, aimed at making the surveillance of

communicable diseases more cost-effective for member states(*World Health Organization Sierra Leone Annual Report 2017 | WHO | Regional Office for Africa*, 2025).

For the IDSR programme to function effectively as an early warning system for potential outbreaks, it requires regular evaluation to identify and address challenges before they escalate into epidemics. To facilitate this, the WHO and its partners developed a standardised assessment protocol in 2001 that included a questionnaire to ensure consistency in data collection across settings. This protocol provided a comprehensive guide to conducting the survey, analysing, and presenting the resulting data ((*World Health Organization Sierra Leone Annual Report 2017 | WHO | Regional Office for Africa*, 2025). The present study adopted this established methodology to ensure rigour and comparability in assessing IDSR preparedness in Sierra Leone.

Validity and reliability of the questionnaire

The present questionnaire was administered to assess the Integrated Disease Surveillance and Response (IDSR) programme. Its utility has been previously validated in multiple national contexts for evaluating IDSR implementation and informing strategies to address associated challenges in the control of communicable and non-communicable diseases(Joseph Wu et al., 2018; Masiira et al., 2019; Saleh et al., 2021). Permission for its use was not required from the World Health Organisation.

The instrument was adapted for the local context during a workshop held on the 16th and 17th of September 2021. This workshop took place at the Emergency Operation Centre, Wilkinson Road, Freetown, the central office of the Directorate of Health Security and Emergency. Participants included key IDSR stakeholders: the director, programme managers, the deputy programme manager, health sisters, surveillance officers, and a data manager. The amendments to the questionnaire were minor and did not require further review by the ethics committee.

Ethical approval for the study was granted by the UNICAF Research Ethics Review Committee and the Sierra Leone Ethics and Scientific Review Committee on 10 September 2021.

Trustworthiness of Data

Triangulation was employed as a methodological strategy to enhance the validity and credibility of the study's findings by integrating multiple data sources and methods to produce coherent, reliable results (Dzwigol, 2020; Santos et al., 2020). The study adopted a mixed-methods approach to evaluate the extent to which stakeholders within the Ministry of Health and Sanitation and its partners effectively engaged the core and support functions of the IDSR programme for epidemic prevention and control. Data were collected at three levels—national, district, and health facility—using structured questionnaires with comparable sections, enabling cross-verification of findings across levels. Additionally, methodological triangulation was achieved by integrating quantitative and qualitative data, enabling corroboration of statistical findings with contextual insights.

Transferability:

Transferability was considered to determine the extent to which the study findings could be applied to similar contexts. Given that the IDSR programme is integrated into national health systems across multiple countries, including Sierra Leone, the findings were deemed transferable to settings with comparable health system structures. The study provided sufficient contextual detail to enable readers to assess the applicability of the findings to other countries with similar surveillance frameworks, such as Liberia, Guinea, Senegal, and Malawi, thereby supporting broader relevance beyond the study setting (Munthe-Kaas et al., 2020).

Dependability:

Dependability was ensured by implementing procedures that enhanced the consistency and reproducibility of the study findings, such that similar results would be obtained under comparable conditions. An external audit approach was employed to minimise researcher bias and ensure that interpretations were grounded in empirical evidence rather than subjective influence (Stahl & King, 2020). This involved maintaining transparency in data collection and analysis to ensure the dataset adequately supported the study's conclusions. Additionally, the study was reviewed by external supervisors prior to completion, providing independent verification and strengthening the research's reliability and credibility.

Validity and Reliability of Data

Validity in research is the extent to which the research methodology accurately measures the study's variables. In this study, we used a mixed-methods approach, combining quantitative and qualitative data to provide greater clarity to the research findings. The quantitative data collected supported the study's hypothesis that stakeholders in Sierra Leone's IDSR programme had not been able to effectively engage in the programme's core functions to contain the next infectious disease epidemic. The qualitative data were used to explain the challenges that health workers are facing as they fight infectious disease epidemics (Ahmed & Ishtiaq, 2021).

Reliability is the production of the same result for a specific method that is used for a situation. If a research method is used to produce a result and this same research method is used in a similar condition and it produces the same or similar result then the methodology is reliable (Ahmed & Ishtiaq, 2021).

The questionnaire we used was tested for reliability before the full-scale assessment. I visited five health facilities and five districts, asked questions, and completed the questionnaire. Upon returning, I prepared an Excel sheet detailing respondents' responses from the health

facilities and districts so I could use them in IBM SPSS to calculate Cronbach's alpha (α). Cronbach's alpha (α) is a test for internal reliability of the questions in a questionnaire. This was to examine whether the questions in the questionnaire are all connected, and whether the sole intention of asking them is to determine whether the stakeholders working in IDSR in Sierra Leone have done enough to prevent the next infectious disease epidemic or any public health emergencies of international concern (Amiruddin et al., 2021). The following table was developed as shown below:

Table 4:

The test retests validity and reliability of questions used for health facilities Core functions and timeliness of reporting of the implementation of IDSR in the Health facilities. The result of the Cronbach's Alpha is show below in the SPSS IBM output.

TEST RETEST FOR RELIABILITY OF QUESTIONNAIRE FOR HEALTH FACILITIES

		Ob ser ve nat ion al sur vei lla nc e ma nu al	O bs er ve d th e ex ist en ce of a cli ni ca l re gi ster	O bs er ve d th e co rr ec t fil ling of the cli nica l re gi ster dur ing the prev	O bs er ve d th e pr es en ce of m at er ial s re qu ir ed to col lect	D o y o u h a v e th e ca p ac it y to h a n dl e sp ut um , st o ol ,	Ob ser ve d pre sen ce of tra ns por t me dia for sam ples to the next lev el he alt h fac ilit y	Ha ve yo u lac ke d ap pr op ria te sur vei lla nc e for ms at an y ti me dur ing the last 6 mo	Ob ser ve d tha t the last mon th ly rep ort agr eed wit h the reg iste r for 4 dis eas es (1 for eac h tar get	N u m be r of re po rts in th e la st 3 mon th s com pare d to ex pec ted num	O n ti m e (u se na tio nal de ad lin es)	D o yo u h a v e an ac ti on th re sh old fo r an y of th e co un tr y prio rit y di se	Ob ser ve d pre sen ce of de mo gra phi c dat a at site (E. g. po pul ati on <5 yr., po pul ati on by vill	Ob ser ve d the ex iste nc e of a wri tte n cas e ma na ge me nt pro toc ol for 1 epi de mi c pro ne	Ha s the hea lth fac ilit y im ple me nte d pre ve nti on an d con tr ol me asu res bas ed on loc al dat a	O bs er ve d th at the alt h fa cil ity ac hi ev ed an ac ce pt ab le ca se fat ali ty rat e	O bs er ve d at le ast 1 re po rt or bul letin at the alt h fa cil ity team	Ob ser ve d the mi nu tes or re po rt of at lea st 1 me eti ng bet we en the alt h fac ilit y tea m	Ob ser ve d su per vi sion re po rt or an y evi dence for ap pro pria te rev iew of sur vei lla nce	Ob ser ve d su per vi sion re po rt or an y evi dence for ap pro pria te rev iew of sur vei lla nce	Ha ve yo u bee n train ed in dis eas e sur vei lla nce and epi de mi c ma nag em ent ?	R es ou rc es	Ar e yo u sat isfi ed wit h the sur vei lla nc e sys te m?

[illegible]

[illegible]

Validity was ensured by adopting a mixed-methods approach that integrated quantitative and qualitative data to comprehensively assess the study variables. The quantitative findings supported the hypothesis that stakeholders in Sierra Leone's IDSR programme had not effectively engaged the core functions required for epidemic prevention. At the same time, the qualitative data provided contextual explanations of the challenges faced by health workers in implementing surveillance activities (Ahmed & Ishtiaq, 2021). Reliability was established by ensuring that the research methodology could produce consistent results under similar conditions.

The analysis yielded a Cronbach's alpha (α) of 0.7 for the responses, calculated using IBM SPSS Version 21. This result indicated that the questionnaire possessed sufficient internal consistency to reliably measure the intended constructs. The instrument was therefore deemed appropriate for determining whether stakeholders working in the IDSR programme in Sierra Leone had effectively engaged the core and support functions to prevent the next epidemic at the health facility level.

I validated the district-level questionnaire for reliability using data collected from five districts: Western Area Urban, Western Area Rural, Port Loko, Kambia, and Bombali. As with the health facility questionnaire, I coded positive responses as one (1) and negative responses as zero (0) prior to analysis. The table is shown below:

Table 5:

A table to show the test retest for reliability and validity of the questions used for the district

TEST RETEST FOR RELIABILITY OF QUESTIONNAIRE FOR HEALTH FACILITIES

		Ob	O	O	O	D	Ob	Ha	Ob	N	O	D	Ob	Ob	Ob	Ha	O	O	O	O	Ob	Ha	Re	Ar
		ser	bs	bs	bs	o	ser	ve	ser	u	n	o	ser	ser	ser	s	bs	bs	bs	bs	ser	ve	so	e
		ve	er	er	er	y	ve	yo	ve	m	ti	yo	ved	ved	ve	the	er	er	er	er	ve	you	ur	yo
		na	ve	ve	ve	o	d	u	d	be	m	u	pre	rat	d	he	ve	ve	ve	ve	d	bee	ce	u
		tio	d	d	d	u	pr	lac	tha	r	e	ha	sen	es	the	alt	d	d	d	d	su	n	s	sat
		nal	th	th	th	h	ese	ke	t	of	(u	ve	ce	der	exi	h	th	at	th	su	pe	trai		isfi
		su	e	e	e	a	nc	d	the	re	se	an	of	ive	ste	fac	at	le	e	pe	rvi	ned		ed
		rv	ex	co	pr	ve	e	ap	las	po	na	ac	de	d	nce	ilit	th	as	mi	rvi	sio	in		wit
		eill	ist	rr	es	th	of	pr	t	rt	tio	ti	mo	fro	of	y	e	t 1	nu	sio	n	dis		h
		an	en	ec	en	e	tra	op	mo	s	na	on	gra	m	a	im	he	re	tes	n	re	eas		the
		ce	ce	t	ce	ca	ns	ria	nth	in	l	th	phi	de	wri	ple	alt	po	or	re	po	e		su
		ma	of	fil	of	p	po	te	ly	th	de	re	c	mo	tte	me	h	rt	re	po	rt	sur		rv
		nu	a	li	m	ac	rt	su	rep	e	ad	sh	dat	gra	n	nte	fa	or	po	rt	or	veil		eill
		al	cli	ng	at	it	me	rv	ort	la	lin	ol	a	phi	cas	d	cil	b	rt	or	an	lan		an
			ni	of	er	y	dia	eill	agr	st	es)	d	at	c	e	pre	ity	ul	of	an	y	ce		ce

			ca	th	ial	to	for	an	eed	3		fo	site	dat	ma	ve	ac	let	at	y	evi	and		sys
			l	e	s	h	sa	ce	wit	m		r		a	na	nti	hi	in	lea	evi	de	epi		te
			re	cli	re	a	mp	for	h	on		an	(E.		ge	on	ev	at	st	de	nc	de		m?
			gi	ni	q	n	les	ms	the	th		y	g.		me	an	ed	th	1	nc	e	mic		
			st	ca	ui	dl	to	at	reg	s		of	po		nt	d	an	e	me	e	for	ma		
			er	l	re	e	the	an	iste	co		th	pul		pr	co	ac	he	eti	of	ap	nag		
				re	d	sp	ne	y	r	m		e	ati		oto	ntr	ce	al	ng	su	pr	em		
				gi	to	ut	xt	ti	for	pa		co	on		col	ol	pt	th	be	pe	op	ent		
				st	co	u	lev	me	4	re		u	<5		for	me	ab	fa	tw	rvi	ria	?		
				er	lle	m	el	du	dis	d		nt	yr.,		1	asu	le	cil	ee	sio	te			
				d	ct	,		rin	eas	to		ry	po		epi	res	ca	it	n	n	re			
				ur		st	he	g	es	ex		pr	pul		de	bas	se	y	th	in	vie			
				in		o	alt	the	(1	pe		io	ati		mi	ed	fat	fr	e	las	w			
				g		ol	h	las	for	ct		rit	on		c	on	ali	o	he	t 6	of			
				th		,	fac	t 6	eac	ed		y	by		pr	loc	ty	m	alt	m	su			
				e			ilit	mo	h	nu		di	vill		on	al	ra	a	h		rv			

				pr			y	nt	tar	m		se	age		e	dat	te	hi	fac	on	eill			
				ev				hs	get	be		as	,		dis	a	fo	gh	ilit	ths	an			
				io			blo	?	ed	r		es			eas	for	r	er	y		ce			
				us			od/		gro			?	tot		e	at	m	le	tea		pr			
				30			ser		up				al			lea	os	ve	m		act			
				da			um		[er				po			st	t	l	an		ice			
				ys			an		adi				pul			on	re	d	d		s			
							d		cat				ati			e	ce	ur	th					
							CS		ion				on)			rep	nt	in	e					
							F		;							ort	ou	g	co					
							un		eli							abl	tb	th	m					
							til		mi							e	re	e	m					
							shi		nat							dis	ak	pa	un					
							pm		ion							eas		st	ity					
							ent		;							e		ye	me					
							at		epi							or		ar	m					

							this facility?		demic proportion; major public health improvement							syndromes?		on their websites					

[illegible]

[illegible]

[illegible]

A table to show the test retest for reliability and validity of the questions used for the districts

Responses from five districts were used to validate the questionnaire's reliability. Cronbach's alpha (α) was calculated at 0.851 for the 41 items, indicating a high level of internal consistency and confirming that the instrument was reliable.

This demonstrated that the questionnaire items were well correlated and effectively measured the intended constructs.

However, at the national level, only a single questionnaire was administered, which limited the ability to compute Cronbach's alpha due to the insufficient sample size.

Operational Definition of Variables

Organisation protocol for the assessment of communicable disease programmes, utilising its monitoring and evaluation framework to guide data collection, analysis, and presentation. The framework defined specific indicators applied at the health facility level, with comparative analysis conducted between health facilities and their respective districts. Sociodemographic characteristics of respondents were systematically captured, including geographic location (districts and regions), level and type of health facility (public or private), sex, and professional role within the Ministry of Health and Sanitation.

This structured approach ensured consistency in data collection and facilitated meaningful comparisons across different levels of the health system.

The quantitative variables were as follows:

Data from the DHIS-2 was used to estimate the timeliness and the completeness of reporting. The health facility data was also used to calculate the timeliness and reporting for the time the data was collected.

The timeliness of reporting was measured as the percentage of reports submitted on time according to the Sierra Leone Integrated Disease Surveillance and Response guideline. The data

were collected at two points. The first was during the data collection in the health facilities and desk review at the national level. The timeliness of reporting was used as the dependent variable in the regression model. Data on the timeliness of reporting were collected during health facility visits. The timeliness of reporting was used as the outcome indicator at the health facilities, as all the ones visited had data.

The completeness of reporting was the percentage of reports submitted at any time to the district and national levels. This was also collected during the health facilities visit and at the national level during a desk review. The timeliness of reporting collected during the health facility visit was used as the dependent variable for the regression analysis. The independent variables were the functions collected from the health facilities and laboratories.

Case fatality rates for COVID-19 patients from the districts were taken from DHIS-2 and IDSR reports during the COVID-19 outbreak in 2021. It was defined as the monthly proportion of deaths among confirmed or probable COVID-19 patients in 2021.

Acceptable case fatality at the district level was defined as the case fatality proportion among COVID-19 patients remaining at or below 2%, in line with WHO-recommended benchmark thresholds. This threshold reflects levels observed in settings with effective surveillance, timely case management, and adequate epidemic response capacity (Liu et al., 2022). Acceptable case fatality was calculated monthly throughout 2021. Districts recording a monthly case fatality rate of $\leq 2\%$ were assigned a score of 1, indicating acceptable performance, whereas districts with a monthly case fatality rate of $> 2\%$ were assigned a score of 0, indicating unacceptable performance (Liu et al., 2022; Njuguna et al., 2025).

The average monthly acceptable case fatality score across the 12 months of 2021 was subsequently computed and used as the primary outcome indicator to assess the effectiveness of

IDSR core and support functions at the district level. The acceptable case fatality rate was used as an outcome indicator for the district data because it was not available at all the health facilities visited.(*World Health Organization Sierra Leone Annual Report 2017 | WHO | Regional Office for Africa*, 2025).

A confirmed COVID-19 case was defined as a laboratory-confirmed COVID-19 patient, regardless of clinical signs or symptoms.

A probable COVID-19 case was a suspect case for whom COVID-19 testing was inconclusive. Inconclusive is the result of the test reported by the laboratory.

OR a suspect case for whom testing could not be performed for any reason(Liu et al., 2022; Njuguna et al., 2025; *World Health Organization Sierra Leone Annual Report 2017 | WHO | Regional Office for Africa*, 2025).

Suspect case: A patient with acute respiratory illness (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath), AND a history of travel to or residence in a location reporting community transmission of COVID-19 disease during the 14 days before symptom onset.

OR a patient with any acute respiratory illness AND having been in contact with a confirmed or probable COVID-19 case in the last 14 days before symptom onset; OR a patient with severe acute respiratory infection (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath; AND requiring hospitalization) AND in the absence of an alternative diagnosis that fully explains the clinical presentation(Liu et al., 2022; Njuguna et al., 2025).

The core framework indicators that were assessed for the health facilities:

Regression analysis at the health facilities: The regression analysis assessed the association between performance at the health facilities, as predictors, and the timeliness of IDSR reports at the health facilities, which was used as the outcome indicator. This was to assess whether the IDSR core and support functions at the health facilities were able to predict the timeliness of reporting at the facilities.

The performance at the health facility was measured by assigning one(1) for successful implementation of the question and zero(0) for failed implementation. The total was averaged and put in percentages. For example, the questions for case detection and registration are in the questionnaire located in the appendix.

The average performance of all these indicators was used to assess the effectiveness of the IDSR function's case detection and registration. This figure was used as one of the independent variables in the ordinal regression model to establish a relationship between the performance of the functions and the timeliness of reporting. This was done for all the core and support functions.

Regression analysis at the district: The regression analysis for the district assessed the association between district-level performance predictors and the acceptable case fatality of COVID-19 patients in 2021, which was used as the outcome indicator. This was to determine whether the IDSR core and support functions at the district level could predict the acceptable case fatality rate for COVID-19 patients in 2021.

The performance at the districts was measured by assigning one (1) for successful implementation of the question and zero (0) for failed implementation. The total was averaged and put in percentages. For example, the questions for case detection and registration are in the questionnaire located in the appendix.

The average performance of all these indicators was used to assess the effectiveness of the IDSR function's case detection and registration. This figure was used as one of the independent variables in the ordinal regression model to examine the relationship between the performance of the functions and the acceptable case fatality rate of COVID-19 patients across districts. This was done for all the core and support functions at the districts.

Case Detection and Registration

We calculated the percentage of health facilities utilising the Integrated Disease Surveillance and Response (IDSR) standard case definitions by dividing the number of facilities using these definitions by the total number of facilities interviewed and multiplying by 100. We similarly determined the percentage capable of diagnosing at least one priority disease. To assess registration practices, we calculated the percentage of facilities with an outpatient clinical register and the percentage of priority cases correctly registered, using the same formula for both.

Case Confirmation

We measured case confirmation capacity by calculating the percentages of facilities able to collect specimens and manage them until shipment, as well as those able to ship specimens to the next level. We also calculated the percentage of facilities possessing a guideline for specimen collection, handling, and transportation. We measured overall performance in this domain by assigning a score of 1 for successful implementation of each relevant questionnaire item and 0 for failure, then averaging these scores and expressing the result as a percentage.

Case Reporting

We calculated the percentage of facilities with adequate surveillance reporting forms for the preceding six months and the percentage with a formalised reporting system to the next level, using the total number of interviewed facilities as the denominator.

Data Analysis

We assessed analytical capacity by calculating the percentage of facilities able to analyse and present data by person, by place, and by time. Finally, we calculated the percentage of facilities capable of performing trend analysis.

Epidemic Preparedness and Response

We calculated the percentage of health facilities with an epidemic preparedness and response plan by dividing the number possessing such a plan by the total number interviewed and multiplying by 100. We similarly determined the percentage of facilities that maintained a dedicated budget line for epidemic response. We calculated the percentage of facilities that had a formal epidemic response team. We measured the percentage of facilities that had established action thresholds for Sierra Leone's priority diseases and the percentage that possessed standard case management guidelines for those diseases. We further calculated the percentage of facilities that maintained a one-year stockpile of emergency drugs and supplies for priority diseases, as well as the percentage that reported a shortage of drugs or supplies during the most recent outbreak.

We measured overall epidemic preparedness performance by assigning a score of 1 for successful implementation of each relevant questionnaire item and 0 for failure, then averaging the scores and expressing the result as a percentage. The specific questions on epidemic preparedness are reproduced in the appendix.

Feedback

We calculated the percentage of facilities that had received written feedback or a bulletin from a higher level within the surveillance system. We also determined the percentage of facilities that had produced written feedback or a bulletin themselves over the preceding year.

Availability of Laboratory Support in IDSR:

This is the extent to which health facilities and surveillance systems are equipped to confirm priority diseases through timely reliable and accessible diagnostic services.

This indicator is subdivided into subcomponents as follows:

Laboratory Infrastructure

- Presence of functional laboratory at the health facility or nearby referral centre.
- Level of lab service (e.g., basic microscopy vs. PCR or culture capacity).
- Electricity and water supply to support lab operations.
- Cold chain availability for sample storage (e.g., refrigerators, freezers).

Diagnostic Capacity

- Availability of essential tests for priority diseases (e.g., malaria RDTs, cholera test kits, COVID-19 PCR, measles IgM, etc.).
- Turnaround time for test results.
- Testing algorithms and Standard Operating Procedures in place and used.

Human Resources

- Qualified laboratory personnel (e.g., lab technicians trained in disease diagnostics).
- Regular training/refresher courses on IDSR-related diagnostics and biosafety.
- Staffing levels relative to testing workload.

Supplies and Reagents

- Availability of test kits, reagents, and consumables (e.g., gloves, swabs, sample tubes).
- Stock-out frequency and supply chain reliability.
- Inventory management system in use.

Sample Handling and Transport

- Proper sample collection materials (e.g., sterile containers, swabs).
- Availability of sample transport logistics, including:
 - o Transport boxes with cold packs.
 - o Regular courier or vehicle services.

Chain of custody documentation and packaging standards followed.

Data and Reporting Systems

- Integration of lab results with IDSR reporting platforms (e.g., DHIS2).
- Feedback mechanism from laboratories to clinicians and surveillance teams.
- Participation in External Quality Assurance (EQA) programs or proficiency testing.

Coordination and Referral Networks

- Linkages between peripheral facilities and reference labs (e.g., district or national public health labs).
- Clear protocols for when and where to send samples.
- Communication mechanisms between lab and IDSR teams for outbreak detection.

Biosafety and Waste Management

- Availability of PPE, disinfectants, and biosafety protocols.
 - Proper disposal of biohazard waste (e.g., incineration, sharps containers).
 - Infection prevention and control (IPC) practices.
-

The support functions were defined as follows for health facilities compared with districts

Standards and Guidelines

We calculated the percentage of health facilities that possessed the national standards and guidelines for surveillance of priority diseases by dividing the number meeting this criterion by the total number of facilities interviewed.

Supervision

We determined the percentage of health facilities that had received supervision from a higher-level IDSR officer in the preceding six months. We then calculated the percentage of districts that contained at least one supervised health facility. Finally, we calculated the percentage of districts where supervisors had used a standard IDSR checklist during supervisory visits.

Training

We measured staff training and knowledge by calculating the percentage of health facilities that employed staff with knowledge of IDSR, the percentage with staff aware of IDSR indicators, and the percentage with staff formally trained in IDSR, each expressed as a proportion of the total number of facilities interviewed.

Coordination

We assessed coordination by calculating the percentage of districts that had designated supervisors for the IDSR programme, using the total number of districts interviewed as the denominator.

Minimal Resources:

Logistics and Data Management

We calculated the percentage of health facilities that possessed essential logistics—including electricity, bicycles, motorcycles, and vehicles—to support IDSR activities. We

similarly determined the percentage of health facilities that had the necessary logistics specifically for IDSR data management.

Laboratory Capacity

We assessed the diagnostic laboratory capacity of both health facility–based laboratories and standalone laboratories, analysing variables derived from the questionnaire.

We calculated the percentage of laboratory facilities that provided each of the following services to support identification of IDSR priority diseases: bacteriology, virology, mycobacteriology, parasitology, mycology, and cell culture. We also determined the percentage of laboratory facilities physically connected to a hospital building.

To characterise infrastructure, we calculated the percentage of laboratories with daily electricity, running water, and gas, categorising availability as <50%, 50–95%, and 95–100% for each. We further calculated the percentage of laboratories connected to a backup power system (emergency generator) overall, as well as the percentage using such backup specifically to protect refrigerators or freezers, ventilation or air conditioning systems, and computers.

Data Quality Considerations

We recognised that data obtained from questionnaires may be subject to bias introduced by the respondent or the interviewer. To mitigate this, we emphasised the collection of high-quality data derived from routine IDSR programme activities (Texila American University. & HakwiaKooma, 2019).

Qualitative Data Analysis: A qualitative, deductive method was used.

The purposive sample of health facilities, district, and national staff was interviewed during the data collection visit, at the same time as the quantitative data were collected. The interviews were recorded and transcribed using the WHO communicable disease framework questionnaire.

For each question, the staff suggested challenges and improvements. The data was entered into NVivo 14 and analysed using the same theoretical framework. This was done for the core and support functions of IDSR at the health facility and district levels. The coding structure followed the theoretical framework of core and support functions. The coding was using the a priori themes and categories derived from the WHO communicable disease framework. Some flexibility was shown in the analysis as some codes became very similar; they were reorganised using an Excel sheet to form new themes. Although these new codes were supplementary, they were used to support the prioritisation of the IDSR core and support functions.

The operational definitions of the quality indicators have been collected.

Acceptability, Completeness, and Timeliness

We measured acceptability as stakeholders' willingness to implement the programme by ensuring complete and timely data collection. We calculated completeness as the percentage of health facilities that submitted an IDSR report to the next level by the end of 2021, irrespective of timing. We calculated timeliness as the percentage of health facilities that submitted reports by the deadline specified in the national IDSR technical guideline, dividing the number of timely reports by the total number of facilities required to report and multiplying by 100 (T. Alemu et al., 2019a; Texila American University & HakwiaKooma, 2019).

Data Quality and Predictive Value

We assessed data quality by evaluating completeness of recording and consistency between health facility records and the national DHIS-2 database (Nakiire et al., 2019a; Texila American University & HakwiaKooma, 2019). We calculated the positive predictive value as the number of priority diseases identified by the IDSR programme that were subsequently

confirmed, using data from 2021 (T. Alemu et al., 2019a; Texila American University & HakwiaKooma, 2019).

Flexibility, Representativeness, and Simplicity

We defined flexibility as the system's capacity to add or remove priority diseases or events and to change reporting frequency based on stakeholder decisions supported by evidence. We assessed representativeness by whether the programme reported all priority diseases with their distribution by person, place, and time. We evaluated simplicity as the ease of implementing the programme while meeting the objectives set in the IDSR technical guidelines (T. Alemu et al., 2019b; texila american university. & HakwiaKooma, 2019).

Stability, Usefulness, Sensitivity, and Specificity

We defined stability as the reliable operation of data collection, management, and presentation without failure. We assessed usefulness by the extent to which IDSR data informed public health actions and programme plans. We calculated sensitivity as the proportion of true health emergencies detected by the IDSR programme compared to an independent detection system. We calculated specificity as the proportion of persons correctly identified as not having the priority disease or risk factor (T. Alemu et al., 2019b).

Study Procedure and Ethical Assurance

We obtained ethical clearance from the UNICAF Research Ethics Committee (UREC) on 10 September 2021, prior to commencing data collection on 20 September 2021. To maintain interviewee anonymity, we collected no personal details, including names or ages, thereby masking participants throughout data collection, analysis, and dissemination. The Ministry of Health and Sanitation (MOHS) retained ownership of the completed data collection forms, which we stored under lock at the Directorate of Health Security and Emergencies; the MOHS

Directorate, in consultation with the principal investigator, granted access to the data. The study involved minimal intervention with human participants.

Data Collection Process

We collected data across all 16 districts in Sierra Leone, covering the five regions. Following ethical approval, I submitted the protocol for urgent review to the MOHS Scientific and Ethics Committee, which granted approval on 17 September 2021. I convened a stakeholder meeting on 18–19 September 2021 to adapt the WHO generic questionnaire. Data collection began on 20 September 2021 in Western Area Urban, where I interviewed the Director of Health Security and Emergencies, programme managers for surveillance and health security and their deputies, the surveillance data manager, and the leads for clinical and public health laboratories. I also interviewed the Director of Planning, Policy and Information, DHIS-2 administrators, and monitoring and evaluation officers. In Western Area Urban, I visited 12 hospitals and one community health centre, interviewing 39 individuals, and also visited the central reference public health laboratory to interview managers and staff.

I subsequently visited Western Area Rural, where I surveyed three hospitals, one community health centre, one community health post, and one maternal and child health post. I then proceeded to Kailahun and Kenema in the Eastern Region, followed by Bo, Pujehun, Bonthe, and Moyamba in the Southern Region. In the Northern Region, I visited Bombali, Tonkolili, Koinadugu, and Falaba, and in the North-Western Region, I completed data collection in Kambia, Port Loko, and Karene districts. The entire data collection process lasted twenty-two days.

In each district, I first interviewed the District Health Management Team (DHMT), after which the IDSR programme coordinator accompanied me to the health facilities.

Table 6:*Randomly selected health facilities in the districts*

RANDOMLY SELECTED HOSPITALS, CHC, CHP, AND MCHP IN THE DISTRICTS					
No	REGIONS	DISTRICTS	CHIEFDOMS	HEALTH FACILITIES (HF) TYPES	NAMES OF HF
1	Southern Region	BO	KAKUA	Hospital	Bo Government Hospital
2				Hospital	Gilas Hospital
3				Hospital	Kakua Children`s
4				Hospital	Kindoyal
5				Hospital	Mercyships
6			Tinkonko	CHC	Tinkoko Bo
7				CHP	Sembehun 17
8				MCHP	Sebehun Tabay
9			Wonde	CHC	Gboyama
10				CHP	Bathurst
11				MCHP	Kambawama
12		Bonthe	Yawbeko	Hospital	Bonthe Government

13				Hospital	Mattru UBC
14				Hospital	Sierra Rutile
15				CHC	Talia
16				MCHP	Mobefa
17		Moyamba	Lower Banta	Hospital	Moyamba Government
18				Hospital	UMC Rotifunk
19				CHC	Mokanji
20				CHP	Mokotawa
21				MCHP	Njagbahun
22		Pujehun	Kpanga Krim	Hospital	Pujehun Government
23				CHC	Gobaru
24				MCHP	Vaama
25	EASTERN	Kono	Nimiyama	Hospital	Koidu government
26				CHC	Jaiama Sewafe
27				CHP	Nga Town
28				MCHP	Peya

29		kenema		Hospital	Kenema Government
30				Hospital	Panguma
31				Hospital	Ahymadiya Muslim
32			Niawa	CHC	Sendumei
33				CHP	Gondorhun
34				MCHP	Bandawor
35			Koya(Kene)	CHC	Baoma
36				CHP	Jui
37				MCHP	Bongor
38		Kailahun		Hospital	Kailahun government
39				Hospital	Nixon Methodist
40			Yawei	CHC	Bandajuma
41				CHP	Malema
42	Northern	Bombali		Hospital	Makeni Government
43				Hospital	Arab Hospital

44				Hospital	Mabenteh Community
45				Hospital	Holy Spirit
46			Gbanti	CHC	Panlap
47				CHP	Yoni
48				NCHP	Stocco
49		Tonkolili		Hospital	Tonkolili Government Hospital
50				Hospital	Masanga Leprosy Hospital
51				Hospital	Lion Heart Hospital
52			Sambaya Bendugu	CHC	Bendugu
53				CHP	Kunya
54				MCHP	Dankawalia
55		Kionadugu		Hospital	Kabala Government
56			Kamukeh	CHP	Thellia

57				MCHP	Mandia
58		Falaba	Barawa Wolley	CHP	Firawa
59	Northwest	Port Loko		Hospital	Port Loko Government
60				Hospital	Bai Bureh Memorial
61				Hospital	Lungi Government
62				Hospital	St John of god (Mabesseneh)
63				Hospital	Love Bridge
64			Maforki	CHC	Rogbere Junction CHC
65				CHP	New Maforki CHP
66				MCHP	Maforay MCHP
67		Kambia		Hospital	Kambia Government
68			Bramaia	CHC	Kukuna CHC

69				CHP	Konta CHP
70				MCHP	Gbolon MCHP
71		Karene		Hospital	Kamakwie Wesleyan
72			Tambaka	CHC	Fintonia CHC
73				CHP	Dumbaya CHP
74				MCHP	Sanya MCHP
75	Western	Western Area Urban		Hospital	Aberdeen Women Center
76				Hospital	Choithram Memorial
77				Hospital	Connaught Hospital
78				Hospital	Kingharman Road Government
79				Hospital	Kingtom Police Hospital
80				Hospital	Lumbley Government Hospital

81				Hospital	Macauley Street Gouvernement
82				Hospital	Ola During Children`s Hospital
83				Hospital	PCMH
84				Hospital	RoKupa Government Hospital
85				Hospital	UMC Hospital
86				Hospital	34 Wilberforce Military Hospital
87				CHC	Kroo bay
88		Western Area Rural		Hospital	Adra Hospital
89				Hospital	Christ the King Hospital
90				Hospital	Sierra Leone- China

					Teaching Hospital
91			York	CHC	York
92				CHP	Mambo
93				MCHP	Tissana

Randomly selected health facilities in the districts

We conducted national-level stakeholder interviews using a semi-structured questionnaire aligned with the IDSR monitoring and evaluation framework. We structured the interviews to cover core functions, support functions, quality indicators, and structural components of the IDSR programme. We also attempted to collect data from laboratories, though this proved difficult owing to staff workloads related to COVID-19 testing.

Ethical Assurance

We obtained ethical clearance from the UNICAF University Research Ethics Committee and the Sierra Leone Ministry of Health and Sanitation (MOHS) Scientific and Ethics Committee. I secured letters of support from the Directorate of Health Security and Emergencies, addressed to district medical officers, medical superintendents, and clinical and public health laboratory managers, to facilitate access to data. As the study involved only interviews with stakeholders at national, district, and health facility levels, we classified it as minimal-risk research. Prior to each interview, I asked participants to sign a consent form that explained their right to participate or withdraw without consequence, and provided contact details for the ethics committee in case of concerns about professional misconduct. I stored all signed consent forms under lock and key, accessible only to myself as principal investigator.

Principal Investigator's Role and Qualifications

As principal investigator, I undertook all interviews at national, district, and health facility levels. I printed the questionnaires, collated and cleaned the data, performed the analysis, and generated frequency distribution tables. I extracted data from DHIS-2 to calculate quality indicators and used facility- and district-level data for the remaining indicators. I interpreted the results using the communicable disease programme's monitoring and evaluation framework, wrote the full dissertation, and will prepare papers for publication. My eight years of experience in managing health programmes, surveillance systems, and disease response, including leadership of the case management pillar during the 2017 mudslide and flooding response and extensive work on IDSR following the Ebola epidemic, provided the contextual expertise necessary to conduct this evaluation.

Data Collection and Analysis

Following completion of quantitative data collection, the data were entered into Microsoft Excel for cleaning and preparation, including the generation of frequency distribution tables. IBM SPSS Statistics (version 30) was then used to conduct chi-square tests to examine associations between the IDSR core and support functions and the timeliness of reporting at the health-facility level, as well as between the IDSR core and support functions and acceptable case fatality rates at the district level. Prioritisation of the IDSR core and support functions was subsequently informed by regression analyses assessing the relative contributions of these functions to reporting timeliness at health facilities and acceptable case fatality rates at the district level using their beta (β) coefficients.

In alignment with a mixed-methods design, the qualitative data were systematically managed and analysed using a structured, deductive approach. All qualitative data were imported

and organised within NVivo 14 software to facilitate rigorous coding and retrieval. Analysis was guided by a pre-established conceptual framework based on the core and support components of the Integrated Disease Surveillance and Response (IDSR) system, as detailed in the study's interview instruments.

This deductive methodology involved applying the predefined thematic categories of the IDSR framework—such as case detection, reporting, data analysis, and investigation—as parent nodes within the NVivo project. Transcripts were systematically coded against these nodes, allowing for the organisation of data into coherent, framework-specific themes. This process enabled a targeted examination of participants' perspectives and experiences in direct relation to the standardised IDSR functions, ensuring the analysis remained focused on the study's core objectives. The resultant coded data were then synthesised to generate descriptive thematic outputs, which were subsequently interpreted for convergence or divergence with the quantitative findings within the overarching mixed-methods analysis. The data were collected from national stakeholders in Freetown and from the health management teams in all 16 districts in the provinces. Eight national stakeholders were interviewed at the Directorate of Health Security and Emergency and the Directorate of Planning Policy and Information.

The total number of health facilities visited was Ninety-three (93). Sixty-Eight (73%) of the health facilities visited were public, while the remaining Twenty-Five (27%) were private.

The research questions showed the state of the core, support, structural and quality functions of IDSR.

The data collected to address Research Question 1 were structured around the following null hypothesis: The effective implementation of the nine core functions of the IDSR programme by stakeholders in Sierra Leone is not a significant factor in preventing a future epidemic. This

hypothesis was tested through a mixed-methods approach, in which quantitative indicators for each core function were assessed across the health system using the nine sub-hypotheses.

To evaluate this hypothesis, data about specific performance indicators—such as those for case detection and registration—were collected from ninety-three (93) health facilities. These metrics provided evidence of stakeholder engagement and operational achievement for each IDSR core function. The subsequent table presents the aggregated quantitative findings for all nine core functions across the sampled facilities.

A Chi square test was calculated using the data from this table 11 so that the null sub-hypothesis for the research question one was accepted or fail to accept for each core IDSR function at the health facility.

The qualitative data were used to know why the chi square were accepted or failed for each IDSR core function at both health facilities and districts. Two questions were asked for each IDSR core functions. What were the challenges and how to fix them.

The district data was also used for the nine core functions and a Chi square test was used to calculate and prove the sub-hypotheses.

The core functions at the national level were used to explain the policy decision level

The second research question was about the six support functions of the IDSR in Sierra Leone:

H2o: The six support functions of the IDSR programme were not significantly engaged by the stakeholders to effectively address the nation`s disease surveillance and response.

This was saying that if the support functions of the IDSR are not implemented effectively, Sierra Leone would not be able to prevent the next epidemic. The sub-hypotheses were tested at health facilities and districts.

The third research question was on quality functions of the IDSR programme. The indicators were mostly quality indicators and I used the responses from the stakeholders after they reviewed the quantitative data to show that there was strong engagement by stakeholders or no engagement as indicated by the Hypotheses. These direct statements were put into themes and this gave us the state of the quality functions at the health facilities, districts and national level.

The fourth research question was on IDSR structural functions current state. This was mostly qualitative and I used the result findings to explain the current state of affairs of the IDSR at the health facility district and national level. These direct statements were put into themes and this gave us the state of the structural function of IDSR at national, district and health facility levels. The data for the four-research question is qualitative

The prioritised plan based on the data from the research results was done. This was supported by the quantitative and qualitative findings which gave prioritised strategies to prevent the next epidemic in Sierra Leone.

The indicators for the core and support would be calculated and compared to the national target of 80% for some of the indicators. The indicator definitions have already been stated above (Ministry of Health and Sanitation Sierra Leone,2020).

Summary

Globalisation and industrialisation were recognised as key drivers of increasing infectious disease epidemics, necessitating continuous emergency preparedness, with the Integrated Disease Surveillance and Response (IDSR) strategy identified as a critical approach for epidemic prevention (Fall et al., 2019b). Despite its implementation, recurrent failures in the IDSR system in Sierra Leone had contributed to repeated outbreaks and highlighted gaps in prioritising implementation challenges (T. Alemu et al., 2019b; AlMossawi et al., 2019a). This study therefore

employed a cross-sectional mixed-methods design to evaluate the core and support functions of the IDSR programme at the national, district, and health facility levels.

The study population comprised health workers involved in IDSR implementation, with a total of 272 stakeholders interviewed using 110 structured questionnaires. These included 8 participants at the national level, 48 at the district level, and 159 across public and private hospitals, along with selected peripheral health units identified through multistage random sampling of 10% of chiefdoms in each district. The World Health Organisation's generic questionnaire for communicable disease programme evaluation was adopted and structured to assess core and support functions across all levels, including laboratory and GIS components.

Ethical approval was obtained from both the UNICAF Research Ethics Committee and the Sierra Leone Ministry of Health and Sanitation Ethics and Scientific Review Committee. Following stakeholder engagement and adaptation of the study tool, data collection was conducted between 20 September and 11 October 2021. The analysis applied WHO monitoring and evaluation indicators to assess IDSR performance against national targets outlined in Sierra Leone's technical guidelines, ensuring a standardised and comparative evaluation framework.

CHAPTER FOUR: FINDINGS

INTRODUCTION

The increasing movement of people associated with globalisation and industrialisation has accelerated the spread of infectious diseases across geographic boundaries, making early detection and coordinated response essential for effective epidemic control. The Integrated Disease Surveillance and Response (IDSR) strategy, introduced by the World Health Organization in 1998, was designed as a cost-effective framework to strengthen disease surveillance and response capacities across national, district, health facility, and community levels. The system enables early identification of health threats, investigation of suspected cases, data collation and analysis, and timely reporting to guide national and international public health responses(Fall et al., 2019b; WHO Ebola Response Team, 2016).

Although the IDSR programme has been implemented in Sierra Leone, the country has continued to experience major outbreaks such as Ebola Virus Disease and COVID-19, indicating persistent challenges within the surveillance system. Previous studies have documented implementation gaps within the IDSR framework; however, these studies have not systematically prioritised these gaps using combined quantitative and qualitative evidence(Adokiya et al., 2016; Njuguna et al., 2019b, 2022, 2025; Sloan et al., 2020; Squire et al., 2025).

This doctoral study addresses these limitations by evaluating the current state of IDSR implementation across national, district, and health facility levels in Sierra Leone using nationwide data. The evaluation focuses on three key domains: the core functions (including case detection, confirmation, registration, notification, management, analysis, outbreak preparedness and response, and feedback), the support functions (standards and guidelines, laboratory capacity, training, supervision, resources, and coordination), and the quality indicators of the surveillance system. These quality indicators include acceptability, completeness, timeliness, data quality,

flexibility, representativeness, simplicity, stability, usefulness, sensitivity, specificity, and positive predictive value.

By analysing these components, the study identifies priority gaps affecting surveillance performance, evaluates how surveillance data are utilised for decision-making, and highlights the need for sustainable financial and technical support to strengthen epidemic preparedness and response in Sierra Leone.

Results

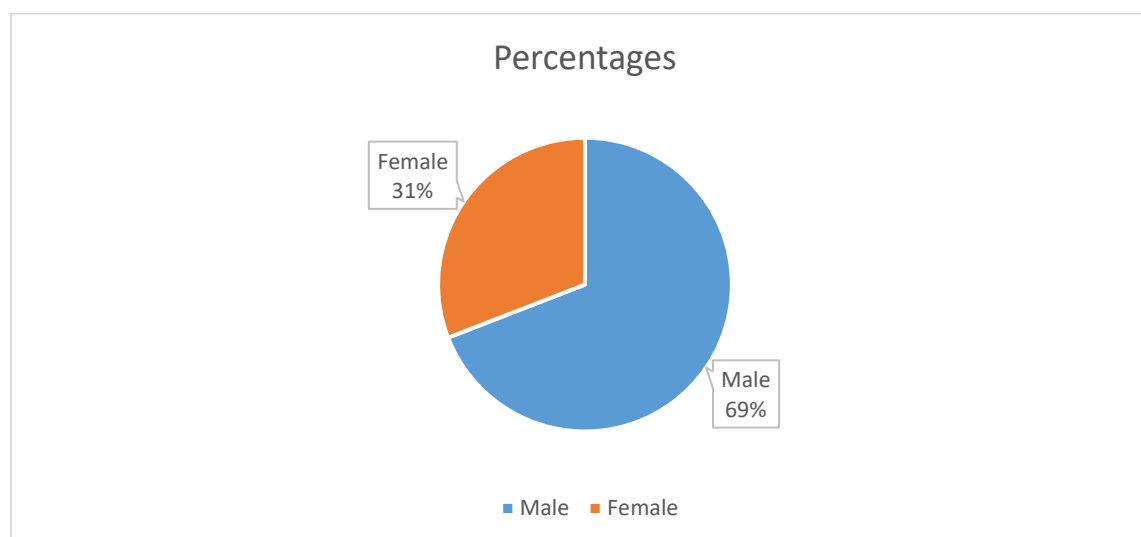
The demographic characteristics of the respondents to the questionnaires was presented by level, starting from the health facilities level to the sixteen districts and then to the national level, as shown in Table 7 below.

Table 7:

Distribution of responders by Position at the Ministry of Health and Sanitation in Sierra Leone, sex and levels at which they are working

Levels		Ministry of Health and Sanitation Positions	Male	Female
National	Head Quarter	Director of Health Security and Emergency	1	0
		Surveillance Programme Manager	1	0
		Emergency Response Programme Manager	1	0
		Deputy Surveillance Programme Manager	1	0
		National Laboratory Manager	1	0
		Monitoring and Evaluation Coordinator Surveillance Programme	1	0
		Senior Public Health Sister Surveillance Programme	0	1
		Senior Surveillance officer in charge of data	1	0
		Subtotal	7	1
Districts	DHMT	District Medical Officers	10	
		District Health Sisters	0	16
		Surveillance Officer	21	1
		Subtotal	31	17
	Hospitals	Medical Superintendent	19	0

		Medical Officer in-charge of the hospital	28	0
		Matrons in hospitals	0	20
		Deputy Matron in hospitals	0	27
		Laboratory Technicians	47	0
		Surveillance officer at the hospitals	18	0
		Subtotal	112	47
	Peripheral Health Units	Community Health Officers	10	1
		Community Health Assistants	18	3
		Maternal and Child Health Aids	0	15
		Community Health Workers	10	0
		Subtotal	38	19
			188	84

Figure 2:*Responders by sex*

The data analysis was done using the theoretical framework of communicable disease programme monitoring and evaluation structure by WHO.

The four categories are core functions, support functions, structure, and quality indicators were calculated and use to prepare a prioritised plan.

Research Question One and Hypothesis

Quantitative Results:

The first research question and Hypothesis are as follows:

The nine core functions state at health facilities, district and national levels

The Hypothesis is:

H1o The nine core functions of the IDSR programme in Sierra Leone are Not significantly engaged by the stakeholders to effectively address the nation's disease surveillance and response.

Based on the stated null hypothesis (H1o), the following sub-hypotheses were formulated by disaggregating the nine IDSR core functions (H1oa, H1ob, H1oc, H1od, H1oe, H1of, H1og, H1oh, H1oi). Each sub-hypothesis tests stakeholder engagement with a specific core function.

Using SPSS IBM software, we used 95% confidence interval to calculate the coefficient of correlation and the assumption for the decision was that if the P value is less than 5% (0.05) the null Hypothesis (Ho) should be rejected. The smaller the p-value the stronger the evidence that you should fail to accept the null Hypothesis.

The following table was used to calculate the correlation coefficient and to determine which of the Hypothesis to accept or fail to accept.

Table 8:

Nine core functions of Sierra Leone's IDSR programme at health facility levels against the stakeholders' engagement.

No.	Sub No.	Core Functions of the IDSR programme	Engagement of the IDSR indicator by the stakeholders

			Yes	No	Percentage of Yes values
1	A	Witness the clinician used one of the case definitions of a priority disease to diagnosis a patient	71	22	76
	B	Witness during the past 30 days that the patients seen by the attending clinicians were recorded correctly and consistently in the clinical register	73	20	79
2	A	Health facilities that can be able to take and store specimens' sample before transportation	8	89	7
	B	The number of health facilities who has the ability to transport specimen to the next level	8	89	7
3	A	The priority disease/condition targeted for the following are correctly filled in the register and report			
	1	Eradication	45	48	48
	2	Elimination	44	49	47
	3	Epidemic prone	52	41	56

	4	Major incidence of public health importance	51	42	55
	B	Health facilities that produce IDSR report for the recent past 3 months	70	23	75
	C	Health facilities that produce IDSR report for the recent past 3 months ON TIME	67	26	72
	D	Health facilities means of reporting to the next level by one of the following:			
	1	Mail	0	93	0
	2	Fax	2	91	2
	3	Telephone	38	55	41
	4	Radio	0	93	0
	5	Electronic	74	19	80
4		Health Facilities that analysed the IDSR data by:			
	A	Person	16	77	17
	B	Place	15	78	16
	C	Time	22	71	24
5		Health Facilities that analysed the IDSR data by Trends:	19	74	20
6		In the most recent outbreak reported by the health facility. How many	5	88	5

		health facilities achieved acceptable case fatality			
7		Health Facilities that have a documented standard case management protocol for at least one priority disease	20	73	22
8		Has the health facility used the data that it is producing to respond to at least one priority disease	31	62	33
9		Did the health facility received at least one feedback from the national or districts in the recent past 12 months for the data they have been reporting	22	71	24

Nine core functions of Sierra Leone's IDSR programme at health facility levels against the stakeholders' responses by indicator

Note. Developed to be used in the SPSS IBM software so that the p value and chi square can be calculated

Table 9:

The average responses of the nine core functions at Health facilities

Core Numbers	Core Functions	Average Per core Function (Yes)	Average Per core Function (No)	Percentage of Yes
1	Case detection and registration	72	21	77
2	Case confirmation	8	89	9
3	Data reporting	40	53	43
4	Data analysis	18	75	19
5	Data interpretation	19	74	20
6	Outbreak investigation	5	88	5

7	Epidemic preparedness	20	73	22
8	Epidemic Response	31	62	33
9	Feedback	22	71	24
	Grand Total	235	606	252
	Average	26	67	28

The average responses of the Nine core functions at Health facilities.

Note. The Nine core functions at Health facilities

Chi-Square Test of Independence Between IDSR Core Functions and Timeliness of Reporting

Table 10:

Predictors against Dependent Variables for the Chi Square analysis at the health facilities.

														Time
Regions	Districts	Chiefdoms	Health Facilities	CASE DETECTION AND REGISTRATION	Case Confirmation	Reporting	Data analysis	Data interpretation	Outbreak investigation	Epidemic preparedness	Epidemic Response	Availability of Lab Support	Feedback	eliness of reporting
	Kambia		Kambia Government	20	33	8	33	0	0	100	0	57.69 231	86	90
			Macauley Street Government	40	25	62	0	0	0	0	4	31	42.9	87
			Dumbaya CHP	100	0	15	0	0	0	0	7	12	57	98

			Tinkoko Bo CHC	100	4	38	0.0	25	0	0	7	25	57	96
			Peya MCHP	80	17	38	0	38	0	100	7	43	86	92
			Tissana MCHP	100	0	38	0	25	0	0	11	28	86	98
			Kamba wama MCHP	100	0	38	0.0	25	0	0	11	30	57	96
			Mokota wa	80	0	38	0	25	100	0	11	28	57	96
			Gondor hun CHP	40	13	23	100	25	0	100	11	28	29	98
			Sanya MCHP	100	17	15	0	38	0	0	11	11	29	92

			Sembeh un 17 CHP	100	17	38	0.0	13	0	0	11	24	29	92
	Kono		Koidu govern ment	0	21	0	0	0	0	100	11	65	29	77
			Panlap CHC	100	21	62	33	25	0	0	11	12	71	96
			Mandia MCHP	100	25	38	67	0	0	0	11	22	29	98
			Fintonia CHC	60	29	46	33	13	0	0	11	31	14	96
			Yoni CHP	100	33	62	33	12.5	0	0	11	24	57	100
			RoKupa Govern	40	42	62	0	0	0	0	11	38	42.9	94

			ment Hospital											
			Holy Spirit	60	42	62	33	0	0	0	11	35	14	90
	Kare ne		Kamak wie Wesleya n	60	54	8	33	0	0	0	11	42	0	96
			Sebehun Tabay MCHP	100	0	15	0.0	25	0	0	15	32	86	90
			Christ the King Hospital	80	0	31	67	38	0	0	15	46	100	92

			New Maforiki CHP	100	0	31	0	25	0	0	15	24	42.9	96
			Mobefa MCHP	100	0	31	33	13	0	0	15	24	43	100
			York CHC	100	0	38	0	25	0	0	15	35	86	94
			Gboyam a CHC	100	0	46	33.3	25	0	0	15	32	100	96
			Bathurst CHP	100	0	46	33.3	25	0	100	15	33	71	89
			Nixon Methodi st	100	17	46	0	13	0	0	15	46	100	87

			Nga Town CHP	100	17	62	67	50	0	0	15	24	86	98
			Bandaju ma CHC	100	21	38	100	38	0	100	15	29	100	83
			Bongor MCHP	100	33	62	0	13	0	0	15	24	71	90
			Maforay MCHP	100	0	31	0	25	0	0	19	20	71.4	89
			Kroo bay CHC	80	0	62	0	0	0	0	19	24	28.6	92
			Stocco MCHP	100	13	62	67	25	0	0	19	15	57	100
	Kaila hun		Kailahu n	100	17	38	0	50	0	0	19	46	100	85

			govern ment											
			Dankaw alia MCHP	100	17	54	0	25	0	0	19	15	100	100
Sout hern Regi on	BO		Bo Govern ment Hospital	0	38	15	0.0	0	0	100	19	58	57	87
			Malema CHP	80	63	46	0	38	0	100	19	24	86	84
	Falab a		Firawa CHP	100	0	38	67	13	0	0	22	20	29	69
			Bandaw or MCHP	100	0	31	0	13	0	100	22	28	57	90

			Mambo CHP	100	0	38	0	0	0	0	22	23	71	94
			Njagbah un	0	0	38	0	38	0	0	22	15	43	98
			Kunya CHP	60	17	31	0	13	0	0	22	23	14	98
			Lumble y Govern ment Hospital	100	25	23	0	0	0	0	22	46	42.9	96
			Thellia CHC	100	25	38	67	0	100	0	22	24	43	98
			Kingto m Police Hospital	40	25	54	0	0	0	0	22	42	0.0	73

			Aberdeen Women Center	100	42	62	0	0	0	0	22	46	0.0	79
			Connau ght Hospital	0	50	31	0	0	0	0	22	38	0.0	73
			Ola During Childre n`s Hospital	80	92	54	0	13	0	0	22	50	42.9	94
			Vaama	40	0	31	33	0	100	0	26	32	71	94
			Mokanji	40	0	38	33	25	0	0	26	27	57	96
	Moya mba		Moyamba	60	0	69	0	0	100	100	26	46	29	69

			Govern ment											
			Arab Hospital	60	13	31	0	0	0	0	26	42	29	87
			Sendum ei CHC	80	17	23	0	13	0	100	26	35	29	96
			Kinghar man Road Govern ment	40	33	62	0	0	0	0	26	46	42.9	69
Nort hern regi on	Bomb ali		Makeni Govern ment	100	100	62	33	0	0	0	26	54	43	96

			Talia CHC	100	0	8	100	38	0	100	30	35	57	100
	Pujeh un		Pujehun Govern ment	100	0	31	0	0	0	0	30	42	57	94
			UMC Hospital	40	4	62	0	0	0	0	30	38	42.9	69
			PCMH	40	13	62	0	0	0	0	30	22	0.0	92
			Mabent eh Commu nity	100	54	62	33	0	0	0	30	35	86	85
			Gbolon MCHP	100	0	8	67	0	0	0	33	11	100	94
			Gobaru	100	0	31	0	25	0	0	33	28	0	92

			Ahymad iya Muslim	0	25	15	0	0	0	0	33	31	0	75
			Bendug u CHC	80	29	69	0	25	0	100	33	23	57	90
			Jui CHP	40	50	23	0	38	0	0	33	28	57	89
			Jaiama Sewafe CHC	100	50	38	0	38	0	100	33	29	86	89
	Koin adug u		Kabala Govern ment	100	63	62	100	0	0	0	33	54	43	89
			Love Bridge	60	0	8	0	0	0	0	37	15	0.0	98
			Konta CHP	100	0	31	67	0	0	0	37	12	71	69

			Kindoya l	60	8	46	0.0	0	0	0	37	42	29	81
East ern Regi on	Kene ma		Kenema Govern ment	80	67	23	100	25	0	0	41	73	57	89
			Mattru UBC	80	13	31	0	0	0	0	44	54	57	96
			34 Wilberf orce Military Hospital	80	17	54	0	0	0	0	44	65	0.0	85
			Baoma CHC	80	33	23	0	25	0	0	44	28	29	83

			Choithram Memorial	100	92	54	0	0	0	100	44	69	42.9	85
			Kakua Children's	60	8	46	0.0	0	0	0	48	35	57	69
			Kukuna CHC	80	17	54	0	38	0	0	48	24	71	92
			MercyShips	100	25	38	0.0	0	0	0	48	62	0	89
			St John of god (Mabess eneh)	100	75	31	0	0	0	0	48	46	0.0	96

	West ern area Rural		Adra Hospital	100	17	31	0	38	0	0	56	50	43	98
			Gilas Hospital	60	17	38	0.0	0	0	0	56	38	29	90
			Bai Bureh Memori al	100	58	38	0	0	0	0	56	42	28.6	90
	Tonk olili		Tonkolil i Govern ment Hospital	80	63	62	0	25	0	100	56	42	14	98

			Panguma	100	92	38	100	38	100	100	59	58	0	89
	Bont he		Bonthe Govern ment	100	17	0	0	25	0	0	63	54	29	100
			Rogbere Junction CHC	100	17	31	0	38	0	0	63	31	100.0	98
			Sierra Rutile	40	42	54	0	0	0	0	63	58	0	69
Nort h Wes tern Regi on	Port Loko		Port Loko Govern ment	100	83	38	0	0	0	0	63	54	71.4	98

			UMC Rotifun k	40	25	46	0	38	0	0	67	38	43	92
			Lungi Govern ment	100	54	46	0	13	0	0	70	50	42.9	98
			Lion Heart Hospital	80	46	62	0	13	0	100	74	50	29	69
			Sierra Leone- China Teachin g Hospital	40	17	31	0	0	0	0	85	50	0	96

			Masang a Leprosy Hospital	100	58	62	0	0	0	100	85	65	29	96
Wes tern Regi on	West ern area Urba n		Pearson Chi Square Tests											
			Values	108.989	356.88 3	178.5 36	51.93 9	73.182	5.071	16.497	324.8 22	386.0 19	108.5 03	
			df	80	320	160	48	64	16	16	336	480	128	
			P-value	0.017	0.076	0.15	0.323	0.202	0.995	0.419	0.659	0.999	0.893	
			Signific ant/Not	Significa nt	Not Signifi cant	Not Signi ficant	Not Signi ficant	Not Signifi cant	Not Signifi cant	Not Signifi cant	Not Signi ficant	Not Signifi cant	Not Signi ficant	

The data presented in Table 10 were analysed using the Chi-Square (χ^2) test of independence to determine the relationship between Integrated Disease Surveillance and Response (IDSR) performance indicators and the timeliness of reporting across 93 health facilities.

H1a: Case detection and registration are **not significantly engaged** by stakeholders in the implementation of the IDSR programme in Sierra Leone.

A Chi-Square test was conducted to examine the association between case detection and registration and the timeliness of reporting. The analysis revealed a statistically significant relationship between the two variables, $\chi^2 (80, N = 93) = 108.99, p = .017$. The null hypothesis was not accepted because the p-value (.017) was less than the alpha level of .05. This finding suggests that case detection and registration were significantly associated with the timeliness of reporting, indicating that stakeholders at the health facility level actively and effectively implemented this IDSR core function. The result implies that the case detection and registration function can predict timely reporting within the surveillance system.

Similarly, a Chi-Square test was conducted to assess the relationship between case confirmation and timeliness of reporting across the same health facilities.

H1b: Case confirmation (laboratory diagnosis) is **not significantly engaged** by stakeholders in the implementation of the IDSR programme in Sierra Leone.

The result showed no statistically significant association between the variables, $\chi^2 (320, N = 93) = 356.88, p = .076$. Given that the p-value (.076) exceeded the .05 threshold, the null hypothesis was accepted, suggesting that case confirmation was not significantly associated with the timeliness of reporting. This indicates that the case confirmation function of the IDSR system was not effectively implemented by stakeholders at the facility level and, therefore, could not predict reporting timeliness.

H1c: Case reporting is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1d: Data analysis are not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1e: Data interpretation are not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1f: Outbreak preparedness is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1g: Outbreak response is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1h: Feedback is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

H1i: Epidemic preparedness and response coordination is not significantly engaged by stakeholders in the implementation of the IDSR programme in Sierra Leone.

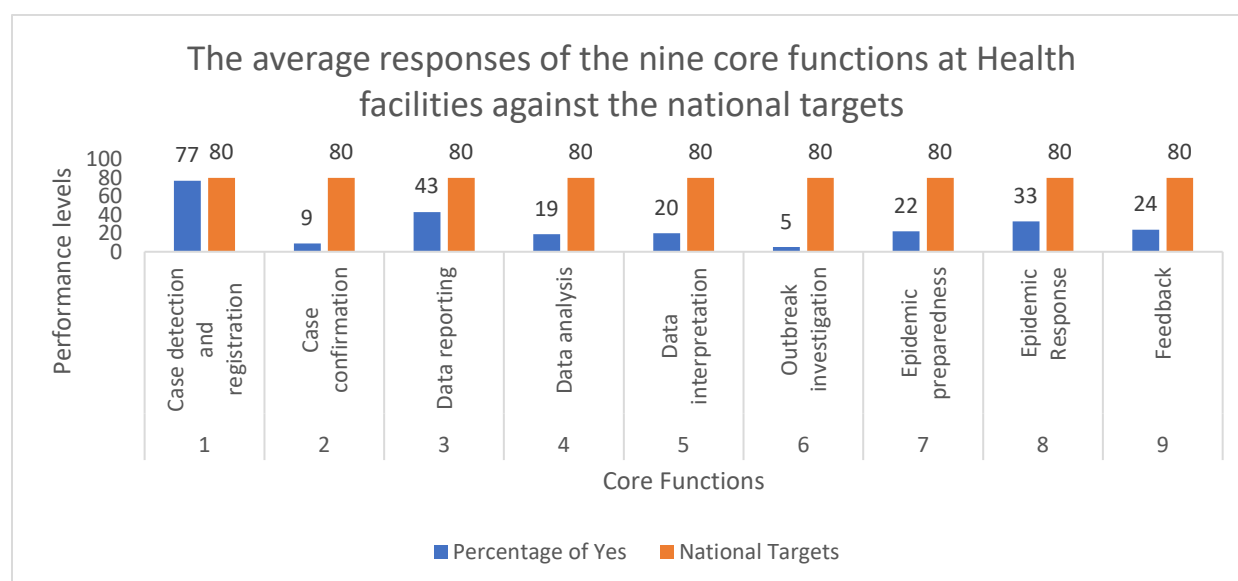
The results in table 10 showed that case reporting ($p = .150$), data analysis ($p = .323$), data interpretation ($p = .202$), outbreak investigation ($p = .995$), epidemic preparedness ($p = .419$), epidemic response ($p = .659$), laboratory support ($p = .999$), and feedback ($p = .893$)—all yielded p -values greater than .05. Consequently, the null hypotheses for these variables were retained. These results indicate that these respective functions were not significantly associated with the timeliness of reporting and may not have been effectively implemented by stakeholders within the health facilities.

This means that the stakeholders working in IDSR programme in Sierra Leone have not fully engaged the core indicators in IDSR programme. The acceptance of the null hypothesis is

too strong saying there was much more that the stakeholders of Sierra Leone IDSR programme need to do to prevent the next epidemic.

Figure 3:

Achievements of the core functions of the IDSR programme in Sierra Leone against the national targets



Achievements of core functions of IDSR programme in Sierra Leone against the national targets

Note. Level of engagement of core functions of IDSR programme at health facilities against the national target showing non-achievements by the programme.

A research gap that was identified was to evaluate the most effective IDSR subthemes in preventing the next epidemic; thereby prioritising the IDSR functions that would be used by the stakeholders in responding to the next epidemic. The dependent variable that was used to show good response of the IDSR programme performance was timeliness of reporting from the health facilities. The predictor variables are shown in the table 10:

Table 11:

The parametric estimates by different quantiles from the quantile regression analysis of the IDSR core functions at the health facilities.

Parameter Estimates by Different Quantiles			
Parameter	q=0.25	q=0.5	q=0.75
Intercept	- 335.830	-335.830	-335.830
[CASE DETECTION AND REGISTRATION=0]	- 188.422	-188.422	-188.422
[CASE DETECTION AND REGISTRATION=20]	-53.901	-53.901	-53.901
[CASE DETECTION AND REGISTRATION=40]	-68.607	-68.607	-68.607
[CASE DETECTION AND REGISTRATION=60]	16.805	16.805	16.805

[CASE DETECTION AND REGISTRATION=80]	-50.735	-50.735	-50.735
[CASE DETECTION AND REGISTRATION=100]	0 ^c	0 ^c	0 ^c
[Case Confirmation=.000000000000000]	75.816	75.816	75.816
[Case Confirmation=4.166666666666666]	-53.812	-53.812	-53.812
[Case Confirmation=8.333333333333332]	71.441	71.441	71.441
[Case Confirmation=12.500000000000000]	42.697	42.697	42.697

[Case Confirmation=16.66666666666660]	35.781	35.781	35.781
[Case Confirmation=20.83333333333330]	124.742	124.742	124.742
[Case Confirmation=25.00000000000000]	60.153	60.153	60.153
[Case Confirmation=29.166666666666670]	- 163.304	-163.304	-163.304
[Case Confirmation=33.33333333333330]	6.272	6.272	6.272
[Case Confirmation=37.50000000000000]	46.519	46.519	46.519

[Case Confirmation=41.66666666666670]	-25.853	-25.853	-25.853
[Case Confirmation=45.83333333333330]	- 116.233	-116.233	-116.233
[Case Confirmation=50.00000000000000]	150.064	150.064	150.064
[Case Confirmation=54.16666666666660]	29.003	29.003	29.003
[Case Confirmation=58.33333333333340]	162.926	162.926	162.926
[Case Confirmation=62.50000000000000]	44.323	44.323	44.323

[Case Confirmation=66.66666666666660]	304.559	304.559	304.559
[Case Confirmation=75.00000000000000]	-15.952	-15.952	-15.952
[Case Confirmation=83.33333333333340]	187.775	187.775	187.775
[Case Confirmation=91.66666666666660]	-50.208	-50.208	-50.208
[Case Confirmation=100.00000000000000]	0 ^c	0 ^c	0 ^c
[Reporting=.000000000000000]	402.085	402.085	402.085
[Reporting=7.692307692307693]	206.707	206.707	206.707

[Reporting=15.384615384615380]	217.758	217.758	217.758
[Reporting=23.076923076923070]	276.120	276.120	276.120
[Reporting=30.769230769230770]	228.661	228.661	228.661
[Reporting=38.000000000000000]	280.957	280.957	280.957
[Reporting=38.461538461538460]	257.396	257.396	257.396
[Reporting=46.153846153846150]	220.408	220.408	220.408
[Reporting=53.846153846153850]	309.098	309.098	309.098
[Reporting=61.538461538461540]	291.555	291.555	291.555

[Reporting=69.230769230769220]	0 ^c	0 ^c	0 ^c
[Data analysis=.0000000000000000]	4.864	4.864	4.864
[Data analysis=33.333333333333330]	8.214	8.214	8.214
[Data analysis=66.666666666666660]	15.490	15.490	15.490
[Data analysis=100.000000000000000]	0 ^c	0 ^c	0 ^c
[Data interpretation=.0]	22.180	22.180	22.180
[Data interpretation=12.5]	32.135	32.135	32.135
[Data interpretation=25.0]	31.485	31.485	31.485

[Data interpretation=37.5]	28.955	28.955	28.955
[Data interpretation=50.0]	0 ^c	0 ^c	0 ^c
[Outbreak investigation=0]	-48.735	-48.735	-48.735
[Outbreak investigation=100]	0 ^c	0 ^c	0 ^c
[Epidemic preparedness=0]	-87.865	-87.865	-87.865
[Epidemic preparedness=100]	0 ^c	0 ^c	0 ^c
[Epidemic Response=.0000000000000000]	0 ^c	0 ^c	0 ^c
[Epidemic Response=3.703703703703704]	-61.801	-61.801	-61.801

[Epidemic Response=7.407407407407407]	133.388	133.388	133.388
[Epidemic Response=11.111111111111110]	97.076	97.076	97.076
[Epidemic Response=14.814814814814810]	90.426	90.426	90.426
[Epidemic Response=18.518518518518520]	83.573	83.573	83.573
[Epidemic Response=22.000000000000000]	0 ^c	0 ^c	0 ^c

[Epidemic Response=22.22222222222220]	29.297	29.297	29.297
[Epidemic Response=25.925925925925920]	109.349	109.349	109.349
[Epidemic Response=29.629629629629630]	100.035	100.035	100.035
[Epidemic Response=33.333333333333330]	66.240	66.240	66.240
[Epidemic Response=37.037037037037040]	82.858	82.858	82.858

[Epidemic Response=40.740740740740740]	0 ^c	0 ^c	0 ^c
[Epidemic Response=44.444444444444440]	183.631	183.631	183.631
[Epidemic Response=48.148148148148140]	99.289	99.289	99.289
[Epidemic Response=55.555555555555560]	-19.810	-19.810	-19.810
[Epidemic Response=59.259259259259260]	- 149.978	-149.978	-149.978

[Epidemic Response=62.962962962962960]	-38.917	-38.917	-38.917
[Epidemic Response=66.666666666666660]	73.442	73.442	73.442
[Epidemic Response=70.370370370370370]	-7.960	-7.960	-7.960
[Epidemic Response=74.074074074074080]	0 ^c	0 ^c	0 ^c
[Epidemic Response=85.185185185185180]	0 ^c	0 ^c	0 ^c

[Availablility of Lab Support=11.000000000000000]	179.996	179.996	179.996
[Availablility of Lab Support=11.538461538461530]	15.358	15.358	15.358
[Availablility of Lab Support=12.000000000000000]	116.424	116.424	116.424
[Availablility of Lab Support=15.000000000000000]	362.524	362.524	362.524
[Availablility of Lab Support=15.384615384615380]	107.629	107.629	107.629

[Availablility of Lab Support=20.0000000000000000]	137.031	137.031	137.031
[Availablility of Lab Support=22.0000000000000000]	118.134	118.134	118.134
[Availablility of Lab Support=23.0000000000000000]	176.877	176.877	176.877
[Availablility of Lab Support=23.076923076923070]	586.016	586.016	586.016
[Availablility of Lab Support=24.0000000000000000]	137.178	137.178	137.178

[Availablility of Lab Support=25.000000000000000]	195.108	195.108	195.108
[Availablility of Lab Support=26.923076923076920]	154.776	154.776	154.776
[Availablility of Lab Support=28.000000000000000]	103.793	103.793	103.793
[Availablility of Lab Support=29.000000000000000]	-33.955	-33.955	-33.955
[Availablility of Lab Support=30.000000000000000]	101.793	101.793	101.793

[Availablility of Lab Support=30.769230769230770]	311.086	311.086	311.086
[Availablility of Lab Support=32.000000000000000]	142.081	142.081	142.081
[Availablility of Lab Support=33.000000000000000]	47.216	47.216	47.216
[Availablility of Lab Support=34.615384615384610]	106.442	106.442	106.442
[Availablility of Lab Support=35.000000000000000]	73.051	73.051	73.051

[Availablility of Lab Support=38.461538461538460]	245.215	245.215	245.215
[Availablility of Lab Support=42.307692307692300]	134.874	134.874	134.874
[Availablility of Lab Support=43.000000000000000]	66.916	66.916	66.916
[Availablility of Lab Support=46.153846153846150]	175.816	175.816	175.816
[Availablility of Lab Support=50.000000000000000]	291.979	291.979	291.979

[Availablility of Lab Support=53.846153846153850]	137.132	137.132	137.132
[Availablility of Lab Support=57.692307692307690]	285.093	285.093	285.093
[Availablility of Lab Support=61.538461538461540]	63.976	63.976	63.976
[Availablility of Lab Support=65.384615384615380]	-0.960	-0.960	-0.960
[Availablility of Lab Support=69.230769230769220]	0 ^c	0 ^c	0 ^c

[Availability of Lab Support=73.076923076923070]	0 ^c	0 ^c	0 ^c
[Feedback=.0000000000000000]	53.571	53.571	53.571
[Feedback=14.285714285714280]	46.011	46.011	46.011
[Feedback=28.571428571428570]	0 ^c	0 ^c	0 ^c
[Feedback=29.000000000000000]	0 ^c	0 ^c	0 ^c
[Feedback=42.857142857142850]	0 ^c	0 ^c	0 ^c
[Feedback=57.142857142857140]	0 ^c	0 ^c	0 ^c

[Feedback=71.428571428571430]	0 ^c	0 ^c	0 ^c
[Feedback=85.714285714285710]	0 ^c	0 ^c	0 ^c
[Feedback=100.000000000000000]	0 ^c	0 ^c	0 ^c
a. Dependent Variable: Timeliness of Reporting			
b. Model: (Intercept), CASE DETECTION AND REGISTRATION, Case Confirmation, Reporting, Data analysis, Data interpretation, Outbreak investigation, Epidemic preparedness, Epidemic Response, Availability of Lab Support, Feedback			
c. Set to zero because this parameter is redundant.			

Parametric Quantile regression analysis that was conducted to evaluate the impact of IDSR core functions (case detection and registration, case confirmation, data analysis, data interpretation, data reporting, epidemic preparedness, epidemic response, outbreak investigation, Available Laboratory support and feedback) on the dependent variable (Timeliness of reporting of the health facilities) across different quantiles of its distribution at the health facility level. Parameter estimates were examined at the 25th, 50th, and 75th percentiles.

Regression Results analysis

The regression was done to model the impact of IDSR functions on the timeliness of reporting as a dependent variable as shown in table 11. The assumption is that if the health facilities

IDSR functions were working well they would be able to produce timely report to the district and national levels. The predictors were case detection and registration, case confirmation, data analysis, data interpretation, data reporting, epidemic preparedness, epidemic response, outbreak investigation, Available of Laboratory support and feedback. I must say that there are other functions that affect the good implementation of IDSR like the support, structures and the quality functions.

The quantile regression analysis examined the effects of various health facilities and epidemiological response variables on reporting timeliness, with parameter estimates calculated at the 25th, 50th, and 75th percentiles (Table 11). The results demonstrated a perfect model fit (goodness-of-fit = 1 for all quantiles), and the parameter estimates were largely consistent across quantiles, indicating stability of the predictor effects.

Case detection and registration showed a strongly negative effect at the 0% level ($\beta = -188.42$, $SE = 67.19$, $p < .01$) but a positive, non-significant effect at the 60% level ($\beta = 16.81$, $SE = 48.73$). This suggested that improvements in case detection significantly increased timeliness, particularly at the median and higher quantiles.

Case confirmation yielded widely varying estimates: the strongest positive relationship occurred at 66.67% ($\beta = 304.56$, $SE = 76.09$, $p < .001$), whereas negative associations were observed at 29.17% ($\beta = -163.30$) and 45.83% ($\beta = -116.23$). Thus, case confirmation hindered timeliness in weaker facilities but improved it in better-performing ones.

The reporting function exhibited uniformly positive associations (β coefficients ranging from 206.71 to 402.09), meaning that health facilities that reported early and completely sent more timely reports to districts and the national level.

Epidemic preparedness had mixed effects: negative coefficients at lower quantiles ($\beta = -16.62$) but strong positive effects at higher quantiles ($\beta = 160.06$), suggesting that preparedness was not uniformly effective but had a greater impact in better-performing systems.

Epidemic response was a robust predictor across all quantiles (β range = 61.90–110.73), underscoring its critical role in timely reporting regardless of facility performance.

Outbreak investigation contributed significantly at higher quantiles, peaking at $\beta = 160.78$, indicating a strong influence in better-performing facilities.

Availability of lab support demonstrated one of the strongest effects, with a particularly robust positive influence at higher levels (e.g., at 23.08%, $\beta = 586.02$).

Feedback showed weaker overall contributions, with smaller coefficients ($\beta = 40.61$) and non-significant results at several quantiles, suggesting a limited impact on timeliness.

Most Influential Predictors:

Availability of Lab Support and Reporting dominate the impact ranking. The highest beta effect (586.02) was seen with Lab Support at 23%, underscoring critical infrastructure's influence. Epidemic Response and Preparedness also show substantial impacts, especially when values are low or mid-range. Case Confirmation and Case Detection have moderate-to-strong effects, depending on levels. Below is a table showing a ranking of the predictors of the regression evaluation done.

Table 12:

Top Predictors that influence Health facilities Timeliness of reporting.

Rank	Predictor Variable	Absolute Effect Size Range (B)	Direction of Effects	Interpretation

1	Availability of Laboratory Support	(-33.96) – 586.02	Mostly positive (one negative)	Strongest overall contributor; higher support strongly improves reporting timeliness.
2	Reporting	206.71 – 402.09	Positive	Consistently large positive effect on reporting timeliness.
3	Case Confirmation	(-163.30) – 304.56	Mixed (positive & negative)	High variability; strong improvements at certain levels, but negative at others.
4	Epidemic Response	7.96 – 183.63	Mixed (positive & negative)	Several strong positive effects, but some negative

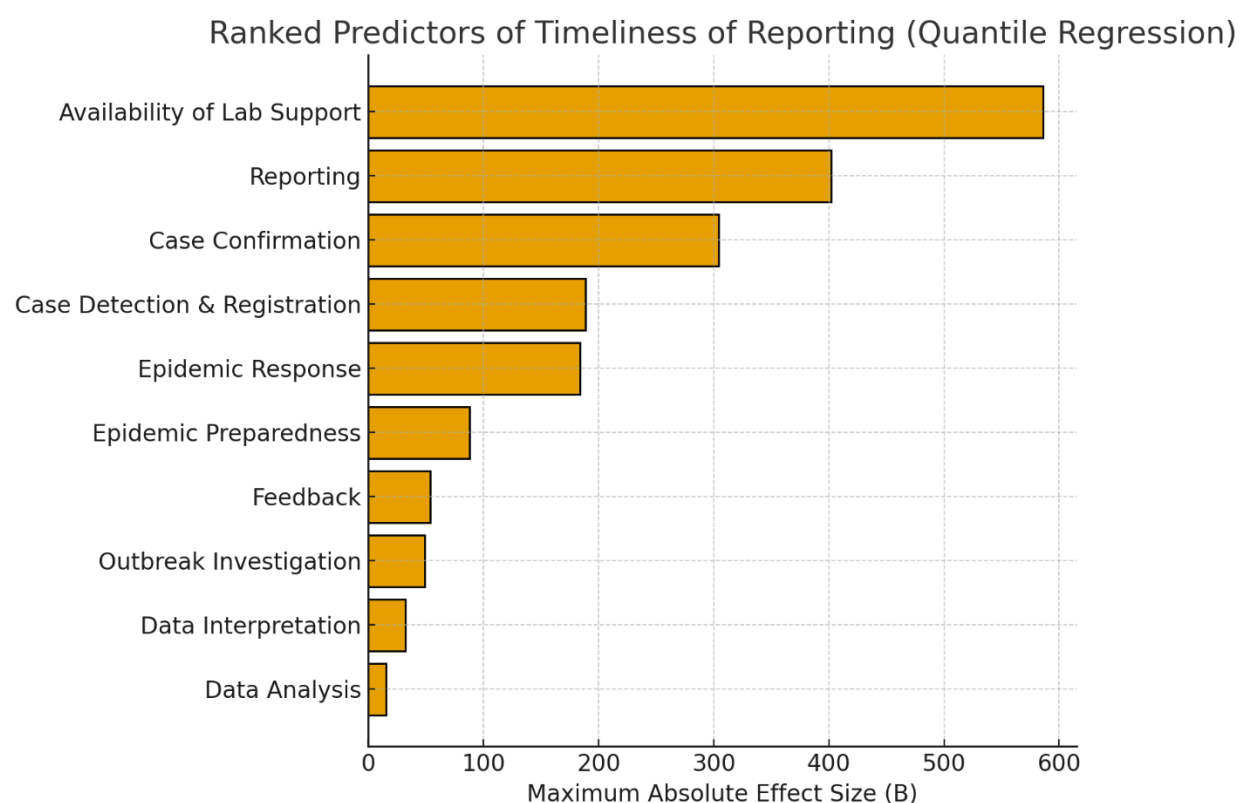
				associations at intermediate levels.
5	Case Detection & Registration	16.81 – 188.42	Mixed (positive & negative)	Lower values strongly negative; moderate improvements at higher levels.
6	Epidemic Preparedness	87.87	Negative	Strong negative association at baseline.
7	Outbreak Investigation	48.74	Negative	Small but consistent negative association.
8	Data Interpretation	22.18 – 32.14	Positive	Moderate, consistent positive contribution.
9	Data Analysis	4.86 – 15.49	Positive	Small, steady positive association.

10	Feedback	46.01 – 53.57	Positive (limited)	Positive but weak; most higher levels redundant.

Top Predictors that influencas Health facilities Timeliness of reporting

Figure 4:

Bar chart of ranking IDSR performance functions against maximum absolute effect size on the Timeliness of reporting at the health facilities.



Bar Chart of ranking IDSR performance functions against maximum absolute effect size on the timeliness of reporting at the health facilities.

The ranking of predictors of health facility timeliness of reporting demonstrated that the availability of laboratory support was the strongest predictor ($\beta = -33.96$ to 586.02), with predominantly large positive effect sizes. This indicated that improved laboratory infrastructure increased reporting speed. Higher-performing facilities, such as Kenema Government Hospital (73%) and Choithram Memorial Hospital (69%), outperformed lower-tier facilities, such as Gbolon MCHP (11%) and Sanya MCHP (11%), reflecting more effective implementation of laboratory support functions as shown in Table 33.

The second strongest predictor was the reporting function, which showed consistently positive effects ($\beta = 206.71$ - 402.09). Most facilities demonstrated strong adherence to reporting timelines, with Makeni Government Hospital (100%), Ola During Children's Hospital (92%), and Choithram Memorial Hospital (92%) performing highly. However, some facilities, including Love Bridge (8%), Gbolon MCHP (8%), and Talia CHC (8%), showed low reporting scores despite timely submission, indicating gaps in data completeness and quality.

Case confirmation ranked as the third strongest predictor ($\beta = -163.30$ to 304.56), showing both positive and negative effects. Facilities with strong diagnostic capacity, such as Makeni Regional Government Hospital and Ola During Government Hospital, demonstrated better timeliness. In contrast, weaker facilities lacked adequate infrastructure and capacity, highlighting implementation disparities.

Epidemic response was the fourth strongest predictor ($\beta = -149.98$ to 183.63), with variable effects across facilities. While it improved timeliness in well-resourced settings, it

sometimes negatively affected reporting in lower-capacity facilities due to competing demands during outbreaks.

Case detection and registration ranked fifth, showing mixed effects: higher-performing facilities benefited, while lower-performing facilities experienced delays. Epidemic preparedness ($\beta = -87.87$) and outbreak investigation ($\beta = -48.74$) demonstrated negative effects, suggesting systemic limitations such as inadequate resources and support.

Data interpretation ($\beta = 22.18$ to 32.14) and data analysis ($\beta = 4.86$ to 15.49) were weak predictors, while feedback showed limited positive influence ($\beta = 46.01$ to 53.57). Overall, the findings highlighted laboratory support and reporting capacity as key drivers of timeliness, while inconsistencies in other functions reflected structural and resource-related gaps across health facilities.

QUALITATIVE RESULTS OF THE CORE FUNCTIONS

Coding and Thematic Analysis:

During the questioning of the stakeholders in the health facilities, districts and national level; they responded to the quantitative data about the core, support, quality and structural functions of IDSR implementation.

At the health facilities, the responses are in table 13 below.

Table 13:

Stakeholders' responses at the health facilities on the core functions of IDSR.

Domain / Interview Question	Themes	Illustrative Codes (Condensed from Data)

Case detection & registration	Resource shortages	Lack of clinical registers
	Capacity gaps	Staff need training on identification of priority diseases
		Lack of LABORATORY structural resources EG PCR machines
	Structural/technical gaps	Lack of equipment for confirmatory tests for priority diseases;
Case confirmation		Lack of infrastructures to support trained staff
	Human resource limitations	Lack of highly trained staff to conduct specialised tests
	Logistics constraints	Lack of specialised transport media for specimen collection
Data reporting	Resource shortages	No standard strategy for IDSR registers/forms; Missed data due to lack of reporting tools
	ICT limitations	Limited support for internet and computer accessories (e.g., MSGH)
	Integration challenges	Limited integration of health commodities on the IDSR report
	Motivation challenges	Low motivation of community-based workers → incorrect or zero reporting

	Capacity gaps	Limited staff knowledge in data analysis;
Data analysis		Reporting staff lack awareness of threshold levels for escalation
	ICT limitations	Limited computers and internet accessories
	Systemic support issues	Limited district-level support for analysis and community involvement
Epidemic response	Systemic/financial constraints	Limited support for prevention, control, and rapid response
		Limited health system capacity
	IPC & therapeutic shortages	Poor infection prevention due to lack of IPC commodities; Limited therapeutics
	Supply chain interruptions	Frequent interruptions in vaccines and emergency medication supplies
	Supervisory gaps	Lack of support for supervision and feedback
Epidemic Preparedness	Human resource capacity	Lack of skilled to adopt management protocol for priority diseases.
	Supervisory challenge	Limited support from the district on producing management protocols
System improvements	Integration & digitalisation	Integrate IDSR with DHIS2, lab data, and one-health (animal + human) systems; Strengthen real-time digital surveillance

	Capacity building	Train clinicians and non-clinicians on priority disease recognition and reporting in health schools
	Preparedness & simulation	Conduct simulations and after-action reviews every three months
	Laboratory strengthening	Improve lab data use for timely confirmation; Deploy simple diagnostic tools (e.g., GeneXpert)
	Transport/logistics	Develop reliable specimen transport networks
	Community engagement	Train and equip CHWs for early outbreak detection and reporting

Health facilities response and their codes of the statements

The sorting of the themes was done in excel and is presented as shown below.

Table 14:

Themes sorted with their codes from the health facilities the IDSR core functions.

Themes	Illustrative Codes (Condensed from Data)
Resource shortages	No standard strategy for IDSR registers/forms; Missed data due to lack of reporting tools

	Limited support for prevention, control, and rapid response to outbreaks
	Frequent interruptions in vaccines and emergency medication supplies
	Lack of support for supervision and feedback due to limited resources
	Poor infection prevention due to lack of IPC commodities; Limited therapeutics
	Limited health system capacity like limited speciality departments, robust emergency departments and hospital systems
	Limited district-level support to the health facilities for analysis and community involvement
	Lack of clinical registers
Human Capacity building gaps	
	Lack of highly trained staff to conduct specialised tests in the laboratory
	Train clinicians and non-clinicians on priority disease recognition and reporting
	Limited staff knowledge in data analysis;
	Reporting staff lack awareness of priority disease threshold levels for escalation

Infrastructure gaps	Lack of LABORATORY structural resources EG PCR machines
	Lack of equipment for confirmatory tests for priority diseases
	Lack of infrastructures to support trained staff
	Lack of specialised transport media for specimen collection
	Limited support for internet and computer accessories in health facilities
Integration challenges	Integrate IDSR with DHIS2, lab data, and one-health (animal + human) systems; Strengthen real-time digital surveillance
	Limited integration of health commodities on the IDSR report
	Low motivation of community-based workers → incorrect or zero reporting
IDSR functions improvements	

	Implement surveillance outbreak response management and analysis systems in the health facilities to shorten outbreak response time
	Conduct simulations and after-action reviews every three months
	Train and implement quality improvement at the health facilities
	Improve lab data use for timely confirmation; Deploy simple diagnostic tools (e.g., GeneXpert)
	Develop reliable specimen transport networks
	Train and equip CHWs for early outbreak detection and reporting
	Improve laboratory infrastructures in health facilities

Note: The themes with the health facilities response and the codes of their responses.

At the end of the analysis, four overarching themes emerged that highlighted the challenges to implementing IDSR in Sierra Leone. The health facilities also proposed strategies to improve the IDSR system.

Resource Shortages: This was one of the most critical concerns raised by the health facilities.

“Sometimes we have no registers, so we improvise with exercise books, and cases get missed.”

Surveillance officer In-charge for IDSR in Connaught Hospital

This came from all the health facilities. Some of them do not keep registers of reporting forms. This have led to missed data and unexplained figures when reconciling the data from the health facilities and the ones from the DHIS-2.

Human Capacity building gaps: This theme was the second most critical challenge stated by the stakeholders at the health facilities.

“Most of our staff are not trained in identifying priority diseases, so cases go unnoticed.”

Surveillance officer- in-charge Kunya CHP

Most of the health facilities are challenged with the identification of priority diseases clinically as well as through laboratory confirmation as shown in table 13 above.

Infrastructure gaps: This was the third critical challenge that the health facilities identified as shown in table 14. Most of the infrastructural challenges are about laboratory diagnosis. This was also shown by the quantitative studies as data prioritised laboratory challenge as the major concern.

“The health facility does not have the ability to confirm most of the priority diseases. Also sending samples to the referral laboratories is a challenge because of limited transport media and a lack of strategy to transport the samples. The health facilities usually rely on the availability of vehicles at the DHMT or personnel travelling to the big cities to take samples along”.

Community Health Officer In-charge in Bendugu CHC

Integration Challenges: The IDSR programme in Sierra Leone is integrated. However, the health facilities are saying that there are challenges with this integration at the health facilities. Community health worker who have closer to the people are one of the early warning strategies used in IDSR but because of low motivation, they always send zero reporting in their weekly report. This would lead to missed cases.

“As a community health worker, I am often close to the people and play a vital role in early warning for IDSR. However, because of low motivation, I do not have the resources to travel or take care of my family. I sometimes send zero reports in my weekly returns, leading to missed cases.”

Community Health Worker in Thellia CHC

Health commodities are reportedly done separately from the IDSR report. This made it challenging for staff to plan responses to outbreaks due to a lack of pharmaceutical products, such as drugs and vaccines.

“As a health worker, I struggle to plan for the COVID-19 outbreak because health commodities are reported outside the IDSR system. This separation means I was not able to align surveillance data with the availability of drugs and vaccines, leaving me unprepared when cases emerge. If commodities were integrated into the IDSR report, I would have been able to plan and respond more effectively to protect my communities.”

Maternal and Child Health Aid In-Charge Mobefa MCHP

This came from all the health facilities, indicating the significance of this challenge. Knowledge of animal diseases is unavailable primarily at health facilities. This is because the One Health strategy mostly stays at the district and national levels.

“In my facility, I realised that an integrated real-time digital surveillance for animal and human data is urgently needed. If we had stronger digital tools at the health facility, it would help us detect outbreaks earlier from animals or humans, report cases on time, and respond faster before diseases spread further.”

Community Health Assistant In-Charge Dumbaya CHP

This concern came from all the health facilities showing the importance of this concern.

The themes explain the state of the IDSR core functions in Sierra Leone. It explained the preparedness of health facilities to respond to outbreaks. It describes the challenges stakeholders face when implementing IDSR and the strategies that could improve IDSR functions. The

qualitative theme findings support the quantitative data on whether the stakeholders have sufficiently implemented the IDSR programme to prevent the next epidemic.

The stakeholders at the health facilities suggested ways to improve IDSR implementation at their facilities, as shown in Table 13. The qualitative data reveal that stakeholders prioritised seven strategies to improve IDSR at the health facilities. Human resource capacity, logistics and infrastructure, technology and digital systems improvements, supplies and commodities and community engagement and surveillance.

Human resource limitations were particularly evident among community-based workers, including inadequate training, limited knowledge of priority disease thresholds, and low motivation, particularly regarding financial resources to access communities. Similarly, logistical and infrastructural challenges—such as a lack of registers, specimen transport, and supervisory support—emerged as cross-cutting barriers to effective implementation. Constraints in supplies and commodities, especially for case confirmation and epidemic response (e.g., diagnostic equipment, IPC commodities, and therapeutics), further weakened system resilience.

At the same time, participants highlighted opportunities for improvement. Strengthening technology and digital integration with DHIS-2 and laboratory databases could reduce reporting delays and promote real-time surveillance. Laboratory capacity and simplified diagnostic methods were crucial for the timely confirmation of priority diseases. Preparedness through regular simulation exercises and after-action reviews was also emphasised as a proactive measure to strengthen epidemic readiness. Learning from the limitations of IDSR systems and correcting them before a real situation occurs could make a massive difference in the response to epidemics. Finally, improved community engagement and surveillance were identified as essential for early detection and reporting, closing critical gaps between health facilities and their populations.

These domains form a conceptual framework that illustrates how structural, technical, and human factors interact to shape overall IDSR system performance in Sierra Leone.

The health facility in-charges were asked how they think the core functions of the IDSR for health facilities can be improved.

"In order to improve early case identification, reporting and planning of response, public health surveillance must be improved by doing more training of health facility staffs on surveillance. It must be supported with resources from the districts "

Medical Superintendent In-charge of Bo government Hospital

Districts Core Functions

Quantitative analysis for the district core functions:

The outcome for the district data came from the current outbreak at the time of data collection, the acceptable case fatality rate of COVID-19 patients.

Table15:

The average percentage of months for which the district acquired the acceptable case fatality rate in 2021

DISTR ICTS	Indicators	Janu ary	Febr uary	Mar ch	April	May	June	July	Aug ust	Septe mber	Octo ber	Nove mber	Dece mber	TOT AL
	Confirm/prob ably cases	304	300	200	350	300	1170	600	456	400	400	300	159	4939
WAU	No. of death	1	1	1	10	0	50	20	10	2	3	1	1	100
	Case Fatality Rate	0.3	0.3	0.5	2.9	0.0	4.3	3.3	2.2	0.5	0.8	0.3	0.6	2.0
	YES/NO(1/0)	1	1	1	0	1	0	0	0	1	1	1	1	8
	% Acceptable CFR													66
WAR	Confirm/prob ably cases	111	120	100	100	45	96	88	45	300	300	200	100	1605
	No. of death	0	0	0	0	1	2	2	1	0	0	0	0	6
	Case Fatality Rate	0	0	0	0	2.222 222	2.083 333	2.272 727	2.222 222	0	0	0	0	0.373 832
	YES/NO(1/0)	1	1	1	1	0	0	0	0	1	1	1	1	8
	% Acceptable CFR													70
Tonkol ili	Confirm/prob ably cases	1	2	20	30	1	1	20	10	10	5	10	1	111
	No. of death	0	0	0	0	1	1	0	0	0	0	0	0	2
	Case Fatality Rate	0	0	0	0	100	100	0	0	0	0	0	0	1.801 802
	YES/NO(1/0)	1	1	1	1	0	0	1	1	1	1	1	1	10

[illegible]

Koinadugu	Confirm/probably cases	1	1	3	1	46	47	44	43	42	42	45	30	345
	No. of death	0	0	0	0	1	1	1	1	1	1	0	0	6
	Case Fatality Rate	0	0	0	0	2.173 913	2.127 66	2.272 727	2.325 581	2.3809 524	2.380 952	0	0	1.739 13
	YES/NO(1/0)	1	1	1	1	0	0	0	0	0	0	1	1	5
	% Acceptable CFR													40
Falaba	Confirm/probably cases	46	0	0	0	3	49	1	1	1	56	45	46	248
	No. of death	1	0	0	0	0	1	0	0	0	0	1	1	4
	Case Fatality Rate	2.173 913	0	0	0	0	2.040 816	0	0	0	0	2.2222 2222	2.173 913	1.612 903
	YES/NO(1/0)	0	1	1	1	1	0	1	1	1	1	0	0	8
	% Acceptable CFR													70
Karene	Confirm/probably cases	40	60	45	46	46	43	34	35	45	30	40	30	494
	No. of death	0	0	1	1	1	1	1	1	0	0	0	0	5
	Case Fatality Rate	0	0	2.222 222	2.173 913	2.173 913	2.325 581	2.941 176	2.857 143	0	0	0	0	1.012 146
	YES/NO(1/0)	1	1	0	0	0	1	0	0	1	1	1	1	7
	% Acceptable CFR													60
Bo	Confirm/probably cases	36	34	230	178	78	80	45	42	40	56	45	60	924
	No. of death	0	0	5	4	2	2	1	1	1	0	0	0	16
	Case Fatality Rate	0	0	2.173 913	2.247 191	2.564 103	2.5	2.222 222	2.380 952	2.5	0	0	0	1.731 602

[illegible]

[illegible]

Table16:

Nine core functions of Sierra Leone's IDSR programme at district levels against the acceptable case fatality for COVID-19 patients with their corresponding Pearson's Chi square of significant

No	Districts	IDSR Core Functions									
		CASE DETECTION AND REGISTRATION	Case Confirmation	Reporting	Data analysis	Data interpretation	Outbreak investigation	Epidemic preparedness	Epidemic Response	Feedback	Acceptable Case Fatality for the most recent Outbreaks (COVID-19)
1	Western area Urban	100	100	63	71	100	80	67	25	0	66
2	Western area Rural	100	100	75	57	100	80	67	25	50	70
3	Port Loko	100	100	75	71	100	100	67	63	50	80
4	Kambia	100	100	63	57	100	80	67	25	50	70
5	Bombali	100	100	63	57	67	80	50	25	0	60
6	Koinadugu	0	100	63	57	33	60	50	0	50	50
7	Falaba	0	100	63	57	67	60	50	0	0	40
8	Karene	100	100	63	71	100	80	67	25	50	70

9	Bombali	100	0	63	57	100	80	50	0	50	60
10	Bo	50	0	63	57	33	60	67	0	0	40
11	Bonthé	50	100	75	57	67	80	67	0	50	60
12	Moyamba	50	100	63	100	67	100	50	0	0	59
13	Pujehun	100	0	63	71	100	80	67	25	50	60
14	Kenema	50	100	63	57	100	100	67	25	50	66
15	Kailahun	100	100	88	57	100	80	67	25	50	75
16	Kono	100	100	88	57	100	80	67	25	50	76
	Average Totals	75	81.25	68.375	63.1875	83.375	80	61.6875	18	34.375	62.625
Pearson's Chi-Square Test of Independence Between IDSR District core functions and Acceptable Case Fatality for covid-19 patients.											
	Values	19	6.154	22.384	21.545	20.4	28.533	9.018	27.556	10.182	
	df	16	8	16	16	16	16	8	16	8	
	P-value	0.269	0.630	0.131	0.158	0.203	0.027	0.341	0.036	0.252	
	Significant or NOT	Not significant	Not significant	Not significant	Not significant	Not significant	Significant	Not significant	Significant	Not significant	

Note: Nine core functions of Sierra Leone's IDSR programme at district levels against the stakeholders' responses by indicators against the Acceptable Case Fatality for the most recent Outbreaks (COVID-19) by indicator with their corresponding Pearson's Chi square of significant.

Pearson's Chi square of independence for IDSR core functions for districts

A Chi-Square test of independence was conducted to determine whether stakeholders have been able to implement activities and whether there was a statistically significant association between the IDSR core functions and acceptable case fatality rates at the district level (see Table 15).

The results revealed that the association between case detection and registration and acceptable case fatality rates was not statistically significant as shown in table 16 above, $\chi^2(16, N = 16) = 19.00$, $p = .269$, indicating that stakeholders at the district level had not yet effectively implemented case detection and registration practices across all districts to prevent epidemics. However, the linear-by-linear association was statistically significant, $\chi^2(1, N = 16) = 8.46$, $p = .004$, suggesting that as performance in case detection and registration improves, the likelihood of achieving acceptable case fatality rates increases. In other words, improved case detection and registration were associated with more effective outbreak control.

Further analyses indicated that the associations between case confirmation ($p = .630$), reporting ($p = .131$), data analysis ($p = .158$), data interpretation ($p = .203$), epidemic preparedness ($p = .341$), and feedback ($p = .252$) with acceptable case fatality rates were all not statistically significant ($p > .05$). This finding implies that stakeholders at the district level need to strengthen

these IDSR core functions to improve surveillance effectiveness and epidemic prevention. In contrast, outbreak investigation ($p = .027$) and epidemic response ($p = .036$) demonstrated statistically significant associations with acceptable case fatality rates ($p < .05$), suggesting that improvements in these functions contribute meaningfully to reducing fatality rates during outbreaks.

Regression analysis of the core functions of IDSR at the district level

A multiple linear regression was conducted to predict acceptable case fatality for the most recent outbreaks, using the following predictors: case detection and registration, case confirmation, reporting, data analysis, data interpretation, epidemic preparedness, outbreak investigation, epidemic response, and feedback at the district level.

Table 17:

Model summary of the Predictors against the Dependent core functions variable at the districts

Model Summary										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.992 ^a	0.985	0.962	2.288	0.985	42.724	9	6	0.000	2.535
a. Predictors: (Constant), Feedback, Case confirmation, Case detection and Registration, Data analysis, Epidemic preparedness, Reporting, Outbreak investigation, Epidemic response, Data interpretation										
b. Dependent Variable: Acceptable Case Fatality for the COVID-19 patients										

Table 17 showed the results of the regression analysis, which suggested that the model explained most of the variance in the dependent variable. **$R^2 = .985$, Adjusted $R^2 = .962$, $F(9, 6)$**

= 42.72, $p < .001$. This model suggests a robust relationship between the listed predictors and the outcome variable (Acceptable Case Fatality). Therefore, strengthening these areas —especially epidemic preparedness, outbreak investigation, and data interpretation —may significantly improve outcomes during public health emergencies at the district level.

Table 18:

Regression coefficients showing how much the core functions predicts the acceptable case fatality at the districts.

Regression Coefficients													
Model		Unstandar dized Coefficient s		Standar dized Coeffici ents	t	Sig .	95.0% Confidenc e Interval for B		Correlations			Collinearity Statistics	
		B	Std. Err or	Beta			Lo wer Boun d	Upp er Boun d	Zer o-ord er	Part ial	Par t	Toler ance	VI F
1	(Consta nt)	3.958	8.201		0.483	0.646	- 16.109	24.024					
	Case detect and Reg	0.146	0.030	0.457	4.861	0.003	0.073	0.220	0.751	0.893	0.246	0.289	3.454
	Case confir	0.087	0.019	0.300	4.631	0.004	0.041	0.133	0.395	0.884	0.234	0.608	1.644
	Reporti ng	0.209	0.084	0.162	2.503	0.046	0.005	0.414	0.576	0.715	0.127	0.613	1.630
	Data analysis	0.089	0.072	0.088	1.227	0.266	- 0.088	0.266	0.099	0.448	0.062	0.495	2.020
	Data interpret a	0.020	0.046	0.043	0.448	0.670	- 0.091	0.132	0.797	0.180	0.023	0.282	3.544
	Outbrea k investig at	0.159	0.079	0.173	2.013	0.091	- 0.034	0.353	0.677	0.635	0.102	0.348	2.876

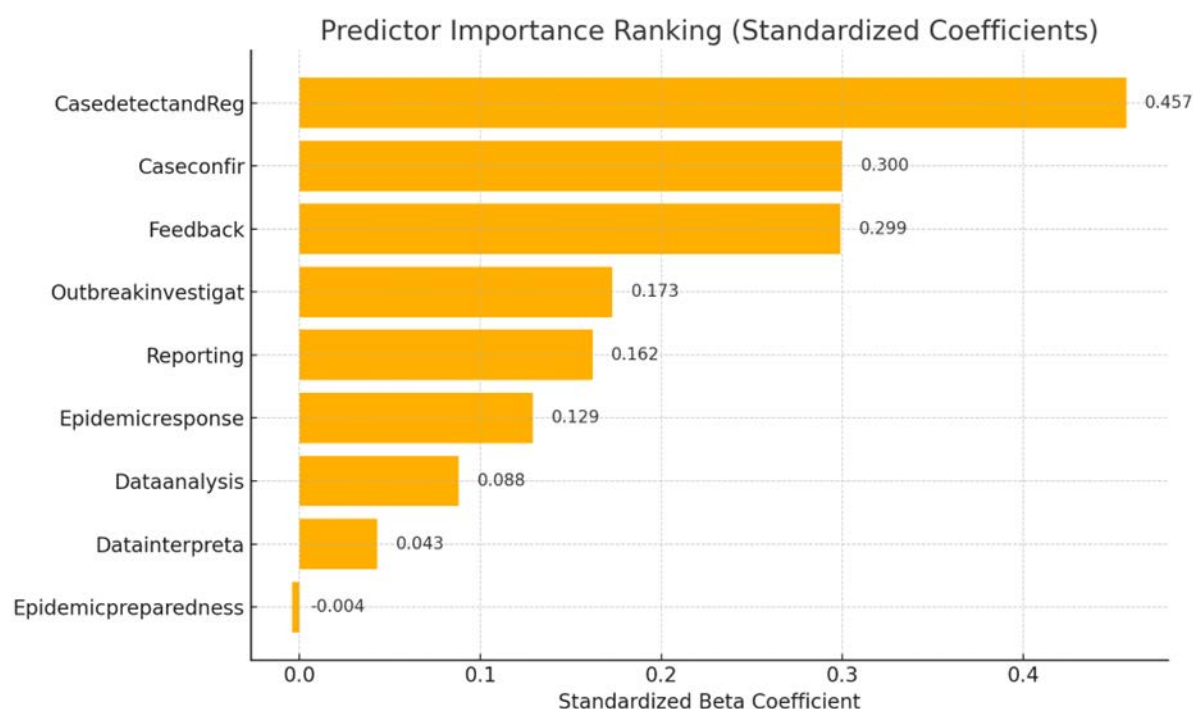
Epidemi c prepare dness	- 0.00 5	0.0 95	-0.004	- 0.0 57	0.9 56	- 0.23 9	0.22 8	0.5 26	- 0.0 23	- 0.0 03	0.579	1.7 26
Epidemi c respons e	0.08 8	0.0 56	0.129	1.5 67	0.1 68	- 0.04 9	0.22 5	0.7 76	0.5 39	0.0 79	0.376	2.6 58
Feedbac k	0.14 6	0.0 33	0.299	4.3 50	0.0 05	0.06 4	0.22 8	0.5 74	0.8 71	0.2 20	0.543	1.8 41
a. Dependent Variable: Acceptable Case Fatality for the most recent Outbreaks												

Prioritization of the IDSR core functions at the district level

The strength of the IDSR core functions in predicting the outcome was determined by the beta coefficient from the regression analysis. Shown in figure 5.

Figure 5:

Strength of the IDSR core functions predicting acceptable case fatality rates at the district level



As illustrated in Figure 5, case detection and registration were identified as the strongest predictors of the acceptable case fatality rate at the district level ($\beta = .457$). Correspondingly, Table 18 demonstrates that districts such as Western Area Urban (100), Port Loko (100), Kailahun (100), and Kono (100), which achieved full performance in case detection and registration, also reported favourable and acceptable case fatality outcomes—Western Area Urban (66), Western Area Rural (70), Port Loko (80), Kailahun (75), and Kono (76). In contrast, districts such as Koinadugu (0), Falaba (0), Bo (50), and Bonthe (50), which exhibited poor performance in case detection and registration, recorded less acceptable case fatality outcomes—Koinadugu (50), Falaba (40), Bo (40), and Bonthe (60).

These findings suggest that districts with well-established case detection and registration systems are more likely to maintain case fatality rates within acceptable thresholds. Therefore, investments in early case-detection strategies, including digital surveillance tools like electronic ring fence for quarantine suspects in surveillance, mobile phone-based reporting technologies using GP in mobile, and streamlined case registration processes, are critical to improving epidemic response outcomes. Strengthening these systems at the district level would enhance early identification, tracking, and management of cases—ultimately reducing mortality and limiting the spread of epidemics.

Figure 5 shows that the case confirmation function was the second-strongest contributor to acceptable case fatality at the district level ($\beta = .300$). Accurate and timely case diagnosis and confirmation would play a significant role in improving acceptable case fatality rates. Patient management would be swift, and the response to the epidemic would be quick and accurate, thereby stopping it. The districts should strengthen laboratory diagnostic capacity, rapid confirmatory testing methods, such as GeneXpert machines, and laboratory training to improve the speed of confirmation and the reliability of the test.

In the illustrated Figure 5, the feedback function was the third-strongest contributor to acceptable case fatality at the district level ($\beta = .299$). Real-time feedback from the field to the central level and back. Also, feedback between ministries, departments and agencies. The remaining IDSR functions are listed in the following order. Outbreak investigation ($\beta = .173$), reporting ($\beta = .162$), epidemic response ($\beta = .129$), data analysis ($\beta = .088$), data interpretation ($\beta = .043$), and epidemic preparedness ($\beta = .004$).

Qualitative Results for the districts core functions

The stakeholder's response to the themes were put on NVivo 14 as describe below:

Table 19:

Thematic Structure of IDSR Implementation Challenges at the Districts

Thematic Structure of IDSR Implementation Challenges at the Districts		
Main Themes/Research questions	Themes	Illustrative Codes / Condensed Issues
1. Case Detection and Registration	Resource shortages	Lack of resources to produce and distribute clinical registers and reporting forms.
	Capacity building gaps	Limited resources to train and re-train staff on treatment protocols for priority diseases.
2. Case Confirmation	Specimen transport limitations	Lack of specialised transport media;
		Overdependence on non-functional DHMT vehicle systems.
	Laboratory and human resource gaps	Lack of trained laboratory staff
		Inadequate infrastructure for specimen management training.
3. Data Reporting	Resource shortages and logistics	No standard strategy to provide IDSR registers/forms

		Missed data due to stock-outs of reporting tools.
	ICT and integration challenges	Limited internet and computer support at DHMT
		Weak integration of one-health, lab, and commodity data.
	Motivation and community reporting gaps	Low motivation among community-based workers resulting in zero reporting.
4. Data Analysis	Knowledge and skill deficits	Limited staff capacity for data analysis.
	Technology constraints	Inadequate computer and internet facilities.
5. Epidemic Investigation	Systemic and financial constraints	Inadequate funding for IDSR prevention and control
		Partner-driven funding cycles; lack of dedicated IDSR budget lines.
	IPC and therapeutic shortages	Poor infection prevention due to limited IPC commodities.
		Lack of emergency therapeutics.
	Supply chain interruptions	Frequent interruptions in vaccines and emergency medicine supplies.
	Supervisory and feedback gaps	Lack of supportive supervision.

		Limited district feedback mechanisms.
	Digital surveillance and decentralisation gaps	Weak electronic outbreak investigation systems; need for district-level autonomy with financial/technical resources.
6. Epidemic Response	Funding and logistical constraints	Delayed or absent government funds.
		Reliance on partners for epidemic response; late budget disbursements.
	Pharmaceutical shortages	Absence of reserve IPC products, vaccines, and drugs for emergencies.
7. Feedback Mechanisms	Resource limitations	Inadequate resources to organise supervision and feedback sessions.
	Communication gaps	Weak information flow from DHMT to health facilities and communities.
8. System Strengthening and Future Improvements	Governance and funding reform	Establish a national emergency commission with autonomous budget for health emergencies.
	Laboratory capacity enhancement	Improve laboratory infrastructure and install confirmatory equipment (e.g., GeneXpert).
	One-health and digital integration	Integrate IDSR with DHIS2, laboratory, and animal health data to strengthen real-time surveillance.
	Capacity building and simulation training	Conduct regular training for clinicians and non-clinicians

		Implement quarterly outbreak simulation and after-action reviews.
	Specimen transport and confirmation systems	Develop reliable transport networks.
		Deploy simple disease confirmation tools at health facility level.
	Community engagement	Strengthen community-based early detection and reporting mechanisms through training and motivation of CHWs.

The response from the district stakeholders were analysed using NVIVO 14 forming themes and sub-themes as shown in table 20 were categorised into new themes using excel sheets as shown in table 20 below.

Table 20:

Themes and their codes for the district qualitative response

Themes	Illustrative Codes (Condensed from Data)	Interpretive Meaning
Resource shortages	Resource shortages for clinical registers and reporting forms	Consistently cited as a key operational gap, the lack of tools disrupted early detection and registration of priority diseases.

	Lack of dedicated budget line for IDSR implementation	This was the most critical challenge. The absence of a dedicated funding stream resulted in delayed outbreak response and dependence on donor support, undermining local preparedness and rapid action.
	Limited resources to train and retrain staff on treatment and specimen management protocols	Recurrent across multiple functions, this code reflects sustained weaknesses in human capacity and technical competency for disease surveillance.
	Late release of IDSR activity funds	Commonly cited as causing missed intervention windows during emerging outbreaks.
	Limited support for feedback and supervision	Resource shortages prevented effective feedback loops and quality assurance mechanisms.
	Partner-dependent outbreak response	Heavy reliance on partners delayed rapid response and hindered district-level autonomy.
Human Capacity building gaps		
	Limited training and retraining on treatment protocols for priority diseases	Recurrent across multiple functions, this code reflects sustained weaknesses in human capacity and technical competency for disease surveillance.

	Limited knowledge of data analysis among staff	Lack of analytical capacity weakened interpretation of surveillance data, hindering early warning insights.
	Lack of standardised strategy for provision of IDSR tools	Absence of structured procurement and distribution mechanisms resulted in inconsistent data flow and underreporting.
	Limited internet and computer resources	Technological deprivation impeded real-time reporting, data validation, and analysis, weakening evidence-based response.
	Lack of reliable specimen transport network	Affected sample viability and slowed confirmation cycles.
	Overdependence on non-functional DHMT vehicle transport systems	This hindered timely specimen transfer to laboratories, delaying confirmation and outbreak verification.
	Limited laboratory infrastructure for confirmatory testing	Constrained the speed and accuracy of disease confirmation.
Supply chain Gaps		
	Interruption of vaccine and emergency medication supply	Frequent interruptions disrupted emergency preparedness and outbreak containment.

	Lack of reserved IPC products, vaccines, and drugs for emergencies	Repeatedly cited as a direct cause of delayed epidemic containment measures.
	Poor infection prevention due to limited IPC commodities	Constrained infection control within facilities, heightening vulnerability during epidemics.
Integration gaps		
	Low motivation among community-based health workers	Contributed to frequent zero reporting and reduced community-based disease detection.
	Lack of functional electronic outbreak investigation systems that support both animal and human epidemic	Absence of a decentralised platform slowed data exchange and outbreak management that works in both animal and human outbreaks.
	Weak coordination between district and national levels	Reduced coherence between local and national outbreak management responses.
	Limited emergency preparedness, simulations and after-action reviews	Limited capacity to test readiness and identify operational gaps pre-outbreak.

	Poor integration between IDSR, laboratory, and One Health data systems at the district level.	Disconnected data streams limited cross-sectoral coordination and outbreak triangulation especially at the district level.

Most of the district's stakeholders identify resource gaps as the most important challenge in implementing IDSR at the district level. As shown in Table 20 above. The lack of available, timely funding from the government allocation stipulated for integrated disease surveillance and response and emergencies is the main obstacle to its implementation. A district medical officer said in one of my interviews that sending someone into war without a weapon. This was his direct statement below.

“At the district, the most important challenge we face with implementation of IDSR is the availability of a dedicated government budget allocation. We use scare funds allocated for health activities to support IDSR activities. This means that we have to prioritize IDSR activities above the other health systems activities that are also very important to the general wellbeing of the population”.

District Medical Officer, Kenema DHMT

A similar response was given by the district medical officer in Bo district health management team (DHMT).

“Most of the outbreak activities are delayed until partners are able to support them because the funds allocated by the government to the district are too scare and they come very late. If people are dying from the outbreak the government would ask that funds for other activities are converted to respond to the outbreak”.

District Medical Officer, BO DHMT.

The second most important theme that was discussed as a challenge for the districts was the human resource capacity gap. They commented on the gap in knowledge on identification of priority diseases by the clinical staff, inability to identify priority diseases in the laboratory, and

their inability to analyse the data collected from the health facilities about the outbreaks. Some of their statements are shown below. The district health sister in-charge of IDSR in Bombali district was so emotional when talking about the difficulties that they face in the identification of priority diseases in the health facilities with the lack of knowledge of the clinicians that see them.

“Patients would present with symptoms of priority diseases that should have been identified by the clinical staff, but it would go weeks or even months until deaths started happening in the communities that would be the time an alert would be raised for us at the districts to go and investigate and with support from senior clinicians to identify the disease.”

District Health Sister in-Charge of IDSR, Bombali District.

The participants in the districts persistently discuss infrastructural and logistic constraints that are faced by the stakeholders in the implementation of IDSR. Limited internet resources and accessories limit the reporting, analysis and validation of the data. This eventually delays the planning and implementation of response to outbreaks at district level. Transportation of biological samples was another constraint faced under this theme. This is because staff said that there was no formal system for the transportation of samples. In some districts DHMT vehicles were used when they are available for sample transport. Some send a carrier with a person handling the samples. In some outbreaks these methods had led to spread of infectious diseases (e.g. Ebola Outbreak in 2014).

“We sometimes prepare the samples but cannot transport them to the reference laboratory in Freetown. The samples often sit in the fridge for several days until a vehicle becomes available, or someone has to travel with them by motorbike.”

Falaba District Hospital Laboratory Technician

The participants also discuss about supply chain challenges that obstruct the growth of IDSR in the district. They talked about lack of emergency supply for outbreaks that should be reserved for any response. The supplies from the central medical store were always limited and

was not able to response to the normal activities of the health facilities. This means that they are not able to keep any supply for emergencies. Supplies like medications, vaccines and infection prevention control supplies are limited in the health facilities for normal activities. When an outbreak happens, the normal activity supplies are used to respond to the outbreak and this would lead to gaps in the normal services to patients causing unnecessary deaths. The district health sister in Port Loke said this:

“We face serious supply chain problems in this district. No emergency supplies are kept aside for outbreaks, and what we receive from the central medical store is often not enough for our routine services. When an outbreak occurs, we must use our supplies for normal operations—like medicines, vaccines, and infection control items—to respond to the emergency. This leaves huge gaps in our regular services, and sometimes patients suffer or even die because of these shortages.”

District Health Sister, Port Loko District

Surveillance in Sierra Leone is integrated, but the integration has faced some challenges, and participants at the district level discussed them. Stakeholders report that community health workers complain of low motivation because they lack support for daily needs, such as transportation and a decent salary. A community health worker supervisor explains.

“I really like reporting deaths and diseases in Kossoh Town, but my community is vast, and it is hard to cover all areas without money for transport or walking long distances. The health facility does not provide transport, and the small stipend we are supposed to receive either comes late or does not come at all. Because of that, I sometimes cannot go to places where I hear rumours of sickness or death. Instead, I send in a zero report every week.

Community Health Worker Coordinator, Western Area Rural, DHMT.

There were other integration challenges discussed by the stakeholders, such as the absence of a digital platform for epidemics with both human and animal outbreaks, decentralised to the health facility level. The current digital platform is primarily for human outbreaks, and the national team would need to support investigations and responses at the health facility level. They usually

say that practice makes a system perfect. The IDSR currently conducts simulation exercises, and after-action reviews are held once a year at the national level. The stakeholders say the districts should have the capacity to conduct simulation exercises and review the findings in an after-action review meeting with all their health facilities and community stakeholders. They should be able to use the recommendations from this process in decision-making and planning of district activities, and implement them. This is to test the readiness for any future outbreak response.

National Level:

The national level had the best capacity to analyse data from the districts, and they could analyse by person, place, and time. They can also present data on priority diseases with timelines, called trend analysis.

The national level had rapid response teams that met regularly during outbreaks and out of epidemics. The lack of a national budget is affecting all activities of the IDSR programme. The response to health systems challenges had been affected the worst in Sierra Leone. Supervision in the field is challenged by a lack of financial resources, and feedback to the districts was significantly affected. Only 34.4% of districts (national target: 100%) reported receiving feedback from the national level in 2021, as shown in Table 16. In Table 8, 24% (national target 100%) of health facilities reported that they received a bulletin from a higher level in Table 7.

However, the feedback to the lower-level health facilities was more affected by the competing priorities the national staff were engaged in. In 2021, the national staff were focused on the COVID-19 pandemic response, with little attention paid to the remaining priority diseases. With support from partners, all national-level staff had been trained in IDSR.

The laboratory managers were asked what should be done to improve case confirmation in the laboratories.

"We are challenged with the availability of resources to use the 12 quality service essentials in quality improvement to build the districts and public health reference laboratories. Some staff have been trained on quality management systems, but there are limited resources available to fund its implementation nationwide"

(Manager of Laboratory systems)

Research Question Two/Hypothesis

The second research question and Hypothesis are as follows:

This was about the current state of the six support functions at the national, district, and health facility levels.

The second Hypothesis is as follows:

H2o The engagement of the six support functions of IDSR by the stakeholders is not significant at the national, district and health facility levels.

Based on six support functions H2o was sub-divided into the following null sub-hypotheses H2oa, H2ob, H2oc, H2od, H2oe, and H2of as described below.

The second research question was as follows:

The current state of the six support functions of Sierra Leone's IDSR programme at the National, district and health facility levels.

H2oa: Standards and guidelines for IDSR implementation are not significantly engaged by stakeholders in Sierra Leone.

H2ob: Training and capacity building for IDSR implementation are not significantly engaged by stakeholders in Sierra Leone.

H2c: Supervision of IDSR activities is not significantly engaged by stakeholders in Sierra Leone.

H2d: Availability of minimum resources (human, financial, logistical, and ICT) for IDSR implementation is not significantly engaged by stakeholders in Sierra Leone.

H2e: Coordination and partnership among relevant stakeholders for IDSR implementation are not significantly engaged by stakeholders in Sierra Leone.

H2f: Stakeholders satisfaction of the IDSR implementation are not significantly engaged by stakeholders in Sierra Leone.

Quantitative Data for support functions

The health facilities support functions of the IDSR implementation performance was investigated against the timeliness of health facility reports. The table 21 showed the percentage positive performance of the support functions against the percentage timeliness of reporting.

Table 21:

The six support functions of Sierra Leone IDSR programme at the health facility levels against the stakeholders' responses

No	Support functions indicator for the IDSR programme	Engagement of the indicator	
		% Yes	% No
1	National surveillance Manual Present	67	33
2	Most staff trained on IDSR epidemic management course	66	34
3	The health facility has minimum resources to implement IDSR programme activities	30	70

[illegible]

1	Western area Urban	Health facilities							
		Aberdeen Women Center	0	0	24	100	0	0	79
		Choithram Memorial	0	100	48	0	100	0	85
		Connaught Hospital	0	0	24	0	0	0	73
		Kingharman Road Government	0	0	28	0	100	0	69
		Kingtom Police Hospital	0	0	28	0	0	0	73
		Lumbley Government Hospital	100	100	20	0	100	0	96
		Macauley Street Governement	100	0	4	0	100	0	87
		Ola During Children`s Hospital	100	100	20	0	100	0	94
		PCMH	100	100	28	0	0	0	92

		RoKupa Government Hospital	100	100	8	0	100	0	94
		UMC Hospital	100	100	28	0	100	0	69
		34 Wilberforce Military Hospital	100	100	48	0	0	0	85
		Kroo bay CHC	100	0	20	0	67	50	92
	Western area Rural	Adra Hospital	100	100	60	100	100	0	98
		Christ the King Hospital	100	100	12	100	100	0	92
		Sierra Leone- China Teaching Hospital	100	100	92	100	0	0	96
		York CHC	100	100	12	100	67	50	94
		Mambo CHP	100	100	20	100	33	50	94
		Tissana MCHP	100	100	8	0	67	50	98
	Port Loko	Port Loko Government	100	100	68	0	100	0	98
		Bai Bureh Memorial	100	100	56	0	67	0	90

		Lungi Government	100	100	68	100	100	0	98
		St John of god (Mabesseneh)	100	100	52	100	0	0	96
		Love Bridge	0	0	36	0	0	0	98
		Rogbere Junction CHC	100	100	60	0	100	50	98
		New Maforki CHP	100	100	12	100	33	50	96
		Maforay MCHP	0	100	16	100	100	50	89
	Kambia	Kambia Government	0	0	0	0	0	0	90
		Kukuna CHC	50	100	40	100	67	50	92
		Konta CHP	50	100	32	100	67	50	69
		Gbolon MCHP	50	0	40	100	67	50	94
	Bombali	Makeni Government	100	100	20	100	100	0	96
		Arab Hospital	0	0	24	0	33	50	87
		Mabenteh Community	0	100	24	100	100	50	85
		Holy Spirit	0	0	12	0	33	0	90
		Panlap CHC	100	100	8	100	67	50	96
		Yoni CHP	100	0	8	0	67	50	100

		Stocco MCHP	0	100	12	100	0	100	100
	Koinadu	Kabala	100	0	28	0	33	50	89
	gu	Government							
		Thellia CHC	100	0	24	0	33	50	98
		Mandia MCHP	50	0	16	0	0	50	98
	Falaba	Firawa CHP	0	100	24	100	33	50	69
	Karene	Kamakwie	0	100	12	100	0	0	96
		Wesleyan							
		Fintonia CHC	50	100	8	100	0	50	96
		Dumbaya CHP	0	100	8	100	67	100	98
		Sanya MCHP	0	100	12	100	0	100	92
	Tonkolii	Tonkolili	100	0	60	100	0	50	98
		Government							
		Hospital							
		Masanga	100	100	84	100	33	50	96
		Leprosy							
		Hospital							
		Lion Heart	100	100	76	100	67	0	69
		Hospital							
		Bendugu CHC	100	100	28	100	67	100	90
		Kunya CHP	100	100	20	100	33	0	98
		Dankawalia	100	100	20	100	67	0	100
		MCHP							

	Bo	Bo Government Hospital	100	50	36	0	0	50	87
		Gilas Hospital	100	100	60	0	67	0	90
		Kakua Children`s	100	100	52	100	67	0	69
		Kindoyal	100	100	40	100	67	0	81
		MercyShips	100	0	56	100	0	100	89
		Tinkoko Bo CHC	100	0	12	0	0	100	96
		Sembehun 17 CHP	0	0	20	100	0	50	92
		Sebehun Tabay MCHP	100	0	16	100	67	100	90
		Gboyama CHC	100	100	12	100	100	50	96
		Bathurst CHP	100	0	16	100	0	50	89
		Kambawama MCHP	0	0	16	100	67	0	96
	Bonthe	Bonthe Government	100	100	64	100	67	50	100
		Mattru UBC	100	100	44	100	67	100	96
		Sierra Rutile	0	0	68	0	0	0	69
		Talia CHC	100	100	32	100	67	100	100
		Mobefa MCHP	100	100	8	100	67	50	100

	Moyamba	Moyamba Government	0	100	24	0	33	50	69
		UMC Rotifunk	50	100	68	0	67	50	92
		Mokanji	50	100	28	0	67	0	96
		Mokotawa	100	0	12	0	33	50	96
		Njagbahun	50	100	20	100	0	50	98
	Pujehun	Pujehun Government	100	0	32	100	67	100	94
		Gobaru	100	100	32	0	0	0	92
		Vaama	100	100	24	100	100	100	94
	Kenema	Kenema Government	100	100	36	100	67	50	89
		Panguma	100	100	60	0	0	50	89
		Ahymadiya Muslim	0	0	36	0	0	0	75
		Sendumei CHC	0	0	28	0	33	50	96
		Gondorhun CHP	0	0	16	0	67	50	98
		Bandawor MCHP	100	100	20	0	67	100	90
		Baoma CHC	100	100	44	100	0	50	83
		Jui CHP	0	100	36	100	67	100	89
		Bongor MCHP	0	100	12	0	100	50	90

	Kailahun	Kailahun government	100	100	16	100	67	100	85
		Nixon Methodist	100	100	12	100	67	100	87
		Bandajuma CHC	100	100	16	100	33	50	83
		Malema CHP	100	100	16	100	67	50	84
	Kono	Koidu government	100	0	12	0	0	50	77
		Jaiama Sewafe CHC	100	0	36	100	67	100	89
		Nga Town CHP	0	100	16	100	67	100	98
		Peya MCHP	0	0	8	100	67	100	92
		Total	6200	6150	2752	5300	4567	3800	
		Average	67	66	30	57	49	41	
		Chi square of independence for support IDSR functions against timeliness of reporting at the health facilities							
		Values	26.46	40.3 9	333.9 4	18.87	48.18	28.64	
		df	32	32	320	16	64	32	
		P-value	0.743	0.14 7	0.285	0.276	0.93	0.637	

		Significant/Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	
		Linear-by-linear association P-value	0.23	0.321	0.276	0.179	0.377	0.036	
		Significant/Not Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Significant	

Average responses of the six support functions at the health facility levels with p value and chi square

Note. The Six Support functions with P-values at the health facility level

The chi-square test of independence from table 22, showed that the association between adherence to standards and guidelines and the timeliness of reporting at the health facility was not statistically significant, $\chi^2(32, N = 93) = 26.46$, $p = .743$, indicating no strong overall association. However, the test for linear-by-linear association was significant, $\chi^2(1, N = 93) = 5.16$, $p = .023$, suggesting a meaningful linear trend: higher adherence to standards was associated with better timeliness of reporting. According to the cross-tabulation of healthcare facility performance data, there is a noticeable association between adherence to standards and guidelines

and the timeliness of reporting. Table 22 showed that health facilities that fully adhere (100%) tend to report more promptly. This means that the stakeholders are effectively implementing standards and guidelines effectively to prevent the next epidemic. This can be further explored by fitting an ordinal logistic regression model to examine how adherence to standards and guidelines predicts the timeliness of reporting.

This cross-tabulation from table 22 reveals a pattern in which facilities with better timeliness in reporting are more likely to comply (100%) with standards and guidelines fully. Facilities with 0% adherence to guidelines cluster disproportionately in the lower reporting timeliness bracket (e.g., 69–75%), as shown by their positive residuals in those ranges in Table 22. Conversely, 100% adherence clusters in higher timeliness ranges (94%–100%), suggesting a positive relationship between adherence and timely data submission.

The chi-square of independence from table 22 showed that there was no statistically significant association between staff training level and reporting timeliness, $\chi^2(32, N = 93) = 40.39$, $p = .147$. Additionally, the test for a linear trend was not statistically significant, $\chi^2(1, N = 93) = 0.99$, $p = .321$. An ordinal regression analysis would be conducted to examine how staff training level predicts the timeliness of reporting.

The association between the availability of a minimal level of resources and the timeliness of reporting at the health facilities from table 22 was not significant, as the null hypothesis was accepted ($\chi^2(320, N = 93) = 333.94$, $p = .285$). Likewise, the linear-by-linear association test was not significant, $\chi^2(1, N = 93) = 1.19$, $p = .276$. The cross-tabulation from table 22 showed that facilities with greater resource availability ($\geq 40\%$) were more likely to submit their reports on time, especially within the 87%–98% timeliness range. This means that minimal levels of resources do not help the health facilities to promptly report for IDSR but much higher levels would do.

Stakeholder satisfaction from table 22 showed no statistically significant association with the timeliness of reporting, $\chi^2(16, N = 93) = 18.87, p = .276$. A linear-by-linear association test also from table 22 revealed no significant trend, $\chi^2(1, N = 93) = 1.80, p = .179$. A cross-tabulation examined the relationship between health workers' satisfaction with IDSR implementation (0% = not satisfied; 100% = fully satisfied) and the timeliness of health data reporting in 93 healthcare facilities. The data from table 22 showed that facilities with higher staff satisfaction were more concentrated in higher reporting timeliness categories ($\geq 90\%$), while unsatisfied health facilities were more represented in lower performance bands.

The district-level supervision of the health facilities from table 22 showed no statistical significant association with the timeliness of health facility reporting, $\chi^2(64, N = 93) = 48.18, p = .930$. Similarly, the linear-to-linear trend was not significant for this function, $\chi^2(1, N = 93) = 0.78, p = .377$.

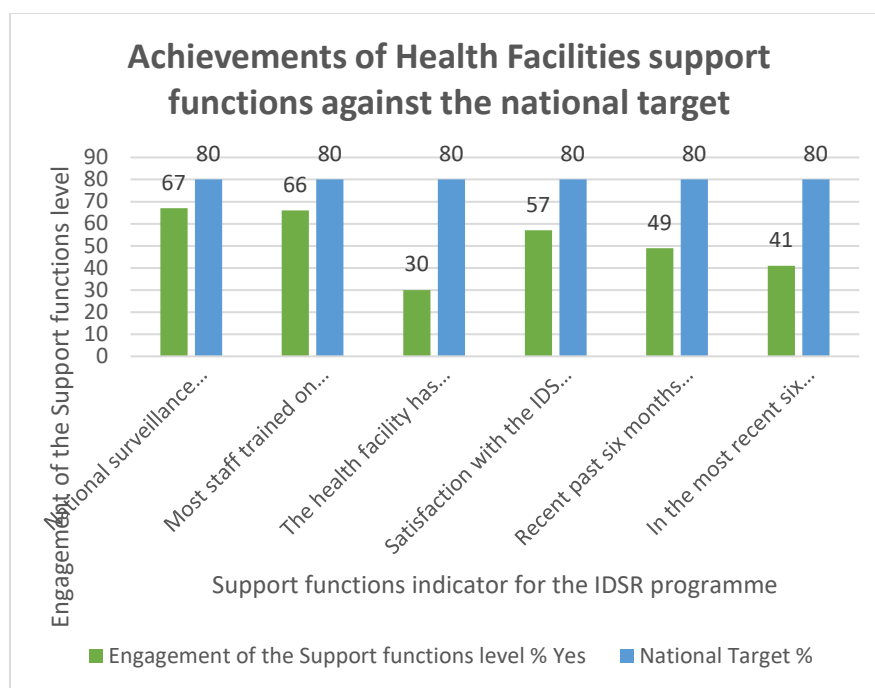
A crosstab analysis from table 22 showed that facilities with no supervision were slightly more common in lower timeliness categories (69–85%), whereas those receiving full (100%) supervision were more concentrated in higher timeliness bands (94–100%), as seen in Table 22. Although none of the adjusted residuals exceeded ± 2.0 , indicating statistical significance, the observed trends suggest a potential positive association between supervision and reporting performance.

The test of independence for coordination of the health facility and community activities on IDSR was not statistically significantly associated with the timeliness of reporting to the districts, $\chi^2(32, N = 93) = 28.64, p = .637$. The linear-to-linear association was significant, $\chi^2(1, N = 93) = 4.38, p = .036$. This suggested a positive linear relationship: facilities with higher coordination levels tend to report more promptly. The cross-tabulation showed that facilities

lacking coordination (0%) were over-represented in the lower reporting timeliness categories (69–84%) and under-represented in the higher timeliness categories (especially 89%, 96%, and 98%). Facilities with 50% and 100% coordination were more common in higher timeliness bands, although most adjusted residuals did not exceed the threshold for statistical significance (± 2.0).

Figure 6:

Achievements of Health Facilities support functions against the national target



Achievements of support functions against the national target

Note: Level of engagement of Support functions of IDSR programme at health facilities against the national target.

An ordinal regression analysis was done to predict how much the achieved health facilities support functions were able to predict the timeliness of reporting. Indicating that the health facility support functions had been effectively implemented to prevent the next epidemic. As it is only if

the support functions are effectively implemented that would lead to a positive prediction of the outcome indicator.

The ordinal regression model tests whether all the predictor indicators are included in the model equation; if so, can they predict the outcome indicator in the same way as when no predictor indicators are included in the model? If the predictors are added to the model, would it improve the description of the outcome? The results from Table 23 showed that the final model yielded an improvement over the model with the predictor indicators, as the p value was < 0.05 ($p = .014$), $\chi^2(31) = 50.86$, $p = .014$. The cumulative effect of support functions at the health facilities improves the timeliness of reports reaching the districts.

Table 23:

Ordinal regression model fitting information for IDSR support functions at the health facilities

Model Fitting Information					
Model	-2 Log Likelihood	Chi-Square	df	Sig.	
Intercept Only	459.069				
Final	408.207	50.862	31	0.014	
Link function: Logit.					

A parametric analysis was done to know how much each of the predictor account for the variations in the timeliness of reporting as shown in Table 23.

Table 24:

Parametric estimates of the support functions of IDSR at the health facilities against the timeliness of reporting with their confidence intervals

Parameter Estimates									
		Estimate	Standard Error	Wald	df	Sig.	95% Confidence Interval		
							Lower Bound	Upper Bound	
Threshold	[Timeliness of reporting = 69]	-5.340	2.097	6.486	1	0.011	-9.449	-1.230	
	[Timeliness of reporting = 73]	-5.026	2.087	5.801	1	0.016	-9.115	-0.936	
	[Timeliness of reporting = 75]	-4.883	2.083	5.498	1	0.019	-8.965	-0.801	
	[Timeliness of reporting = 77]	-4.754	2.079	5.227	1	0.022	-8.829	-0.679	

	[Timelinessofreporting = 79]	- 4.634	2.0 76	4.9 80	1	0.0 26	- 8.70 3	- 0.56 4	
	[Timelinessofreporting = 81]	- 4.519	2.0 74	4.7 48	1	0.0 29	- 8.58 3	- 0.45 4	
	[Timelinessofreporting = 83]	- 4.310	2.0 69	4.3 39	1	0.0 37	- 8.36 5	- 0.25 5	
	[Timelinessofreporting = 84]	- 4.215	2.0 67	4.1 59	1	0.0 41	- 8.26 7	- 0.16 4	
	[Timelinessofreporting = 85]	- 3.857	2.0 60	3.5 05	1	0.0 61	- 7.89 5	0.18 1	
	[Timelinessofreporting = 87]	- 3.515	2.0 54	2.9 29	1	0.0 87	- 7.54 1	0.51 1	
	[Timelinessofreporting = 89]	- 2.899	2.0 44	2.0 12	1	0.1 56	- 6.90 4	1.10 6	

	[Timelinessofreporting = 90]	- 2.350	2.0 35	1.3 33	1	0.2 48	- 6.34 0	1.63 9	
	[Timelinessofreporting = 92]	- 1.781	2.0 28	0.7 71	1	0.3 80	- 5.75 6	2.19 4	
	[Timelinessofreporting = 94]	- 1.358	2.0 24	0.4 50	1	0.5 02	- 5.32 6	2.61 0	
	[Timelinessofreporting = 96]	- 0.274	2.0 23	0.0 18	1	0.8 92	- 4.23 9	3.69 0	
	[Timelinessofreporting = 98]	1.430	2.0 60	0.4 82	1	0.4 88	- 2.60 8	5.46 8	
Locati on	[StandardsandGuidelines=0]	- 0.762	0.5 17	2.1 76	1	0.1 40	- 1.77 5	0.25 0	
	[StandardsandGuidelines=50]	1.330	0.8 39	2.5 11	1	0.1 13	- 0.31 5	2.97 4	

	[StandardsandGuidelines=100]	0 ^a			0				
	[Trainingofstaff=0]	0.452	0.5 07	0.7 93	1	0.3 73	- 0.54 2	1.44 6	
	[Trainingofstaff=50]	0.038	2.0 57	0.0 00	1	0.9 85	- 3.99 4	4.07 0	
	[Trainingofstaff=100]	0 ^a			0				
	[Minimumresourcesavailability= 0]	- 1.058	2.5 89	0.1 67	1	0.6 83	- 6.13 3	4.01 8	
	[Minimumresourcesavailability= 4]	- 3.497	2.6 91	1.6 89	1	0.1 94	- 8.77 2	1.77 7	
	[Minimumresourcesavailability= 8]	0.823	2.0 10	0.1 67	1	0.6 82	- 3.11 8	4.76 3	
	[Minimumresourcesavailability= 12]	- 0.807	1.9 35	0.1 74	1	0.6 77	- 4.60 0	2.98 5	

[Minimumresourcesavailability= 16]	- 1.999	1.9 96	1.0 03	1	0.3 16	- 5.91 2	1.91 3	
[Minimumresourcesavailability= 20]	- 0.380	1.9 31	0.0 39	1	0.8 44	- 4.16 4	3.40 4	
[Minimumresourcesavailability= 24]	- 3.016	2.0 51	2.1 63	1	0.1 41	- 7.03 6	1.00 4	
[Minimumresourcesavailability= 28]	- 2.532	2.0 12	1.5 83	1	0.2 08	- 6.47 6	1.41 3	
[Minimumresourcesavailability= 32]	- 1.223	2.0 71	0.3 49	1	0.5 55	- 5.28 2	2.83 6	
[Minimumresourcesavailability= 36]	- 2.170	2.0 54	1.1 16	1	0.2 91	- 6.19 6	1.85 5	
[Minimumresourcesavailability= 40]	- 2.906	2.2 31	1.6 97	1	0.1 93	- 7.27 8	1.46 6	

[Minimumresourcesavailability=44]	- 1.874	2.2 30	0.7 06	1	0.4 01	- 6.24 6	2.49 7	
[Minimumresourcesavailability=48]	- 2.706	2.2 67	1.4 25	1	0.2 33	- 7.15 1	1.73 8	
[Minimumresourcesavailability=52]	- 2.787	2.1 92	1.6 17	1	0.2 03	- 7.08 3	1.50 8	
[Minimumresourcesavailability=56]	- 2.285	2.2 33	1.0 47	1	0.3 06	- 6.66 1	2.09 2	
[Minimumresourcesavailability=60]	0.044	2.0 20	0.0 00	1	0.9 82	- 3.91 4	4.00 3	
[Minimumresourcesavailability=64]	21.40 7	0.0 00		1		21.4 07	21.4 07	
[Minimumresourcesavailability=68]	- 0.996	2.0 84	0.2 28	1	0.6 33	- 5.08 0	3.08 9	

[Minimumresourcesavailability=76]	- 23.77 5	0.0 00		1		- 23.7 75	- 23.7 75	
[Minimumresourcesavailability=84]	- 0.335	2.6 20	0.0 16	1	0.8 98	- 5.47 0	4.80 0	
[Minimumresourcesavailability=92]	0 ^a			0				
[SatisfactionwithIDSRimplement ation=0]	- 0.441	0.4 92	0.8 03	1	0.3 70	- 1.40 4	0.52 3	
[SatisfactionwithIDSRimplement ation=100]	0 ^a			0				
[SupervisionfromdistrictstoHealt hfacilities=0]	- 0.616	0.6 50	0.8 99	1	0.3 43	- 1.89 0	0.65 8	
[SupervisionfromdistrictstoHealt hfacilities=33]	0.016	0.7 67	0.0 00	1	0.9 83	- 1.48 8	1.52 0	

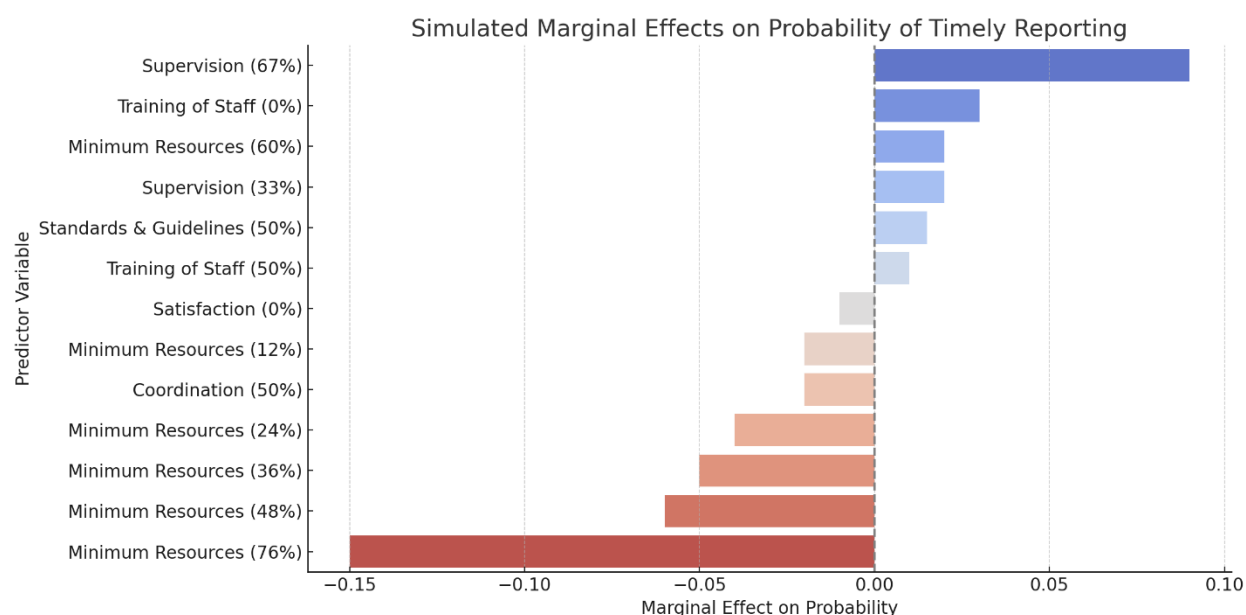
	[SupervisionfromdistrictstoHealth facilities=67]	- 0.454	0.6 61	0.4 72	1 92	0.4 1.75	- 2 0	0.84	
	[SupervisionfromdistrictstoHealth facilities=67]	3.339	2.1 12	2.5 01	1 14	0.1 0.79	- 8 9	7.47	
	[SupervisionfromdistrictstoHealth facilities=100]	0 ^a			0				
	[Coordination=0]	- 0.200	0.6 75	0.0 88	1 67	0.7 1.52	- 3 3	1.12	
	[Coordination=50]	- 0.497	0.6 41	0.6 02	1 38	0.4 1.75	- 9 4	0.75	
	[Coordination=100]	0 ^a			0				
Link function: Logit.									
a. This parameter is set to zero because it is redundant.									

A parametric analysis was done to examine the impact of the achieved support functions of IDSR on the timeliness of reporting at the health facilities. The results as shown in Table 24

states that the combine effect of the predictors was statistically significant but the individual impact on the outcome indicator was not significant as $p < 0.05$. A simulated marginal effect on probability of the timeliness of reporting was calculated as shown in figure 7 below.

Figure 7:

Simulated marginal Effects on Probability of timely reporting at the health facilities



The marginal effect analysis showed that the supervision at 67% was associated with the earliest IDSR data reporting from health facilities to district level as shown in figure 7. Minimal resource availability at the health facilities 60% was associated with positive impact on IDSR data reporting. However, there are other factor that determine how availability of resource impact early reporting as minimal resource availability at 67% showed negative impact on the rates of reporting. It is important to see that the data suggested that supervision and resource mobilisation should be the priority for stakeholders to improve on reporting at the health facility level based on the quantitative data.

Qualitative data for Support functions of IDSR at the health facilities

The data from the quantitative studies shows that there is more that can lead to an epidemic than just the numbers. The stakeholders were asked to identify the challenges with the IDSR support functions at the health facilities and how to improve the implementation in Table 25 and 26.

Table 25:

Thematic responses and codes from the stakeholders on the challenges of IDSR support functions at the health facility level

Research questions	Answers from the stakeholder	Property Codes (Condensed from Transcript)
1. Availability of Standards and Guidelines	Gaps in guideline availability	Lack of standards and guidelines
	Capacity gaps for guideline utilisation	Need training and retrain on standard and guidelines
		Need mentoring on guideline use
2. Staff Training	Workforce turnover and capacity limitations	Transfer of trained staff lead to attrition

		New staff lack IDSR capacity
	Weak IDSR teaching in universities	Limited or no IDSR coverage in university doing health workers training
		Lecturers lack practical IDSR experience
		Low lecturer motivation because they feel they should be paid extra salaries for teaching any public health strategy
3. Resources	Inadequate supply and distribution systems	No standard strategy for resource provision
	Poor maintenance culture	Frequent breakdown due to lack of maintenance
	ICT constraints	Limited support for internet and computer accessories
	General resource shortages	Limited availability of ICT materials and accessories
4. Satisfaction with IDSR Implementation	Low understanding of IDSR value	Limited knowledge of importance of IDSR/data

	Absence of feedback culture	No strategy for stakeholder feedback to health workers
5. Supervision	Structural and financial barriers	No government allocation for supervision
		No functional strategy for regular supervision
		Limited transport capacity
	Weak supervisory capacity	Limited knowledge on supervision/mentoring
		Lack of supervision kits
	Poor digital support	No functional mobile-based supervision applications
		District staff perceived as punitive, not supportive
		Low staff motivation—no stipends, data bundles, new job aids
6. Coordination	Weak community-level governance	Non-functional village health committees
		Political interference in committee commitment
	Exclusion of community actors	Chiefs, village leaders excluded from IDSR activities

		No strategy for community suggestions
		No open health facility days
	Absence of communication systems	No communication protocol for alerts, outbreaks, deaths, stock levels
	Limited community preparedness	Community leaders not trained in outbreak preparedness/mobilisation
		Community excluded from simulation exercises
	Resource constraints for engagement	No megaphones, SMS platforms, kiosks
	Lack of community accountability mechanisms	No community by-laws mandating support for surveillance and response
7. Improvement Strategies for IDSR Support Functions	Strengthening academic and training systems	Train university lecturers; Provide practical IDSR experience
		Complete IDSR curriculum and include simulations for the Universities and institutions training health workers

	Enhancing digital and blended learning	Blended learning: WhatsApp, Zoom, Microsoft Teams
	Improving job aids and frontline tools	Review, print, distribute, and mentor on job aids for all cadres
	Strengthening resource mobilisation	Mobilise local resources for registers, forms, computers, internet
	Strengthening sample transport and lab systems	Integrated specimen transport system, trained personnel, budget
		Strategy for specimen transport
	Improving supply chain and logistics	Improve supply chain for drugs, vaccines, IPC supplies, RDTs, containers, outbreak kits
	Strengthening digital integration	Integrate IDSR reporting with DHIS2, lab information systems, human resources for IDSR and One Health data

Rearrangement of the themes, subtheme, codes and interpretative statements using excel application led to the development of the three challenges and a suggestion for improvement from the stakeholders as shown in Table 26.

Table 26:

Themes, Subthemes and Codes for the statements from the stakeholders on the support functions of IDSR at the health facility level

Main Theme	Subtheme	Illustrative Codes	Interpretive Statement
1. Resource Shortages	Gaps in guideline and tool availability	Lack of standards and guidelines; Inconsistent access to job aids; No strategy for resource provision	Inadequate availability of guidelines and tools repeatedly disrupted early detection and registration processes, reducing the system's reliability.

	Limited financial and logistical support	No government allocation for supervision; Inability to fund community engagement tools (megaphones, SMS platforms, kiosks); No resources for maintenance	Chronic financial constraints prevented consistent supervision, community mobilisation, and the maintenance of essential equipment, creating avoidable operational gaps.
	Infrastructure and ICT constraints	General shortages of ICT materials; Frequent equipment breakdowns	Insufficient ICT infrastructure hindered data processes and weakened real-time reporting, limiting the responsiveness of IDSR activities.

	Staff motivation barriers	No stipends, data bundles, or job aids; Low motivation	The lack of incentives and basic operational support reduced staff morale and likely contributed to performance inconsistencies and reporting gaps especially at the community level.
	Shortage of supervision materials	Lack of supervision kits	Supervisory systems were weakened by the absence of basic tools required for mentoring, monitoring, and feedback at health facilities.

2. Human Capacity Building Gaps	Limited capacity of existing health workforce	Need for mentoring; New staff lack IDSR capacity; Staff attrition due to transfer of trained personnel	Gaps in mentoring and continuous professional development weakened frontline practitioners' ability to implement IDSR effectively.
	Weak pre-service training systems	Limited or no IDSR content in universities; Limited trained university lecturers; Lecturers lack practical experience	The absence of structured IDSR curricula and limited lecturer expertise produced graduates with insufficient competency in surveillance and outbreak response.

	Motivation and knowledge challenges among educators	Lecturers' low motivation to teach IDSR without additional pay	Institutional and remuneration constraints undermined the quality and consistency of pre-service IDSR training.
	Knowledge gaps among stakeholders	Limited knowledge of IDSR importance; District staff lack mentoring/supervision skills; Community leaders not trained in outbreak preparedness	Knowledge deficiencies across health workers, district teams, and community leaders reduced the overall coherence and functionality of the surveillance system.

3. IDSR Integration Gaps	Weak feedback and supervision mechanisms	No stakeholder feedback strategy; No regular supervision strategy	The absence of structured feedback loops and supervision systems hampered performance improvement and accountability.
	Limited capacity for specimen transport	Lack of functional transport systems; Limited transport personnel	Ineffective transport arrangements delayed specimen movement and laboratory confirmation, undermining timely outbreak verification.

	Weak community engagement	Community excluded from simulations; Chiefs and leaders excluded; No community suggestions strategy; No open facility days	Excluding communities from surveillance processes eroded trust and reduced the timeliness and completeness of alerts and reporting.
	Governance and coordination barriers	Political interference; Non-functional village health committees; No community by-laws supporting surveillance	Political and governance constraints weakened coordination and reduced the legitimacy and continuity of IDSR activities.

	Communication failures	No communication protocol for alerts, outbreaks, deaths, stock levels; No functional mobile-based supervision apps	Poor communication structures led to delays, misreporting, and missed opportunities for early action during public health threats.
4. Improvement Strategies for IDSR Support Functions	Strengthening training and capacity	Blended learning platforms (WhatsApp, Zoom, Teams); Train lecturers; Provide practical IDSR experiences; Mentor staff on revised job aids	Leveraging digital learning, strengthening training institutions, and providing hands-on IDSR experience can significantly enhance workforce competency.

	Enhancing university curricula	Complete IDSR curriculum; Introduce simulations	Curriculum reforms and simulation-based learning are essential for producing graduates equipped for real-world surveillance tasks.
	Improving logistics and supplies	Strengthening supply chains for vaccines, IPC materials, RDTs, containers; Ensure availability of outbreak kits	Strengthened supply chains would enhance preparedness and ensure uninterrupted case detection and response activities.

	Strengthening specimen transport	Integrated transport system; Dedicated personnel; Budget provision; Clear transport strategy	Establishing a resilient, well-funded specimen transport network is critical for rapid laboratory confirmation and early outbreak control.
	Improving system interoperability	Integrate IDSR reporting with DHIS2, LIS, HR systems, and One Health data	Advanced data integration would enable more comprehensive, real-time surveillance across sectors and improve decision-making accuracy.

The stakeholder statements provided a clear picture of how far these three theme challenges are affecting the implementation of IDSR at the health facilities. They further suggested how the IDSR support functions can be improved, as shown in Table 25 and 26 above.

The first theme discussed was the gaps in resources starting with how the gap in the implementation of Standards and guidelines supplied to health facilities can be helpful if staff know how to use them. A community health officer at Baoma CHC told us about his struggle to use the National IDSR guideline that was sent to them.

“The availability and use of the National IDSR guideline had been a challenge because we were using the expired guideline for a while before the new one was distributed. This new one in 2021 brought many changes, and we need to be trained on them so we know how to use them better. Until an opportunity for training presents itself, mentorship from district or national staff would have been helpful. Unfortunately, that is not happening, so we rely on whatever information is lying around to continue our work.”

Community Health Officer Baoma CHC.

The quantitative data showed that stakeholders are not meeting the national training target. The Ministry of Health and Sanitation had worked with the Universities to train health workers to incorporate the IDSR curriculum and train the staff before they are sent to start service. They have also trained scores of batches of health workers on field epidemiology at introductory and intermediate levels. These trainings were crucial for preventing and responding to epidemics like COVID-19 in 2020 (Gebru et al., 2025). However, a sister in charge of IDSR implementation at Connaught Hospital said there are challenges with training and retaining staff knowledgeable in IDSR implementation.

“Some staff have been trained on IDSR implementation, and some are doing well. We usually have problems with newly recruited staff who have not completed in-service training. Staff attrition at Connaught Hospital is high, creating a knowledge gap that needs to be quickly filled. The new staff complained that they are not given enough time in their school curriculum to learn about IDSR. Some of our lecturers are not committed to teaching, and they complain of not having enough knowledge, as they do not have practical experience.”

Matron in-Charge- of IDSR, Connaught Hospital.

The availability of resource is crucial for the implementation of IDSR. The quantitative data showed that this is not effectively implemented by the stakeholders and it has the second most predictive effect on timely reporting. A surveillance officer at Jaiama Sewafe CHC said that they are always struggling to maintain their resources.

“We always need to replace and lack minimal resources to use in IDSR implementation, like megaphones, data bundle, computers and their accessories. We do not have a strategy in place for managing these resources. The DHMT would give the health facility what is available, not according to our needs. Some NGO also provides.”

Community Health Officer in-charge of surveillance at Jaiama Sewafe CHC.

District IDSR Support function Chi square

Table 27 was used to investigate the second research question on the association between the effectiveness of the support functions which was calculated as the performance in percentages and the acceptable case fatality rate of patients with COVID-19. The results are shown in table below.

Table 27:

District Support Functions with Chi square calculation

No	Districts	District IDSR Support Functions						
		Standards and Guidelines	Training	Resources	Supervision	Satisfaction	Coordination	Acceptable Case Fatality for the most recent Outbreaks (COVID-19)

1	Western area Urban	100	60	64	53	60	70	66
2	Western area Rural	100	20	64	53	50	80	70
3	Port Loko	50	30	59	33	40	40	80
4	Kambia	50	30	68	27	20	30	70
5	Bombali	50	30	64	40	30	50	60
6	Koinadugu	50	20	64	27	70	70	50
7	Falaba	50	30	59	27	89	90	40
8	Karene	50	30	59	0	59	90	70
9	Bombali	100	70	68	20	68	40	60
10	Bo	100	70	68	20	100	70	40
11	Bonthe	50	30	64	0	40	20	60
12	Moyamba	50	30	64	33	100	20	59
13	Pujehun	50	50	59	13	40	10	60
14	Kenema	100	70	64	20	80	90	66
15	Kailahun	50	50	64	40	100	90	75
16	Kono	50	40	59	33	30	30	76

**Pearson`s Chi-Square Test of Independence Between Support IDSR District functions
and Acceptable Case Fatality**

	Values	46.406	93.08	52.619	87.6111	130.625	95	
					1			
	df	30	70	40	80	120	90	

	P-value	0.028	0.034	0.087	0.262	0.23906 1	0.339	
	Significant on NOT	Signifi cant	Signifi cant	Signifi cant	Not signific ant	Not signific ant	Not significa nt	

The effectiveness of the IDSR support functions—namely the provision of standards and guidelines (p-value=0.028), training (p-value=0.034), and the availability of minimal resources (p-value=0.087) at the district level —was found to be statistically significant when independently evaluated in relation to the acceptable case fatality rate among COVID-19 patients, as presented in Table 27 above. On the other hand in table 27, the same effectiveness of the IDSR support functions -namely the supervision (p-value=0.262), coordination (p-value=0.2390), and stakeholders' satisfaction (p-value=0.339) at the district level were found to be statistically not significant when independently evaluated in relation to the acceptable case fatality rate among COVID-19 patients.

Using table 27, the ordinal regression analysis was done to estimate the best predictors of the acceptable case fatality rate for the COVID-19. This was used to prioritize which district support functions should the stakeholders spend their resource on to improve the IDSR support functions at the district level. From the parametric estimate a table of predictors was done as shown in Table 28 below:

Table 28:

Predictors from Ordinal Logistic Regression Parametric Output showing the IDSR support functions, the β estimates, p-values and their interpretation

Predictor	Category Level Compared to Reference	Estimate (β)	Sig. (p-value)	Interpretation
Standards & Guidelines	50 vs 100	19.721	0.243	Not statistically significant; no meaningful effect on acceptable case fatality outcome.
Training	20 vs 70	6.419	0.308	Not significant.
	30 vs 70	-26.55	0.117	Not significant, but trend toward reducing odds.
	40 vs 70	-22.174	0.273	Not significant.
	50 vs 70	-7.571	0.669	Not significant.
	60 vs 70	~0	1	No effect.

Resources	59 vs 68	49.987	0.014	Significant positive predictor; higher resource score 59 increases odds of acceptable case fatality.
	64 vs 68	24.684	0.115	Not significant.
Supervision	0 vs 53	-12.055	0.194	Not significant.
	13 vs 53	-56.336	0.009	Significant negative predictor; low supervision score (13) strongly reduces odds of acceptable case fatality.
	20 vs 53	0	—	Reference level.

	27 vs 53	-43.158	0.024	Significant negative predictor; poor supervision reduces odds of acceptable case fatality.
	33 vs 53	-5.981	0.357	Not significant.
Satisfaction	20 vs 59	81.09	0.008	Significant positive predictor; high satisfaction increases odds of favourable outcome.
	40 vs 59	12.055	0.12	Not significant.
	68 vs 59	17.855	0.246	Not significant.
Coordination	All levels	0	–	Predictors redundant; no effect estimated.

From table 28 above a summary of the statistically significant predictors of the acceptable case fatality rates for patients with COVID-19 are in table 29.

Table 29:

Summary of Statistically Significant Predictors

Predictor	Category	Direction of Effect	Meaning
Resources (59)	Compared to 68	Positive ($\beta = 49.987$, $p = .014$)	Higher resource availability significantly increases odds of achieving acceptable case fatality rate.
Supervision (13)	Compared to 53	Negative ($\beta = -56.336$, $p = .009$)	Poor supervision significantly reduces odds of good outcomes.
Supervision (27)	Compared to 53	Negative ($\beta = -43.158$, $p = .024$)	Moderate-to-low supervision significantly worsens outcomes.

Satisfaction (20)	Compared to 59	Positive ($\beta = 81.090$, $p = .008$)	Higher stakeholder satisfaction significantly improves acceptable case fatality performance.

The data in table 28 and 29 showed that the strongest predictor of the outcome was the availability of minimal district-level resources to support IDSR implementation. This finding confirms the critical role of adequate resourcing—including IDSR reporting tools, logistics such as spray, gloves, cleaning materials and reagents, computers and IT accessories, internet and databases, and special software for data analysis and modelling for new and resurgent priority diseases and supplies—in reducing fatalities. District systems with better resourcing were far more likely to manage disease burden effectively, possibly due to faster diagnosis, better treatment adherence, and overall health system responsiveness. These resources would allow the rest of the IDSR to prevent the next epidemic. The more resources that are available, the better IDSR functions would perform and prevent patient deaths from epidemics, as shown in Table 28 and 29.

The data from table 28 and 29 showed that the second strongest predictor was the district's national-level supervision and its supervision of the health facilities. Supervision can also take the form of staff mentoring. These negative coefficients highlight that inadequate supervision—whether minimal or inconsistent—has a substantial detrimental effect on public health outcomes.

Lack of mentoring, oversight, and operational accountability likely leads to suboptimal protocol implementation, delayed responses, and poor data quality.

Table 28 and 29 showed that the third strongest predictor was stakeholders' satisfaction. The higher the stakeholders' confidence in the implementation of the IDSR, the better the system can do in preventing deaths. This emphasises the value of stakeholder engagement and morale. When staff, community members, and system participants are satisfied potentially due to recognition, inclusion in planning, or adequate compensation the overall system performance improves, leading to better survival rates and response effectiveness.

The standards and guidelines, coordination and training support functions were not significant at any level as shown in table 28 and 29. This could also mean that they are affected by a wider range of factors which were not part of the assessment by the quantitative method. The need to look at the qualitative method became very important.

In summary, the quantitative findings of the district support IDSR function requires urgent investment in resource availability ensuring that all districts have adequate resources to implement IDSR functions. The districts should enhance their supervision strategies ensuring that supportive supervision was implemented across all sixteen districts according to the needs of the districts. Finally, stakeholders should be engaged better to ensure that they have confidence in the systems and they are able to support it.

Qualitative analysis for the support functions of IDSR at the district level

The staff were asked what challenges that were facing while implementing IDSR support functions at the district level and how they think these challenges can be improved by all the stakeholders. The responses are shown in the table below:

Table 30:

Stakeholders' response to challenges and improvement of the IDSR support functions at the districts

Thematic District IDSR Support Function			
No.	Domines	Themes	Codes
1	Standards & Guidelines	Availability & Distribution	Lack of resources to produce standards
			Lack of resources to distribute guidelines
		Training on Guidelines	Limited resources for training and retraining
2	Training	Training Gaps	Few staff trained in IDSR/field epidemiology
			Poor university teaching due to lack of practical experience
			No field experience in university IDSR programs
		Retention and Quality	High attrition among trained staff
			Limited in-service training opportunities
			Low quality of in-service training due to short duration/funding constraints
3	Supervision	Financial and Technical Resources	No allocated funds for supervision
			Inadequate electronic tools for supervision
			Poor support for internet/computer accessories for reporting

		Capacity and Accessibility	District staff lack knowledge for supportive supervision
			Limited transportation
			Geographic difficulty accessing remote facilities
			Competing staff duties
4	Staff Satisfaction	Inclusion and Motivation	Exclusion from planning and evaluation
			Politically influenced recognition/reward
			Political conflicts affect participation
			Lack of knowledge causing doubts about IDSR success
5	Coordination	Stakeholder Engagement	Weak community governance structures
			Low community and MDA involvement
			No communication channel between district, facilities and communities
		Exclusion and Support	Stakeholders excluded from simulation exercises
			Lack of communication support tools
			No by-laws to enforce stakeholder participation
			Government underfunding; reactive partner support

6	Resources	Resource Planning & Allocation	Ad hoc resource distribution
			Inadequate resource supply for IDSR
			No maintenance support
		Technological & Financial Resources	Weak ICT infrastructure
			No resources for community communication
			Low staff motivation due to lack of support
			Activities reliant on partner funding
7	IDSR System Improvements	Governance & Financing	Create emergency public health commission
			Develop district-level costed plans
		Community Engagement & Integration	Monthly IDSR meetings with communities
			Improve IDSR university curricula
			Develop community-enforced by-laws
			Strengthen communication with communities
		Training & Mentorship	Support e-learning for IDSR
			On-the-job mentorship
		Infrastructure & Digital Integration	Costed plan for digital infrastructure

			Integrate DHIS-2, lab, animal, and environmental data

Table 31:

Themes and Codes rearranged for the support function Challenges at the districts

Themes	Codes
Resources and financial gaps	Lack of resources to produce and distribute standards and guidelines
	Limited resources for training and retraining staff in service
	No allocated funds for supervision
	Poor financial support for internet/computer accessories for reporting
	Limited financial resources for transportation
	Ad hoc resource distribution
	Lack of communication support tools
	Inadequate electronic tools for supervision
	Government underfunding; reactive partner support
	Inadequate resource supply for IDSR
	No maintenance support strategy or plan
	No allocated funds for supervision
	Low staff motivation due to lack of support to community health workers
	Activities reliant on partner funding

	No costed plan for digital infrastructure
Training Capacity gaps	Few staff trained in IDSR/field epidemiology
	Poor university teaching due to lack of practical experience
	High attrition among trained staff creating knowledge gap
	No e-learning for IDSR
	Low quality of in-service training due to short duration constraints
	District staff lack knowledge for supportive supervision
	Lack of knowledge causing doubts about IDSR success
	No On-the-job mentorship
Integration challenges	Exclusion from planning and evaluation
	Low community and MDA involvement
	Stakeholders excluded from simulation exercises
	Limited communication with communities
	Unreliable integration of DHIS-2, lab, animal, and environmental data
	Competing staff duties
Governance	Non-independence of the emergency public health commission
	No district-level costed plans
	Limited monthly IDSR meetings with communities
	Politically influenced recognition/reward

	Political conflicts affect participation
	Weak community governance structures
	No by-laws to enforce stakeholder participation

The responses from staff working at the district were systematically reported, extracted, classified, analysed, and interpreted to form thematic sections with their corresponding codes, using NVivo 14, as shown in Tables 30 and 31. These issues account for the systematic, operational, and contextual challenges faced during the implementation of IDSR support functions at the district level. The challenges were divided into four main themes: resources and financial gaps, training gaps, integration and governance gaps.

Resource and Financial Gaps

The theme with the most challenges was the resource and financial gap, which had the highest number of codes in all the support functions of the IDSR at the district level. The participants emphasised structural gaps in financial resources, procurement, digital infrastructure, and operational deficiencies as shown in table 30 and 31.

The districts stakeholder discussed about constant lack of funds to support the printing and distribution of standards and guidelines. They discussed financial constrained faced in the training and retraining of in-service staff leading to gaps in knowledge at the health facilities and districts. The participants also discussed the massive financial constrained faced in the implementation of supportive supervision and it strategies. This also led to inadequate oversight from the districts to the health facilities and frequent mistakes in the implementation of IDSR procedures. Poor financial support also led to inadequate computer and internet access and their accessories. This

has led to limited ability to generate, produce and manage reports from the health facilities and the districts.

“In Kailahun district we constantly struggle for funding to support IDSR activities. I remember in 2014 when the Ebola Viral disease started in The Republic of Guinea close to the boarder with Sierra Leone. The district had no funds to procure and distribute infection prevention control, do boarder surveillance and train our staff on field epidemiology. We only received money after the country experience it first cases of Ebola that started in Kailahun. The same situation occurred in 2019 for COVID-19 even after post-Ebola recovery plan has been implemented.”

District Medical Officer Kailahun DHMT.

The gaps in resources had led to lack of support for the transportation of laboratory specimen, transport for supervision and reaching hard-to-reach communities during supervision, mentoring or collection of laboratory specimen. The participants were quick to mentioned the lack of funding that had led to ad hoc distribution of resources to districts and health facilities leading to unavailability of minimal resources like mega phones, TV sets and projects to support community activities causing maldistribution of their essential resource.

The lack of communication support tools and inadequate electronic supervision tools were identified as significant operational barriers, hindering district teams’ ability to perform essential surveillance and reporting tasks. Government underfunding emerged as a recurrent issue, with respondents stating that support was largely reactive and partner-dependent, particularly during emergencies rather than routine preparedness.

Additionally, participants reported insufficient supplies required for routine IDSR operations, coupled with the lack of a maintenance strategy for equipment. Low staff motivation was also linked to inadequate resources, particularly the absence of support for community health workers leading to missed stipends, and no support for transportation for activities.

Finally, respondents noted the absence of a costed plan for digital infrastructure, which is limiting progress toward integrated, technology-enabled surveillance systems. Collectively, these

findings highlight the extensive financial and resource deficits that limit effective IDSR implementation.

Training Capacity Gaps

The district stakeholders' response analysis table 30 and 31 revealed substantial training capacity gaps that hinder the effective implementation of the Integrated Disease Surveillance and Response (IDSR) system.

Staff consistently identified a shortage of staff trained in IDSR and field epidemiology, noting that the limited number of trained personnel restricts both surveillance coverage and the quality of outbreak detection and response activities. The staff said that the government's new strategy of using the Universities that trained health workers has started, but the lecturers teaching the IDSR module lack field experience, making it difficult for students to be competent in practical IDSR implementation. A community health officer/Surveillance officer in the Port Loko district health management team said that the lack of practical sections during pre-service training of health workers has led to the production of incompetent new graduates. This was compounded by high attrition among competent older staff, leading to persistent knowledge gaps in the districts and health facilities.

"I have seen first-hand how the lack of practical training during university or college education leaves many new graduates without the skills needed to implement IDSR effectively. This problem is made worse by the high attrition of the few experienced staff we have. As they leave, the district loses vital expertise, and we are left with a persistent knowledge gap across both the district team and the health facilities"

Surveillance officer Port Loko DHMT.

Participants also highlighted the absence of e-learning platforms for IDSR, which limits continuous professional development and reduces opportunities for remote or flexible learning shown in table 30. This gap is compounded by the low quality of in-service training, which

respondents attributed to the short duration of training sessions and frequent budget constraints. These limitations reduce the depth of knowledge gained and impede retention of core IDSR competencies.

The findings further in table 30 and 31 revealed that many district staff lack the knowledge needed to conduct supportive supervision, thereby affecting their ability to mentor facility staff and ensure adherence to surveillance standards. This limited knowledge base contributes to uncertainty and doubt about the effectiveness of IDSR implementation, as staff feel inadequately prepared to perform the required tasks.

Finally, table 30 showed that stakeholders reported limited on-the-job mentorship, a component considered essential for reinforcing training, closing knowledge gaps, and supporting new or inexperienced staff as they assume IDSR responsibilities. The staff said that limited mentorship structures were identified as a critical barrier to long-term capacity building.

Integration Challenges

The participants identified IDSR integration process challenges that had led to defective IDSR implementation thereby leading to morbidity and mortality in table 30 and 31.

A central concern raised by participants was the exclusion of key stakeholders from planning, implementation, evaluation, and review processes. Respondents emphasised that both frontline staff and community stakeholders are often left out of critical decision-making forums, reducing the sense of ownership and weakening accountability at all levels.

There was limited engagement with community members and representatives from other Ministries, Departments, and Agencies (MDAs). Meaningful collaboration was needed for IDSR implementation to work. However, current practices reportedly favour siloed operations, with limited involvement of non-health sectors and inadequate participation of community actors in

IDSR-related activities. Stakeholders noted the continuous exclusion of the community leaders and non-health stakeholders in the performance of simulation exercises. This had led to them not been competent when there is an epidemic making the situation a fire fight to get trained to competency levels for the response.

Another recurring theme was the limited and inconsistent communication between health authorities and communities. Participants described inadequate feedback loops and insufficient mechanisms for two-way communication, which compromise public trust and reduce the effectiveness of surveillance and response activities.

Technical integration also proved challenging. Respondents reported that efforts to link surveillance systems remain unreliable and fragmented, particularly for DHIS-2, laboratory, animal health, and environmental data systems. These systems are often not interoperable, leading to delays in information flow and incomplete epidemiological assessments.

Finally, the competing responsibilities of staff—particularly at the end of the month or during reporting periods—were cited as a barrier to meaningful integration. Staff members are frequently overburdened, resulting in low prioritisation of coordination and multisectoral activities.

Taken together, these findings suggest that integration challenges in IDSR are both structural and operational, spanning stakeholder exclusion, weak intersectoral collaboration, poor communication systems, and fragmented data integration. Addressing these challenges requires institutionalising participatory mechanisms, investing in interoperable information systems, and strengthening cross-sector partnerships.

“As a community health worker facing the frontline of the epidemic, we are hardly invited to be part of the planning for IDSR activities. Most of the time we are sent by the health workers to support the activities like surveillance, outbreak investigation and community awareness

campaigns. At time we struggle to appreciate the need for the activity so we do not give it all our support.”

Community Health Worker supervisor Falaba DHMT.

Governance gaps:

The district staff responses in table 30 revealed that governance-related gaps determined the effectiveness of the IDSR support function at the district. A primary concern was the emergency public health commission's that has been proposed to be ratified by parliament lacks independence and the budget was limited to administration, and the fact that most staff would be recruited by other ministries, was perceived as limiting autonomy and weakening the credibility of emergency response structures. Most of the heads of department staff at the emergency public health commission are from the Ministry of Health and Sanitation. Also, the commission's budget was mainly allocated to administrative costs leaving the prevention activities to be produced by other ministries like the Ministry of Health and Sanitation. Participants also highlighted the absence of district-level costed plans, noting that without clearly budgeted operational frameworks, implementation remains fragmented and reactive.

Irregular engagement with communities emerged as another governance gap as shown in table 30. Respondents emphasised that monthly IDSR meetings with community stakeholders are not prioritised and need to be strengthened to improve coordination and local ownership of surveillance activities and data.

“We need to improve the channel of communication with the communities. We hardly hold meetings with our communities to discuss about the implementation of IDSR. Most of the time we would only talk to them when an outbreak occurs. This makes them feel left out of the process and would not own the activities that we give to them”

District Health Sister, Kono DHMT.

The data in table 30 also indicated that political dynamics often shape governance processes. Instances of politically influenced recognition and reward systems, as well as political conflicts, were described as barriers that discourage participation and undermine trust among stakeholders.

At the community level from table 30, governance weaknesses were a recurring theme. Participants described weak community governance structures and the absence of bylaws to enforce stakeholder participation, both of which limit accountability and reduce the effectiveness of multisectoral engagement in IDSR activities.

Overall, the identified governance challenges reflect structural and political constraints that impede coordinated planning, community engagement, and stakeholder accountability—each of which is essential to strengthening IDSR governance frameworks.

National Level Support Function

At the national level, stakeholders effectively engage the support functions. The standards and guidelines are available, and training on the management of epidemic disease outbreaks has been provided to most staff members. The stakeholders said they are satisfied with the implementation of the IDSR programme. Stakeholders held regular partner meetings to coordinate IDSR activities. However, there was a lack of government funding, so the national public health security plan, developed in 2018 and set to end in 2022, has limited activities done to date. This is because most of the resources committed to the Directorate of Health Security and Emergencies are from donors. These donors have their own priorities, which are aligned with the government's, but they can only do as much as the funds they can mobilise. Supervision from the national to the district level was limited in 2021 due to limited funds.

In all the six support functions the national level are meeting target in the four and the other two are left with challenges in the availability of funds.

How do we improve support functions of IDSR in Sierra Leone?

"The main challenge with the implementation of support functions is the financial support to national, district and health facility levels. The ministry of health and sanitation through the Directorate of Health security and emergencies has drafted the public health act that is suggesting the establishment of a functional public health agency. This agency will be able to receive funds directly from the ministry of finance without going through the ministry of health and sanitation to respond to public health emergencies. "

Director Directorate of Health Security and emergencies, MOHS.

Research Question Three/Hypothesis

The operational definitions of the quality indicators collected are shown below (T. Alemu et al., 2019).

Acceptability of IDSR interventions: implementing IDSR in a community can only happen if people are willing to believe it will help them prevent or control health emergencies. The means of measuring people's willingness is by calculating the timeliness and completeness of reporting. In this study, all the health facilities are supposed to report weekly to the districts using their tablets. The timeline for this report is Monday at 12 noon, as indicated in the national technical guideline for the IDSR programme in Sierra Leone. Data from DHIS-2 were collected from January to December 2021 (Alemu et al., 2019; Ministry of Health and Sanitation, 2020f). The data showed in table 32,

The completeness and timeliness of the reports from the health facilities that were selected for the survey is shown below:

Table 32:

Completeness and timeliness of reporting from the 93 health facilities visited in this research

REGIONS	DISTRICTS	HEALTH FACILITIES	TYPE	Expected reports	Actual reports	Timely Report	% Timeline ss	% Completeness
SOUTHERN								
	BO	Bo Government Hospital	Hospital	52	48	45	86.5	92.3
		Kindoya Hospital	Hospital	52	48	42	80.8	92.3
		Gilas Hospital	Hospital	52	47	47	90.4	90.4
		Bo Childrens Hospital	Hospital	52	51	49	94.2	98.1
		Mercy (Bo City) Hospital	Hospital	52	48	46	88.5	92.3
		Sembehun 17 (Tikonko) CHP	CHC	52	49	48	92.3	94.2
		Sebehun Tarbay MCHP	MCHP	52	52	47	90.4	100.0
		Tikonko (Bo) CHC	CHC	52	51	50	96.2	98.1
		Kambawama MCHP	MCHP	52	51	50	96.2	98.1
		Gboyama CHC	CHC	52	50	50	96.2	96.2
		Bathurst MCHP	MCHP	52	52	46	88.5	100.0
	BONTHE	Bonthe Government Hospital	Hospital	52	52	52	100.0	100.0
		Sierra Rutile Hospital	Hospital	52	0	0	0.0	0.0
		Mattru UBC Hospital	Hospital	52	52	50	96.2	100.0
		Talia (Yawbeko) CHC	CHC	52	52	52	100.0	100.0
		Mobefa MCHP	MCHP	52	52	52	100.0	100.0
	MOYAMBA	UMC Rotifunk Hospital	Hospital	52	48	48	92.3	92.3
		Moyamba Government Hospital	Hospital	52	25	25	48.1	48.1
		Njagbahun (Lower Banta) MCHP	MCHP	52	52	51	98.1	100.0
		Mokanji CHC	CHC	52	51	50	96.2	98.1

		Mokotawa CHP	CH P	52	51	50	96.2	98.1
	PUJEH UN	Gobaru CHC	CH C	52	52	48	92.3	100.0
		Vaama (Kpanga Krim) MCHP	MC HP	52	50	49	94.2	96.2
		Pujehun Government Hospital	Hos pital a	52	49	49	94.2	94.2
EASTERN	KENEM A	Ahmadiyya Muslim (Nongowa) Hospital	Hos pital	52	39	21	40.4	75.0
		Kenema Government Hospital	Hos pital	52	50	46	88.5	96.2
		Panguma Hospital	Hos pital	52	49	46	88.5	94.2
		Sendumei CHC	CH C	52	51	50	96.2	98.1
		Gandorhun (Niawa) CHP	CH P	52	51	51	98.1	98.1
		Bandawor MCHP	MC HP	52	50	47	90.4	96.2
		Bongor (Koya) MCHP	MC HP	52	52	47	90.4	100.0
		Baoma (Koya) CHC	CH C	52	49	43	82.7	94.2
		Jui (Koya) CHP	CH P	52	48	46	88.5	92.3
	KAILA HUN	Kailahun Government Hospital	Hos pital	52	52	44	84.6	100.0
		Nixon Hospital	Hos pital	52	52	45	86.5	100.0
		Bandajuma CHC	CH C	52	52	43	82.7	100.0
		Malema (Yawei) CHP	CH P	52	52	44	84.6	100.0
	KONO	Ngo Town CHP	CH P	52	52	51	98.1	100.0
		Peya MCHP	MC HP	52	52	48	92.3	100.0
		Jaiama Sewafe CHC	CH C	52	52	46	88.5	100.0
		Koidu Government Hospital	Hos pital	52	52	40	76.9	100.0

NORTHERN	BOMBA LI	Stocco CHP	CH P	52	52	52	100.0	100.0
		Panlap CHP	CH P	52	52	50	96.2	100.0
		Yoni (Gbanti) CHP	CH P	52	52	52	100.0	100.0
		Arab Clinic	Clin ic	52	50	40	76.9	96.2
		Magbenteh Hospital	Hos pital	52	51	44	84.6	98.1
		Holy Spirit Hospital	Hos pital	52	51	47	90.4	98.1
		Makeni Government Hospital	Hos pital	52	52	50	96.2	100.0
	TONKO LILI	Dankawalia CHP	CH P	52	52	52	100.0	100.0
		Kunya CHP	CH P	52	52	51	98.1	100.0
		Bendugu CHC	CH C	52	52	47	90.4	100.0
		Masanga Leprosy Hospital	Hos pital	52	52	50	96.2	100.0
		Magburaka Under Fives Clinic	Clin ic	52	52	51	98.1	100.0
	KOINA DUGU	Kabala Government Hospital	Hos pital	52	48	46	88.5	92.3
		Thellia CHP	CH P	52	52	51	98.1	100.0
		Mandia MCHP	MC HP	52	51	51	98.1	98.1
	FALAB A	Firawa CHP	CH P	100	52	50	50.0	52.0
NORTHWE ST	PORT LOKO	Rogbere Junction CHC	CH C	52	51	51	98.1	98.1
		New Maforki CHP	CH P	52	51	50	96.2	98.1
		Maforay (Maforki) MCHP	MC HP	52	51	46	88.5	98.1
		Lungi Government Hospital	Hos pital	52	51	51	98.1	98.1
		Bai Bureh Memorial Hospital	Hos pital	52	51	47	90.4	98.1
		St John of God CHP	CH P	52	52	50	96.2	100.0
		Love Bridge Hospital	Hos pital	52	0	0	0.0	0.0

	KAMBI A	Kukuna CHC	CH C	52	52	48	92.3	100.0
		Gbolon MCHP	MC HP	52	52	49	94.2	100.0
		Kambia Government Hospital	Hos pital	52	52	47	90.4	100.0
		Konta CHP	CH P	52	0	0	0.0	0.0
	KAREN E	Sanya MCHP	MC HP	52	51	48	92.3	98.1
		Dumbaya CHP	CH P	52	52	51	98.1	100.0
		Fintonia CHC	CH C	52	52	50	96.2	100.0
		Kamakwie Wesleyan Hospital	Hos pital	52	52	50	96.2	100.0
WESTERN AREA	WESTE RN AREA URBAN	Connaught Hospital	Hos pital	52	48	46	88.5	92.3
		Kroo Bay CHC	CH C	52	52	48	92.3	100.0
		Ola During Children's Hospital	Hos pital	52	51	49	94.2	98.1
		Princess Christian Maternity Hospital	Hos pital	52	50	48	92.3	96.2
		Macauley Street Government Hospital	Hos pital	52	50	45	86.5	96.2
		Aberdeen Women Centre Hospital	Hos pital	52	45	41	78.8	86.5
		Lumley Government Hospital	Hos pital	52	51	50	96.2	98.1
		Rokupa Government Hospital	Hos pital	52	51	49	94.2	98.1
		United Methodist Church PLHA Kissy Clinic	Hos pital	52	0	0	0.0	0.0
		Kingharman Road Hospital	Hos pital	52	50	38	73.1	96.2
		Kingtom police hospital	Hos pital	52	48	36	69.2	92.3
		Choithrams Memorial Hospital	Hos pital	52	52	44	84.6	100.0
		Wilberforce 34 Military Hospital	Hos pital	52	50	44	84.6	96.2

	WESTERN AREA RURAL	York CHC	CHC	52	49	49	94.2	94.2
		Mambo CHP	CHP	52	49	49	94.2	94.2
		Tissana (York Rural) MCHP	MCHP	52	51	51	98.1	98.1
		Adra Hospital	Hospital	52	52	51	98.1	100.0
		Sierra Leone-China Teaching Hospital	Hospital	52	52	50	96.2	100.0
		Christ the King Clinic	Hospital	52	51	48	92.3	98.1
		TOTAL					7861.5	8380.8
		AVERAGE					85	90

Completeness and timeliness of reporting from the 93 health facilities visited in this research

Note: Completeness and Timeliness of reporting for the 93 Health facilities visited

The target for timeliness and completeness is 80% in the national IDSR programme guideline. The average timeliness of reporting was 85 in 2021, and the completeness of reporting was 90 from table 32. This indicates that the IDSR programme was well accepted in these hospitals. Some private hospitals face challenges in accepting the IDSR programme; for example, United Methodist Church Kissy, Love Bridge Hospital, and Sierra Rutile Hospital had refused to report. The acceptability was shown better in the data that was collected by this study, in which the reports for IDSR from 93 health facilities in the recent past three months showed that 75% of the health facilities submitted all three months' IDSR reports and 72% of the health facilities were able to submit all the health facility IDSR reports on Time. This means that although many health facilities have accepted the IDSR programme, some are still not reporting as they should or conducting any surveillance for priority diseases. These health facilities may not report a priority disease that might appear in their emergency room, leading to its spread to communities around them or to the rest of the country and the world.

All the national staff said they are satisfied with the implementation of IDSR in 2021, as it is improving, although there are significant challenges.

Table 22 showed that 57% of health facilities are satisfied with the implementation of IDSR. This is below the national target of 80%

Completeness of IDSR reporting in 2021: This is the percentage of health facilities that submitted IDSR reports to the next level by the end of 2021, regardless of the timing of submission. This data was collected from the DHIS-2 software for all the health facilities selected for the study. The average completeness for these 93 health facilities was 90% as shown in Table 32. Private health facilities, such as United Methodist Church Kissy, Love Bridge Hospital, and Sierra Rutile Hospital, have refused to report.

Timeliness of reporting under the IDSR programme in 2021: the IDSR weekly report must be submitted by 12 noon on Monday. Health facilities that meet this Time are considered compliant with reporting timeliness. This was calculated for the 52 weeks of 2021 and reported in the DHIS-2 database for the Ministry of Health and Sanitation in Sierra Leone, as shown in Table 32 (Alemu et al., 2019; Ministry of Health and Sanitation, 2020f; Texila American University & HakwiaKooma, 2019).

The data from Table 32, showed that the timeliness of reporting was 85% on average across the 93 health facilities selected for the survey.

Data quality: In this study, 93 health facilities were assessed for completeness of data collected in 2021. The quality of the data was assessed by the completeness of the data in 2021, and by the consistency of the data from the health facilities to the districts and the national level. The data was taken from the DHIS-2 database (T. Alemu et al., 2019; Texila American University & Hakwia Kooma, 2019).

The completeness of the IDSR programme in the 93 health facilities was 90%, and the consistency of the data collected from the 93 health facilities shows that only 47% (44 of 93) of the health facilities are consistent in their reporting of IDSR data to the next level, as shown in Table 32 above. This is below the 80% target set by the national IDSR technical guideline for Sierra Leone. The health facilities' staff say the low data consistency was due to insufficient training for some staff and the lack of reporting forms.

Positive predictive value: Identifying priority diseases is a must for any IDSR programme. However, the programme should be able to identify a priority disease if it truly happens. The proportion of these diseases correctly identified by confirmation is the positive predictive value (T. Alemu et al., 2019; Texila American University & Hakwia Kooma, 2019).

The IDSR programme in Sierra Leone has a good positive predictive value as all the epidemics of priority diseases like the Ebola in 2014, COVID-19 in 2019, Measles in Kambia in 2018,

Flexibility: Recently, there has been an emergence and re-emergence of infectious diseases and other health emergencies; this is why a robust, cost-effective strategy called the IDSR programme has been introduced. This programme needs to monitor new health emergencies and remove old ones that have been controlled. The process by which the IDSR programme adds and removes health emergencies or infectious diseases, information, case reporting tool, case definition, or procedure without a major change in the IDSR system is called flexibility. The strategy also needs to allow for changes to reporting periods and frequencies, with evidence and approval from stakeholders in the IDSR programme (T. Alemu et al., 2019; Texila American University & HakwiaKooma, 2019).

The IDSR programme in Sierra Leone is highly flexible. This is because the system has changed three times since 2004, when the first guideline was issued. It has accommodated new priority diseases and conditions like maternal and perinatal death, snake bites and COVID-19. There were changes from paper-based systems to online systems in 2020 (Martin, Sloan, Gleason, de Wit, et al., 2020; Moore et al., 2025).

Representativeness of the IDSR programme: In a world of health emergencies, it is important to be able to report all that is happening to the next level. This is why the IDSR programme should be able to report on the distribution and occurrence of health emergencies, including all infectious diseases with epidemic priority, by person, place, and Time (T. Alemu et al., 2019; Texila American University & HakwiaKooma, 2019).

The IDSR programme is less representative than it should be because the percentage of health facilities reporting data by person, place, and Time is well below the target set by the Sierra Leone IDSR programme technical guideline. The percentages of health facilities reporting by person, place, and Time from the selected health facilities in this study are as follows: person (16%), place (15%), and Time (22%) as shown in table 8.

Simplicity of the IDSR programme: In 2004, Sierra Leone adopted the WHO Technical guideline on the IDSR programme. Targets were set for implementing the core, support, quality, and structural indicators. The programme should meet these set targets for all indicators as implementation occurs, so that they remain simple (T. Alemu et al., 2019; Texila American University & HakwiaKooma, 2019).

The stakeholders interviewed said that the IDSR programme is simple to implement, as the case definitions for the priority diseases are clear and are divided into two levels: community case definitions and health facility case definitions (Ministry of Health and Sanitation, 2020d).

However, the IDSR programme is not meeting its objectives. It is not meeting the targets set by the technical guidelines for data quality (core functions such as case confirmation, investigation, and the rest).

Stability: In implementing the IDSR programme activities, they are hosted by the country's standard health care delivery systems. This is the same situation happening in Sierra Leone. However, this arrangement can make the IDSR programme vulnerable to challenges faced by the standard health care delivery system. A stable IDSR programme can withstand the challenges faced by the system that hosts it and continue to collect, manage, present, and use priority disease data (T. Alemu et al., 2019a).

There is instability in the IDSR programme as reported by all the stakeholders. This is because whenever donor funds are withdrawn, the achievements of the IDSR programme are lost. After the post-Ebola response, donors withdrew their resources from the IDSR programme to support other programmes, such as maternal and child health. This led to reduced notification rates under IDSR in the districts ((Njuguna et al., 2019b). The IDSR programme can only be stable if local government agencies start supporting the activities in the districts and chiefdoms (A. Alemu et al., 2019).

Usefulness of the IDSR programme: The implementation of IDSR programme activities occurs at all levels of the health care delivery system, from national to district, health facility, and community levels. In the writing of the strategic and implementation plan for the health care delivery systems, data from the IDSR programme were used. This is because they can provide the magnitude of morbidity and mortality associated with priority diseases, events, and conditions. Health care delivery systems that effectively use data from the IDSR programme to write their plans are making the IDSR programme very useful (A. Alemu et al., 2019, 2019).

In the national and district sectors from table 8, 63% of district health management teams use the data from the IDSR programme to implement their activities. At the health facility level, because there is no budget line for response activities for the IDSR programme, the usefulness is limited to assessing the disease burden and doing little about it locally.

Sensitivity of the IDSR programme: This refers to the system's ability to correctly notify and report all priority diseases, enabling true epidemics to be identified and controlled. The number of epidemics identified against the total number of emergencies detected by all parties. In this situation, if the IDSR programme identifies all health emergencies and the other partners identify none, then the sensitivity will be the highest. If some health emergencies are identified by partners and others by the IDSR programme, the sensitivity will be low (T. Alemu et al., 2019). The IDSR programme's sensitivity is 100%, as all epidemics and outbreaks detected so far in Sierra Leone have been identified through it.

Specificity of the IDSR programme: A false alert for priority diseases can lead to the waste of scarce resources and stress on the already overworked. This quality indicator makes the IDSR programme cost-effective by ensuring that false alerts for epidemic-prone diseases are not generated. To calculate the specificity of the IDSR programme, the number of patients without the epidemic-prone disease will be divided by the total number of patients suspected of having the disease. Therefore, if all the suspected cases that do not have the disease are truly not infected with the priority disease, the specificity will be 100% (T. Alemu et al., 2019).

The IDSR programme has a 100% specificity, as no priority disease or condition has been falsely diagnosed.

Stakeholders in the IDSR programme in Sierra Leone have not fully engaged with all the indicators described above.

Research Question Four/Hypothesis

The fourth research question concerned the support structures of the IDSR programme in Sierra Leone.

RQ4. What is the current state of the support structures of Sierra Leone's IDSR programme?

Stakeholders at the national level provided evidence that the IDSR programme in Sierra Leone is hosted by the Ministry of Health and Sanitation, which is a government agency responsible for the health of the people of Sierra Leone. In this Ministry, the directorate of health security and emergency, with the director acting as the lead, and assisted by the programme manager for surveillance and his team, the programme manager for health emergencies and his team and a host of other team members in the directorate. The MOHS offices are decentralised into the districts and chiefdoms. The IDSR programme is also within the MOHS systems and decentralised within these districts. The leaders of these districts are champions of the IDSR programme.

What is the state of integration of surveillance activities in Sierra Leone?

“Sierra Leone has been able to integrate surveillance activities since 2005 with the development of the technical guideline for integrated disease surveillance and response. However, due to challenges in implementing IDSR and the new WHO recommendations, it was revised in 2011 and 2019. The IDSR is also decentralised, starting at the national, district and health facility levels.”

(The Directorate of health security and emergencies, MOHS).

This means the IDSR programme is integrated at all levels of the MOHS governance structure. The IDSR programme is also part of Sierra Leone's One Health approach. This means that it is not only responding to health issues but also to environmental emergencies such as chemical, Food, ionising, non-ionising radiation, and zoonotic ones(Grieco et al., 2020).

Stakeholders confirmed that the IDSR programme in Sierra Leone started paper-based reporting and transitioned to electronic reporting using tablets and Android phones. National stakeholders also revealed that the IDSR programme in Sierra Leone uses case-based, sentinel, and outbreak-based surveillance data systems—the data flow from communities to health facilities, then to districts, and finally to the national level. The national level will later disseminate the data to partners and international communities (Martin, Sloan, Gleason, de Wit, et al., 2020).

What is the means of data transfer in the IDSR programme?

“When we started implementing IDSR in 2004, data was transferred from the health facilities to the districts by phone every Monday by 12 noon and by paper reporting. The districts send the aggregated IDSR reporting forms to the national monitoring and evaluation officers at the Directorate of Health Security and Emergencies of the Ministry of Health and Sanitation. In 2015, DHIS-2 began interoperating with IDSR reporting systems. The aggregated district data were uploaded to the DHIS-2 software and forwarded to the national level. In 2019, the health facilities were trained and given tablets with software to report IDSR data directly into the DHIS-2, with approval from the districts, before the national can have access to the data.”

(Surveillance programme manager).

The evidence provided suggested that the stakeholders of the IDSR programme in Sierra Leone had fully engaged the IDSR programme’s structural systems to prevent the next epidemic. The IDSR programme reporting form is hosted in the district health information system two (DHIS-2), which is the database for all programmes in the Ministry of Health and Sanitation in Sierra Leone. Stakeholders said that it is due to interprogramme cooperation within the Ministry that has helped in that process. The IDSR programme had also collaborated with agencies such as the WHO Sierra Leone, the CDC Foundation, the CDC Atlanta, Afrinet, and the Africa CDC. The challenge was that the DHIS-2 platform is a database that the Ministry of Health and Sanitation pays the University of Oslo to host. There were times when the Ministry had challenges obtaining resources from its partners to pay the University of Oslo; the DHIS-2 database was shut down for

a while, and IDSR programme data were reported through the paper-based route. This tended to cause data loss and incorrect magnitudes of priority diseases, events, or conditions.

All national-level stakeholders said the directorate had worked with the Expanded Programme on Immunisation to conduct ring vaccination in a village in Kambia, and IDSR data indicated a measles outbreak in 2018. This was an interprogramme cooperation working in the IDSR programme in Sierra Leone.

The legislation supporting the mandatory implementation of IDSR was included in the revised draft of the Public Health Act prepared by the Ministry of Health and Sanitation at the national level. According to the national programme manager for public health emergencies, this act was still at the Government Printing Office. After printing, the act would be published in the gazette for public comment and review. The Public Health Act will be sent to the Health Committee in Parliament for debate and later tabled before the rest of the parliamentary committees for approval. The parliament will later send the Public Health Act to the president for his own approval before it can become law (Overbosch et al., 2020).

Why is it essential to have the public health bill passed in parliament?

“The public health bill that has been drafted is significant as the first bill that supports integrated disease surveillance and response implementation in Sierra Leone. It will make it illegal for someone to run a health facility without implementing IDSR. The public health bill will also provide the legal framework for the establishment of the public health agency in the country.”

(Directorate of health security and emergencies)

TRIANGULATION OF THE IDSR CORE AND SUPPORT FUNCTIONS FINDINGS AT HEALTH FACILITIES AND DISTRICTS

Table 33:

Findings of the core and support functions triangulated to answer the research questions.

TRIANGULATION OF THE FINDINGS FOR THE CORE AND SUPPORT FUNCTIONS OF IDSR PROGRAMME AT HEALTH FACILITIES AND DISTRICTS IN SIERRA LEONE				
Health Facilities	Research Questions	Quantitative Findings	Qualitative Themes	Integrated Interpretation

CORE FUNCTION	How effective is case detection and registration?	Case detection and registration was significantly engaged by the stakeholder; β = 108.989, p = 0.017; 76% the clinician used one of the case definition of a priority disease to diagnosis a patient. This is	Lack of registers, limited training on identification of priority diseases by skilled staff	Health facility stakeholders significantly engaged Case detection and registration (β = 108.989, p = .017), indicating a strong positive influence on the timeliness of IDSR reporting and an effective case detection and registration implementation. Approximately 76% of clinicians reported using at least one case definition of a priority disease when diagnosing patients. This variable ranked as the fourth most influential predictor of reporting timeliness. However, qualitative data revealed persistent challenges, including the lack of standardised registers and limited

		the 4th most predictor of the timeliness of reporting at the health facility		training among skilled staff on identifying priority diseases.

CORE FUNCTION	How effective is case confirmation?	Case confirmation was not significantly engaged by the stakeholders; β = 108.989, p = 0.076.89% of the health facilities lacks specialist transport media. 65% of Health facilities lacks equipments for	Lack of human resource capacity, laboratory infrastructure, specimen transport systems, supply chain for reagents	Case confirmation was not significantly engaged by stakeholders (β = 108.989, p = .076), suggesting a weak statistical association with the timeliness of IDSR reporting and an ineffective case confirmation implementation. Descriptive evidence revealed substantial gaps in laboratory support across health facilities supporting the ineffective implementation of case confirmation. Approximately 89% of facilities lacked specialist specimen transport media, 65% lacked equipment for confirmatory testing, 59% lacked infrastructure to support laboratory staff training, and 60% had no specialist

		confirmation test for priority diseases. 59% of health facilities lack infrastuctures to support the training of laboratory staff. 60% of health facilities lack specialist laboratory trained staff. Laboratory support to		laboratory personnel. Despite the lack of statistical significance, laboratory support emerged as the strongest practical predictor of timely reporting. Health facilities with stronger laboratory systems demonstrated faster confirmation and reporting times. For instance, Kenema Government Hospital (73%) and Choithram Memorial Hospital (69%) performed substantially better in providing laboratory support compared to Gbolon MCHP (11%) and Sanya MCHP (11%). This disparity illustrates inequities in implementing IDSR strategies between higher-capacity hospitals and peripheral facilities.

		health facilities was the strongest predictor of the timeliness of reporting. Better laboratory support would make it faster for health facilities to confirm and send the report on time. Kenema		Qualitative insights further emphasised the lack of human resource capacity, inadequate laboratory infrastructure, weak specimen transport systems, and inconsistent supply of reagents as key barriers to effective case confirmation. These findings indicate that while laboratory capacity is critical for IDSR performance, structural and logistical deficits hinder its effectiveness. Strengthening laboratory networks, investing in transport systems, and ensuring consistent reagent supply are essential to enhancing the speed and reliability of disease confirmation and

		Government (73%) and Choithram Memorial Hospitals (69%) are doing better with providing laboratory support to their patients than Gbolon MCHP (11%) and Sanya MCHP (11%) as shown in table		reporting in Sierra Leone's surveillance system.

		11. This shows that the stakeholders' implementation of the IDSR strategy was effectively done for laboratory support in Choithram Memorial Hospital and Kenema Government hospital than		

		in Sanya MCHP and Gbolon.		

CORE FUNCTION	How effective is case reporting?	Case reporting was not significantly engaged by the stakeholders;$\beta = 178.536$, $p = 0.15$. Reporting was the second most predictor of the timeliness of reporting. Higher performance of reporting by	1. Resource Shortages Persistent lack of standardized IDSR reporting registers and forms led to inconsistent data capture across facilities. 2. ICT Limitations The absence of adequate internet access and computer equipment. This hampered timely data entry, validation, and submission. These technological gaps weakened the functionality of real-time surveillance systems. 3. Integration Challenges Limited integration of essential health commodities and indicators within the IDSR reporting framework. 4. Motivation Challenges A notable	Improved reporting capacity could enhance the timeliness of surveillance outputs and improve the IDRS programme response to outbreaks. However, systemic bottlenecks such as resource deprivation, technological inadequacy, poor integration, and low workforce motivation dilute the potential statistical strength of this relationship. Addressing these barriers strategically through investments would strengthen IDSR reporting efficiency and early warning performance.

		the health facilities means that the timeliness of reporting becomes better($\beta=206.7$ 1 to 402.09).	decline in the motivation of community-based surveillance workers was observed, often leading to inaccurate or zero reporting. Inadequate incentives and feedback mechanisms were frequently cited as contributing factors.	

CORE FUNCTION	How effective is data analysis?	Data analysis was not significantly engaged by the stakeholders; $\beta = 51.939$, $p = 0.323$. Data analysis was the least predictor of the timeliness of reporting. Higher performance of analysis does not have much	Human Capacity Gaps Practical interpretation and use of health facility surveillance data was a challenge for staff. An example was that the staff were not able to tell the threshold for the escalation of the priority diseases. Information Communication and Technology gaps Insufficient availability of functional computers and reliable internet connectivity constrained data entry, validation, and timely submission of IDSR reports. Systemic Support challenges	The data from the quantitative results showed that analysis does not influence a better timeliness of reporting and this was explained by the qualitative analysis that showed challenges in human resource, information communication and technology, and systemic support.

		effect on the timeliness of reporting at the health facilities.	The health facilities had limited support from the district to analysis data at the health facilities and encourage them to communicate and involved the stakeholders in the community to take the lead with their technical support to respond to the identified challenges.	
CORE FUNCTION	How effective is data interpretation ?	Data interpretation was not significantly engaged by the	Similar finding like the analysis of data	The data from the quantitative results showed that interpretation does not influence a better timeliness of reporting and this was explained the qualitative analysis that showed challenges in

		stakeholders;β = 73.182, p = 0.202. Data interpretation was the second to last predictor of the timeliness of reporting. Higher performance of data interpretation does not have much effect on the timeliness		human resource, information communication and technology, and systemic support.

		of reporting a the health facilities.		
CORE FUNCTION	How effective is Outbreak investigation?	Outbreak investigation was not significantly engaged by the stakeholders; β = 5.071, p = 0.995. Outbreak investigation was the third to last	Investigation are done by the districts	The stakeholders need to do more to improve outbreak investigation by capacitating the health facilities to investigate outbreaks using SORMAS which is comprehensive online surveillance system that is used for management, and analysis tool used for infectious diseases.

		predictor of the timeliness of reporting. Higher performance of outbreak investigation does not have much effect on the timeliness of reporting a the health facilities.		

CORE FUNCTION	How effective is Epidemic Preparedness ?	Epidemic preparedness was not significantly engaged by the stakeholders;β = 16.497, p = 0.419. Epidemic Preparedness was the sixth most predictor of the timeliness of reporting. Better	Capacity to develop the management protocol for priority diseases. Limited support from the district to produce management tools	The stakeholders failed to effectively implement the development of management protocol for some health facilities due to low human capacity.

		preparedness of the health facilities to outbreak management does not have much effect on the timeliness of reporting a the health facilities.		

CORE FUNCTION	How effective is outbreak response?	Outbreak response was not significantly engaged by the stakeholders; $\beta = 324.822$, $p = 0.659$. Outbreak response was the fifth most predictor of the timeliness of reporting. Higher performance of	systemic and Financial Constraints There was inadequate financial and logistical support to sustain prevention, control, and rapid response activities. The overall health system capacity remained weak, limiting the district's ability to respond effectively to outbreaks. Infection Prevention and Control (IPC) and Therapeutic Shortages Persistent shortages of infection-prevention commodities and essential therapeutics undermined the implementation of effective IPC measures and delayed appropriate treatment during epidemic	Outbreak response was not significantly engaged by stakeholders ($\beta = 324.822$, $p = .659$), ranking as the fifth most influential predictor of the timeliness of reporting at the health facility level. The results indicate that higher performance in outbreak response activities had a limited effect on improving the timeliness of IDSR reporting. Qualitative findings revealed that this limited influence was mainly due to systemic and financial constraints, including inadequate funding and logistical support to sustain prevention, control, and rapid response activities. Health system capacity was described as weak,

		outbreak response does not have much effect on the timeliness of reporting a the health facilities.	responses. Supply Chain Interruptions Frequent disruptions in the supply of vaccines and emergency medical commodities affected the timeliness and continuity of outbreak response efforts. Supervisory Gaps Insufficient provision for supportive supervision and feedback mechanisms reduced accountability and hindered ongoing performance improvement at health facility and community levels.	with districts struggling to mobilise timely resources during outbreaks.

CORE FUNCTION	How effective is feedback?	Feedback was not significantly engaged by the stakeholders; $\beta = 386.019$, $p = 0.893$. Good feedback was the forth most predictor of the timeliness of reporting. Higher performance of feedback does not have much	Feedback to the community is challenged because of lack of resources, no strategy for feedback	Feedback was not significantly engaged by stakeholders ($\beta = 386.019$, $p = .893$), indicating no meaningful statistical association with the timeliness of IDSR reporting. Although ranked as the fourth most influential predictor, improved performance in feedback delivery showed minimal effect on enhancing the timeliness of reporting at the health facility level. Qualitative data highlighted that feedback mechanisms were weak and inconsistently implemented, primarily due to lacking resources and logistical constraints. Respondents described the absence of structured channels to relay information from

		effect on the timeliness of reporting at the health facilities. 76% of health facilities do not receive feedback from the districts		district health management teams to community-level actors and reporting facilities. This lack of timely feedback limits opportunities for performance improvement, community engagement, and evidence-based decision-making. Strengthening communication systems, ensuring consistent data feedback loops, and allocating dedicated resources for follow-up and supervision are crucial for improving IDSR effectiveness and the timeliness of health facility reporting.
Districts				

CORE FUNCTION	How effective is case detection and registration?	Case detection and registration was not significantly engaged by the stakeholder; β = 1916, p = 0.269; . This was the strongest predictor of the acceptable case fatality rate at the district (β =	Resource constrains and human capacity development challenge	The stakeholders at the district level had not been able to statistically significantly engage the case detection and registration core function to prevent the next epidemic, even though there is statistical evidence that improving case detection and registration would have the greatest improvement in acceptable case fatality. Qualitative data suggested that resource constraints and human capacity developmental challenges were responsible

		.457). Table 16 showed that districts with full case detection and registration performance had favourable case fatality rates during outbreaks. Districts like Western Area Urban, Port Loko, Kailahun, and		

		Kono, reported favourable and acceptable case fatality outcomes compared to Koinadugu, Falaba, Bo, and Bonthe.		
CORE FUNCTION	How effective is case confirmation?	Case confirmation was not significantly engaged by the stakeholder; $\beta = 6.154$, $p =$	Specimen transport limitation with overdependence on DHMT vehicles; laboratory specialist gaps and infrastructure limitations	The district stakeholders had not effectively implemented the case confirmation indicator because of gaps in specimen transportation and laboratory infrastructures.

		0.630; . This is the 2nd highest predictor of the acceptable case fatality rate (.300).		
CORE FUNCTION	How effective is case reporting?	Case reporting was not significantly engaged by the stakeholder; $\beta = 22.384$, $p = 0.131$; . This is the 5TH highest predictor of	The reason for the poor implementation of reporting at the district level was due to resource constrain, technological limitations and low motivation amongst community-based workers	Case reporting was not statistically significant ($\beta = 22.384$, $p = 0.131$), though it ranked as the fifth strongest predictor of achieving acceptable COVID-19 case fatality outcomes. Reporting performance was weakened by resource shortages, limited technological capacity, and low motivation among community-based

		the acceptable case fatality rate (.299).		workers, resulting in inconsistent implementation at district level.
CORE FUNCTION	How effective is data analysis?	Data analysis was not significantly engaged by the stakeholder; $\beta = 21.545$, $p = 0.158$; . This is the 7TH highest predictor of	District said they face limited human capacity to analysis data especially modelling for outbreaks and response. This challenge is compounded by the limited availability of computers and software used in these activities	The district's stakeholders did not statistically significantly implement data analysis because of limited human capacity to analyse data, modelling, computers, computer accessories, and software gaps

		the acceptable case fatality rate (.088).		
CORE FUNCTION	How effective is data interpretation?	Data interpretation was not significantly engaged by the stakeholder; $\beta = 20.4$, $p = 0.203$; . This is the 8TH highest predictor of the acceptable	The same as analysis	Same as analysis

		case fatality rate (.043).		
CORE FUNCTION	How effective is Outbreak investigation?	Outbreak investigation was significantly engaged by the stakeholder; $\beta = 28.533$, $p = 0.027$; . This is the 4TH highest predictor of the acceptable case fatality rate (.173).	Systemic and financial limitations, including inadequate and partner-dependent funding without dedicated budget lines, hindered the implementation of outbreak investigation for IDSR implementation. Infection prevention and control (IPC) efforts were weakened by shortages of essential commodities and therapeutics. Supply chain disruptions frequently affect vaccines and emergency medicines. Additionally, supervisory and feedback mechanisms were weak,	Outbreak investigation showed a significant association with acceptable case fatality rates ($\beta = 28.533$, $p = .027$), ranking as the fourth strongest predictor. However, implementation was constrained by systemic and financial limitations, inadequate IPC resources, frequent supply chain disruptions, and weak supervisory, feedback, and digital surveillance systems, which reduced district capacity for effective outbreak management.

			and digital surveillance systems lacked functionality and district-level autonomy for outbreak management.	
CORE FUNCTION	How effective is Epidemic Preparedness?	Epidemic Preparedness was not significantly engaged by the stakeholder; β = 9.018, $p =$ 0.341; . This is	Lack of technical knowledge in developing the epidemic reports and priority disease management manual for the district. The districts also lacks financial support to fund these activities.	Epidemic preparedness showed no association with the acceptable case fatality rate ($\beta = 9.018$, $p = 0.341$), ranking as the least predictor. This was explained by the liited technical knowledge and resource constrain in supporting the preparation of the priority disease management manual

		the least predictor of the acceptable case fatality rate (.004).		
CORE FUNCTION	How effective is outbreak response?	Outbreak response was significantly engaged by the stakeholder; $\beta = 27.556$, $p = 0.036$; . This is the 6TH highest predictor of the acceptable	Epidemic response efforts were hindered by funding and logistical delays, including reliance on partner support and late government disbursements. Additionally, pharmaceutical shortages, such as the lack of reserve IPC products, vaccines, and emergency drugs, further constrained preparedness and response capacity.	Outbreak response was significantly associated with acceptable case fatality rates ($\beta = 27.556$, $p = .036$), ranking it as the sixth strongest predictor, which is very weak. However, effectiveness was limited by funding and logistical delays, dependence on partner support, and late government disbursements. Pharmaceutical shortages, including insufficient IPC products, vaccines, and

		case fatality rate (.129).		emergency drugs, further weakened response and preparedness capacity.

CORE FUNCTION	How effective is feedback?	Feedback was not significantly engaged by the stakeholder; β = 10.182, $p =$ 0.252; . This is the 3RD highest predictor of the acceptable case fatality rate (.299).	Resource limitations hindered supervision and feedback, and inadequate support for routine sessions weakened the information flow and coordination. Communication gaps between DHMT, health facilities, and communities weakened the information flow and coordination.	Feedback was not significantly associated with acceptable case fatality rates ($\beta = 10.182$, $p = .252$), ranking as the third highest predictor. Even though the stakeholders are not effectively implementing the feedback function of IDSR, they do more to ensure outbreaks have an acceptable case fatality if implemented effectively. The challenges faced by the implementation are explained by resource limitations, constrained supervision, and feedback activities, while communication gaps between DHMT, health facilities, and communities further weakened information flow and coordination.

SUPPORT FUNCTIONS				
HEALTH FACILITIES				
Support Functions	How effective is Standards and Guidelines?	Standards and Guideline was not significantly engaged by the stakeholder; β = 26.46, p = 0.743. Availability of standards and	Stakeholder stated that availability and training gaps are affecting the performance of effectiveness of standards and guidelines at the health facilities	Standards and guidelines were not significantly engaged by stakeholders (β = 26.46, p = 0.743). Although their availability at health facilities tends to support improved IDSR reporting, stakeholders indicated that gaps in availability and inadequate training continue to limit the effective use of these standards and guidelines.

		guidelines at the health facilities favour better report of IDSR.		
Support Functions	How effective is training of staff?	Training was not significantly engaged by the stakeholder; $\beta = 40.39$, $p = 0.147$. The number of staff trained on field	High attrition rates of staff with untrained or inexperienced new staff. Poor practical exposure in the Universities due to inexperienced lecturers with low motivation	Training was not significantly engaged by stakeholders ($\beta = 40.39$, $p = 0.147$), although facilities with a greater number of staff trained in field epidemiology or IDSR tended to report more effectively. Stakeholders highlighted several barriers affecting training effectiveness, including high attrition rates that result in untrained or inexperienced new staff, as well as limited practical exposure

		epidemiology or IDSR at the health facilities favour better report of IDSR.		during university training due to lecturers who lack hands-on experience and demonstrate low motivation. These gaps collectively weaken the overall impact of training on IDSR performance.

Support Functions	How effective is Minimum resource?	Minimum resource availability was not significantly engaged by the stakeholder; $\beta = 333.94$, $p = 0.285$. The availability of higher levels of resources was associated with prompted reporting by the health	Adhoc provision of resources, frequent breakdown of equipments due to lack of maintenance and lack of renewed supply of resources like ICT equipments and internet.	Minimum resource availability was not significantly engaged by stakeholders ($\beta = 333.94$, $p = 0.285$). Nonetheless, health facilities with higher levels of resources were more likely to report promptly, making resource availability the strongest predictor of reporting timeliness. Persistent challenges—such as ad hoc resource provision, frequent equipment breakdowns due to poor maintenance, and the absence of regular replenishment of equipments like ICT tools and internet—continue to constrain consistent performance.

		facilities. This is the most effective predictor of the timeliness of reporting at the health facility		

Support Functions	How effective is Stakeholder satisfaction?	Stakeholders satisfaction of the IDSR implementation was not significantly engaged by the stakeholder; $\beta = 18.87$, $p = 0.276$. The unsatisfied stakeholders at the health facilities was associated with	Lack of understanding of IDSR values with limited communication channels like feedback had led to lack of satisfaction by the stakeholders	Stakeholder satisfaction with IDSR implementation was not significantly engaged ($\beta = 18.87$, $p = 0.276$), and dissatisfaction among health facility staff was linked to poorer reporting of IDSR data. Qualitative insights indicated that this dissatisfaction stemmed largely from limited understanding of IDSR values and weak communication structures—particularly inadequate feedback mechanisms—which undermined stakeholder confidence and engagement.

		poor reporting of IDSR data.		

Support Functions	How effective is Supervision?	Supervision was not significantly engaged by the stakeholder; $\beta = 4818$, $p = 0.93$. The supervision was affected by more factors and does not seem to have a relationship with the timeliness of reporting at the	Adhoc strategy for supervision due to lack of financial allocation and limited human capacity at the districts to support health facilities and supervision tools like functional software.	Supervision was not a significant predictor in the model ($\beta = 4818$, $p = 0.93$). Although supervision had the best performance 67%, it did not show a meaningful association with the timeliness of reporting at health facilities at other levels even higher, suggesting that other factors may be influencing this outcome. Districts relied on ad hoc supervision approaches due to limited financial allocations, inadequate human resources, and the absence of essential tools, including functional software needed to support routine supervisory activities.

		health facilities. This is the 2nd most predictor of the timeliness of reporting at the health facility better at 67% performance.		

Support Functions	How effective is Coordination?	Coordination was not significantly engaged by the stakeholder; $\beta = 28.64$, $p = 0.637$. The more frequent coordination of the activities between the communities and the facilities the better the	Community-level governance was weak due to non-functional health committees and political interference. Key community actors—such as chiefs and village leaders—were excluded from IDSR activities, and there were no formal channels for community input or engagement. Communication systems were absent, with no protocols for reporting alerts, outbreaks, deaths, or stock levels. Community preparedness remained low because leaders were not trained or involved in simulation exercises. A lack of basic communication resources further constrained	Coordination was not a statistically significant predictor of reporting timeliness ($\beta = 28.64$, $p = 0.637$), although facilities that coordinated more frequently with their communities tended to perform better. Weak community-level governance limited these coordination efforts. Health committees were largely non-functional, and political interference excluded key actors—such as chiefs and village leaders—from participating in IDSR activities. With no established channels for community engagement or communication protocols for alerts, outbreaks, deaths, or stock levels,

		timeliness of reporting.	engagement, and no accountability mechanisms, such as community bylaws, were in place to support surveillance and response efforts.	information flow remained poor. Community preparedness was also low due to the absence of training or simulation exercises. Limited communication resources and the lack of accountability mechanisms, such as community bylaws, further reduced community participation in surveillance and response activities.
Support Functions				

Districts	Research Questions			
Support Functions	How effective is Standards and Guidelines?	Standards and Guideline was significantly engaged by the district stakeholder; $\beta = 46.406$, $p = 0.028$. Availability of standards and guidelines at the district favour better	Gaps in standards and guidelines stemmed from insufficient resources to produce, distribute, and train staff on their use. Limited funding constrained both initial and refresher training, contributing to inconsistent implementation across the districts.	Standards and guidelines were a significant predictor of improved IDSR reporting ($\beta = 46.406$, $p = 0.028$), indicating that districts with better access to these materials performed more effectively. However, their availability remained inconsistent due to limited resources for production, distribution, and staff training. Funding shortages further restricted both initial and refresher training, resulting in uneven implementation across districts.

		report of IDSR.		
Support Functions	How effective is training of district staff?	Training was significantly engaged by the stakeholder; $\beta = 93.08$, $p = 0.034$. The number of staff trained on field	Training challenges were driven by limited capacity and weak retention. Few staff were trained in IDSR or field epidemiology, and university programmes lacked practical experience and field exposure. The high attrition rates at the district, the replacement of experienced staff with inadequately trained new staff, and	Training had a significant positive influence on IDSR reporting ($\beta = 93.08$, $p = 0.034$), indicating that districts with more trained staff performed better. However, overall training capacity remained low. Limited practical exposure in university programmes, high staff turnover, and insufficient refresher training weakened skill retention. As

		epidemiology or IDSR at the districts favour better report of IDSR.	limited district training have resulted in poor training quality and reduced competency across the district workforce.	experienced staff were replaced with new personnel lacking adequate preparation, training quality declined, reducing competency and affecting implementation consistency across districts.

Support Functions	How effective is Minimum resource?	Minimum resource availability was significantly engaged by the stakeholder; $\beta = 52.619$, $p = 0.087$. The availability of higher levels of resources was associated with prompted reporting by the district.	Resource gaps stemmed from fragmented strategic planning and inadequate allocation of finances especially at local level. Supplies for IDSR were inconsistent, with no systems in place for maintenance or replacement. Limited technological infrastructure and the absence of communication tools further weakened implementation. Financial constraints reduced staff motivation, and many activities depended on external partner funding rather than sustainable government support.	Minimum resource availability showed a positive association with improved reporting performance ($\beta = 52.619$, $p = 0.087$), and was the strongest predictor of achieving an acceptable COVID-19 case fatality rate. Districts with more resources demonstrated more timely and responsive reporting. However, resource shortages were widespread due to weak planning and limited financial allocation at the local level. Supplies were inconsistent, maintenance systems were absent, and technological and communication tools were lacking. These gaps, combined with financial constraints and reliance on partner

		Availability of resource was the strongest predictor of acceptable case fatality for COVID-19 patients.		funding, reduced motivation and hindered sustainable implementation of IDSR activities.

Support Functions	How effective is Stakeholder satisfaction?	Stakeholders satisfaction of the IDSR implementation was not significantly engaged by the stakeholder; $\beta = 87.61111$, $p = 0.262$. The data showed that stakeholders satisfaction was the third predictor of	Staff satisfaction was undermined by limited inclusion and weak motivation. Staff were excluded from planning and evaluation processes, and recognition systems were influenced by political dynamics, which discouraged participation. Political tensions further reduced engagement, while gaps in understanding of IDSR contributed to uncertainty and reduced confidence in its effectiveness.	Stakeholder satisfaction was not a significant predictor of reporting performance ($\beta = 87.61111$, $p = 0.262$), though it emerged as the third strongest predictor of achieving acceptable COVID-19 case fatality outcomes. Satisfaction levels were affected by low motivation and exclusion from planning and evaluation processes. Political influence over recognition and reward systems reduced fairness and discouraged participation. Limited understanding of IDSR further contributed to uncertainty and weakened confidence in the implementation process.

		acceptable case fatality for COVID-19 patients.		

Support Functions	How effective is Supervision?	Supervision was not significantly engaged by the stakeholder; $\beta = 130.625$, $p = 0.239061$. This was the second strongest predictor of acceptable case fatality for COVID-19 patients.	Financial, technical, and logistical constraints weakened supervision. There were no dedicated funds or functional electronic tools to support supervisory activities, and internet and reporting systems were poorly resourced. District teams lacked the capacity and time to provide practical guidance, while limited transport, rugged terrain, and competing duties further reduced access to remote facilities.	Supervision was not statistically significant ($\beta = 130.625$, $p = 0.239061$), although it emerged as the second strongest predictor of acceptable COVID-19 case fatality outcomes. Its effectiveness was limited by financial, technical, and logistical barriers. With no dedicated funding, inadequate electronic tools, and poorly supported reporting systems, supervisory activities were difficult to sustain. District teams faced capacity gaps, transportation challenges, and competing responsibilities, further restricting their ability to provide consistent support—particularly to remote facilities.

Support Functions	How effective is Coordination ?	Coordination was not significantly engaged by the stakeholder; $\beta = 95, p = 0.339$. The more frequent coordination of the activities between the communities and the districts improve	Coordination was hindered by weak engagement and limited structural support. Community governance systems were not functioning effectively, and community member and other sector involvement remained low. There were no formal communication channels linking districts, facilities, and communities. Key stakeholders were excluded from simulation exercises and other IDSR activities. Communication tools were unavailable to support engagement. Without bylaws to reinforce participation and with government underfunding alongside reactive	Coordination was not a significant predictor of reporting performance ($\beta = 95, p = 0.339$), although better coordination between communities and districts was associated with improved acceptable case fatality of COVID-19 patients. Weak engagement and limited structural support hindered coordination efforts. Community governance structures were ineffective, involvement from community members and other sectors was low, and there were no formal communication channels linking districts, facilities, and communities. Key stakeholders were excluded from simulation activities, and

		acceptable case fatality.	partner-driven support, coordination remained fragmented and inconsistent.	communication tools were lacking. Without bylaws to reinforce participation and with inadequate government funding and reliance on reactive partner support, coordination remained inconsistent and fragmented.

Evaluation of Findings

The IDSR programme was implemented by WHO in Sub-Saharan African countries in 1998 to strengthen existing surveillance in low-income countries. Using this low cost benefit strategy have allowed low in-come country to be able to monitor priority diseases and respond to any epidemic (Saleh et al., 2021). The study was done using the monitoring and evaluation framework for communicable disease by WHO. This led to the construction of four research questions with research Hypothesis. The data collected to answer these questions are in the four-research question:

The first research question looks at the extent to which the stakeholders working on IDSR programme have engage the core indicators of IDSR at the health facility level, districts and national levels. The analysis at the health facility level indicated that the stakeholders have not effectively engaged the core functions of IDSR programme at the health facility level in all the health facilities that were randomly selected from the rest of the health facilities implementing IDSR programme in Sierra Leone. Case detection and registration was significantly engaged by the stakeholder at the health facilities ($\beta = 108.989$, $p = 0.017$) shown in table 33. At the districts case detection and registration was not significantly engaged by the stakeholder; ($\beta = 1916$, $p = 0.269$) from table 33. All the indicators are below the national target for case detection and registration. The qualitative data showed that resources to support the procurement and distribution of IDSR reporting forms and registers and training were the root cause for the ineffective implementation of IDSR at both levels.

A patient with any of the priority disease that goes to a health facility has the probability of been missed diagnosed because the health facility staffs working in the outpatient department were unable to remember the case definition of that priority disease. This was shown in Table 8.

This research in table 8 is saying that only 76% of the health facilities can be able to detect and register patients with priority diseases. This is below the target of 80%.

Case confirmation was not significantly engaged by the stakeholders at the health facilities ($\beta = 108.989$, $p = 0.076$) as well as the districts ($\beta = 6.154$, $p = 0.630$). It was the strongest predictor of the outcome indicator at the health facilities and the second strongest predictor at the district. Therefore, spending money to improve the case confirmation activity would be the best idea and should be prioritised. In Table 8, only 8% of the health facilities are able to confirm priority diseases in Sierra Leone. This is interpreted as a huge problem with the laboratory facilities in the country. In Sierra Leone 98% of the laboratories are connected to health facilities that mean they are under the management of the health facility management. Therefore, if the health facility is not doing well in IDSR programme indicators there is a possibility that the laboratory facility themselves will not do well. 65% of Health facilities lacks equipment's for confirmation test for priority diseases. 59% of health facilities lack infrastructures to support the training of laboratory staff. 60% of of health facilities lack specialist staff to do confirmatory test. The qualitative data suggested that the lack of human resource capacity, limited laboratory infrastructures, and ad hoc specimen transport systems are the root cause to the ineffective implementation of case confirmation.

Case reporting was not significantly engaged by the stakeholders at the health facilities ($\beta = 178.536$, $p = 0.15$) and districts ($\beta = 22.384$, $p = 0.131$). Case report was the second predictor of the outcome indicator at the health facilities but fifth at the district. It shows that although case reporting was a gap it should be less prioritised compared to case confirmation. About 40% of health facilities of the selected ones can send IDSR report effectively to the next level a shown in table 8. In these health facilities, they can print their own surveillance forms at their site and use

the registers correctly, ensuring they fill in the records regularly and send the reports on time. This reporting is done electronically using tablets and Android phones in the health facilities. However, 60% of these health facilities cannot report effectively. The stakeholders said it was because of resource constraints, lack of technology and low motivation at both health facilities and the districts.

Data analysis was not significantly engaged by the stakeholders at the health facilities ($\beta = 51.939$, $p = 0.323$) and districts ($\beta = 21.545$, $p = 0.158$) as shown in table 33. Data analysis was the least predictor of the timeliness of reporting at the health facilities and districts. All the districts had good capacity to review the data and approve it on the DHIS-2 data base so that it can be used for action. Health facilities that do not report effectively are saying that it is because of their lack of ability to print the IDSR forms but they are able to send in their on-line data. The qualitative data showed that human capacity, information communication and technology and systemic gaps are the root cause of these failure in the data analysis function. Data analysis by person, place, time and trend analysis can only be done by 18% of health facilities as shown in table 8. All the district health management teams have capacity to analysis the data by person, place, time and by trends. The national level can also analyse data by person, place, time and trends.

Outbreak investigation was not significantly engaged by the stakeholders at the health facilities ($\beta = 5.071$, $p = 0.995$) but the districts were statistically significant ($\beta = 28.533$, $p = 0.027$) seen in table 33. Outbreak investigation was the third to last predictor of the outcome indicator at the health facilities because most of them do not initiate case investigations. It was the fourth predictor of acceptable case fatality rate for COVID-19 patients at the districts. We look at the rumour log book in the health facilities. There were some health facilities that were not even maintaining a rumour log book. There were only 5 out of the 93 health facilities visited that were

able to show us that they did outbreak investigations in 2021 from table 8. It was expected that 100% of the health facilities should have used their rumours in their log book and gone to the communities to investigate these rumours. However, we did not come across rumours of outbreaks that were identified by other systems in Sierra Leone which could be because they are not present or we were so lucky not to have outbreaks in those communities where those health facilities are located.

Epidemic preparedness was not significantly engaged by the stakeholders at the health facilities ($\beta = 16.497$, $p = 0.419$) and districts ($\beta = 9.018$, $p = 0.341$) as shown by table 33. It was the least predictor of the outcome indicator at the health facilities and the sixth at the district. Therefore, it was least prioritised in this study. However, only 20% of these health facilities had work plan and written management protocol for at least one priority disease. At the district level 11 out of the 16 (69%) district had written plan of epidemic preparedness and response as shown in table 11. This is below the national target of 80% but it is better than the health facilities. There is no district that has emergency stock of drugs and vaccine at all times in the past 2020. None has a budget line for epidemic preparedness and response. All of them had epidemic rapid response teams that can be mobilised within days of and outbreak as seen in table 16. At the national level Sierra Leone has their National Emergency Response plan in 2020 and a programme to respond to national health emergencies which is under the directorate of health security and emergencies.

In order to investigate the level of epidemic response in the health facilities, I went through their quarterly report for the 93 health facilities and found that only 31 health facilities as shown in figure 7 had evidence of minutes that their epidemiological data for surveillance was used in the prevention and control measure like ring vaccination of susceptible measles patients in Kambia and Pujehun in 2020.

Feedback was not significantly engaged by the stakeholder at the health facilities ($\beta = 386.019$, $p = 0.893$) and districts ($\beta = 10.182$, $p = 0.252$) as shown in table 33. The study data from table 33 showed that feedback was the fourth predictor of the outcome indicator at the health facilities but third at the districts. I investigated the supervision report of all the health facilities and found out that 22 of the 93 health have been receiving feedbacks from districts and national level in 2021.

Explanation for research question two

Research question two was the support functions of the IDSR programme in Sierra Leone. This is the second part of the monitoring and evaluation framework for communicable disease programmes by WHO. This is the conceptual framework that I used for carrying out this study. The support functions are six in number and they help the core functions of IDSR function succeeds.

The first one was the standards and guidelines from health facilities to district and national. The data for the standards and guideline was taken from observing the standard and guideline at the health facilities. Standards and Guideline data from table 33 was not significantly engaged by the stakeholder at the health facilities ($\beta = 26.46$, $p = 0.743$) but was significantly engaged by the district stakeholders ($\beta = 46.406$, $p = 0.028$). The data from this study showed that standard and guidelines had the least predictor of the outcome indicators at both health facilities and districts. However, in table 9 68(73%) of the health facilities visited had the national technical guideline guidelines for IDSR programme. This is below the national target of 100% of the health facilities in Sierra Leone. Lack of standards and guideline can lead to miss diagnosis of priority diseases if they could not remember the case definition of the priority disease. We notice that some the health facilities had the guideline under lock and key in a cupboard in the in-charges office whiles the

patients are seen by the attending clinician. This will lead to a missed diagnosis of the priority diseases in that health facility at that specific time.

At the district level, table 16 shows that all the districts have surveillance manual in their offices and it is in use. However, the guidelines for specimen transfer were only present in 13 districts while the rest cannot find its location.

At the national level they have the national technical guidelines and the guidelines for specimen transport from the health facilities to the district and then to the national laboratories. The development and distribution of standards and guideline can work effectively if the health workers are trained on how to use these documents. Training of health workers on IDSR technical guideline is usually done by the national and the districts staffs. Three rounds of trainings have been done by the national and districts IDSR programme teams. These trainings had been based on the health facility and the community-based training of IDSR technical guideline. However, training was not significantly engaged by the stakeholder at the health facilities ($\beta = 40.39$, $p = 0.147$) but had rather done well at the districts ($\beta = 93.08$, $p = 0.034$). Training of health facilities and districts staffs are sometimes faced with a challenge of attrition of the staffs at their location seen in table 33. This usually will lead to more trainings being done to replace the staffs that have been transferred or left for better lives. This study assessed the number of staffs that are in the districts who are trained on IDSR programme activities. At the health facility level table 9 showed that 63(68%) of the health facilities had staff that had been trained on IDSR which is below the national target of 80% in the technical guidelines. There are facility staff management patients that have not been trained on IDSR. This means that if a patient with any of the priority disease are seen by these untrained staff, they may miss diagnose them leading to outbreaks of these epidemic prone diseases.

The districts were asked if their personnel in position of responsibilities have been trained on IDSR programme and field epidemiology and the answer from all of them was yes they have been trained. Most of the district staffs were trained by the national staffs and some of the partners like AFRINET also did some training.

The national level stakeholders have all been trained on IDSR programme and field epidemiology in Sierra Leone. However, there is need to train new employees and those that are newly transferred from other units to work at the surveillance programme of the directorate of health security and emergencies. The university had started training health workers but they do limited practical sessions.

The IDSR programme was implemented by the WHO in 1998 to maximize the use of scare resources that were available in the Sub-Saharan region. These resources are needed by national programme to be able to effectively respond to any possible epidemic prone diseases. In this study the available resources that are used to support IDSR programme at national district and health facilities was assessed. The assessment covers resource in logistics, data management, communication, Information education and communication and hygiene and sanitation material. The presence of the resources and the number of functional one's present were assessed at the health facility level. At the district and national levels, the resources assessed were logistics, data management, communication, information education and communication, and budget line for surveillance.

Minimum resource availability was significantly engaged by the stakeholders at the district level ($\beta = 52.619$, $p = 0.087$) as shown in table 33. At the health facility level this IDSR support function was significantly engaged ($\beta = 333.94$, $p = 0.285$). Minimal resource availability was the strongest predictor of the outcome indicator at health facility and district levels. Therefore, the data

suggested that if resources are spent on this IDSR support function based on what was available in the field, IDSR would be effectively implemented at all levels. Table 9 showed that at the health facility level, 39 (42%) of the health facilities had minimum level of resources that we were able to verify. This is far below the national of 100% and it needs to be worked on. The indicators under logistics were electricity for 95 to 100% of the day, vehicle for surveillance, Motor bicycle and Bicycle to visit hard to reach. The health facility should have electricity and one of the mobility. Under data management the following resources to support IDSR programme were assessed stationery, calculator, computer, printer and statistical package like SPSS, STATA, and others. The health facility should have all of them to be counted as yes. The components of communication include the following, Telephone service, Fax, radio, Computers with modems for internet. The health facility must have Telephone service (mobile), and Computers with modems for internet. If they don't have fax and radio they are still counted as yes. The components of the information communication and education materials is for the health facilities to be able to hold out door meetings within communities and to do outreach education on priority diseases and getting out prevention messages. They are as follows, posters, megaphone, flipcharts or Image box C VCR, TV set, generator, screen, and projector. The health facility needs to have all the components for the programme to work. Hygiene and sanitation components are spray pump, disinfectant and protection materials like personal protective equipment's. The health facility is marked yes if it has two of any of the components.

The district health management teams are the closest to all the health facilities in Sierra Leone and they host the decentralized structure of IDSR programme. They require resources to effectively implement the IDSR programme at their level. None of the districts have a budget line dedicated to health security and emergencies. Whenever there was a health emergency, the

national system will disburse funds and people to manage these funds in the in the district alongside the district health management teams. In this study the other resources assessed in detail were logistics, data management, communication, Information education and communication and hygiene and sanitation material. Table 28 showed that the 16 districts assessed reported that they have all the other resources except funds for IDSR programme.

The fourth support function was whether the stakeholders are satisfied with the function of the IDSR programme in Sierra Leone. The stakeholders were not satisfied with the implementation of IDSR at the health facilities ($\beta = 18.87$, $p = 0.276$) and districts ($\beta = 87.61111$, $p = 0.262$) as shown in table 33. This is because the health facilities know that the core and support functions of IDSR are not effectively engaged by the stakeholders of IDSR. There are a lot of challenges faced by these health workers at their level and they want it to change that was why they are not satisfied with the implementation of IDSR.

The national level feels that they are not satisfied with the implementation of IDSR as they want their own budget line.

Supervision was not significantly engaged by the stakeholder at the districts ($\beta = 130.625$, $p = 0.239061$) and health facilities ($\beta = 4818$, $p = 0.93$). This was the second strongest predictor of acceptable case fatality for COVID-19 patients and the second predictor of the timeliness of reporting at the health facilities as shown in table 33. The supervision of the implementation of IDSR programme serves as a quality improvement strategy at all levels. The national level should supervise the districts and the health facility levels and the districts should supervise the health facility level. At the health facility level as seen in table 9, 53 (57%) of them said that they have been supervised by the districts or the national level and 40 said they have not been supervised. The reason for the lack of supervision at the health facility level was the limited funds and fuel for

supervision at the district level. At the district level all of them said that they were not supervised in the last one year. The national level also agrees that they have not been going for supervision due to lack of funds.

The last support function was the coordination of IDSR programme at health facilities, districts and national level. The health facilities are supposed to have coordination meetings with their communities so that they can disseminate the findings of IDSR programme for the week or month or every three months based on the availability of funds. However, in this study as shown in table 10 and 11, only 30 of the health facilities assessed had at least one community meeting in 2021. This was verified by the meeting reports at the health facilities. Some of the meetings verified were focused on maternal health rather than all the forty-six priority diseases and conditions. The main reason for the limited number of health facilities holding community meetings was the lack of funds. Community-level governance was weak due to non-functional health committees and political interference. Key community actors—such as chiefs and village leaders—were excluded from IDSR activities, and there were no formal channels for community input or engagement. Communication systems were absent, with weak protocols for reporting alerts, outbreaks, deaths, or stock levels. Community preparedness remained low because leaders were not trained or involved in simulation exercises. A lack of basic communication resources further constrained engagement, and no accountability mechanisms, such as community bylaws, were in place to support surveillance and response efforts. At the district level table 28 shows that all the districts had a coordination committee in 2021. In that coordination committee there is a focal point person responsible for the daily operations. This person is the district medical officer. The national level has a coordination team with the director of directorate of health security and emergency providing

leadership in this committee. All the partners working in IDSR programme are part of this committee.

Research question three

This question is focused on the surveillance quality attributes which are mostly focused around timeliness and completeness of reporting. This question was answered with data from DHIS-2 and the period covered was 2021 because that period was when all the other data for the other research questions were collected. IDSR programme in Sierra Leone is done electronically from the health facilities to the districts and finally to the national level since 2019. Research has shown that the timeliness, completeness and availability of data improve with electronic reporting (Sloan et al., 2020). The following quality attributes were calculated:

Acceptability of the IDSR programme in Sierra Leone is very good as the timeliness and completeness of the data is 87% and 91% respectively and they are above the national targets as seen in table 33. This means that the stakeholders working on IDSR programme are following the national technical guidelines and are reporting to the system.

Timeliness of reporting is the most important surveillance attribute that affects the time of reporting potential public health priority diseases or conditions of international concern. The earlier these diseases and conditions are reported the earlier a response can be mounted against them. In Sierra Leone the diseases and conditions have been divided into immediate reporting in 24 hours diseases, events and conditions like haemorrhagic fever viral infections and maternal death shown in table 1. Other reporting like malaria, diarrheal diseases are for weekly reporting only. This study was focused on the weekly reporting as that is what we got from the DHIS-2 electronic system. This will tell use the selected health facilities that have accepted IDSR programme in their facilities. We found out that some facilities like United Methodist Church,

Sierra Rutile hospital, Love Bridge hospital and Konta CHP have not accepted the programme in 2021 shown in table 32.

Completeness of reporting was calculated at 91% against the national target of 81%. This is telling us that a lot of health facilities have accepted IDSR programme and are actively on the lookout for priority diseases to prevent the next epidemic.

Data quality this is assessing the completeness of reporting and seen the completeness is good the data quality is good. However, I did not assess the quality of the case reporting for completeness.

The positive predictive value was good as the outbreaks diagnosed by the IDSR programme were confirmed as true outbreaks like Ebola and COVID-19.

Sensitivity is high because the IDSR programme has identified all the epidemics that have occurred in 2021. There was no outbreak reported by any other systems that was missed by the IDSR programme.

Research question four

The evidence is that the stakeholders working in IDSR programme had effectively engaged the structures of IDSR.

The IDSR programme is an integrated surveillance programme with several disease and conditions been identified, investigated and data going through the same DHIS-2 system. This will reduce the cost of doing surveillance on these diseases and conditions but will help to us the stakeholders to get the most important data for adequate response and control.

The IDSR programme is hosted by the structures of the ministry of health and sanitation at national, district and health facility levels. This will allow the support for the health systems strengthening to be used on the strengthening of the IDSR core, support, quality and structures.

However, the legislation supporting IDSR has not been approved by parliament hence health facilities and other nationals are not mandated to follow instructions from the surveillance programme unless the President passed an emergency act under which the public can response. These emergency acts can only last for a few months of years. This was the reason for some private health facilities to reject surveillance activities and they had acted as a risk for the introduction of infections of public health and international concerns like what happened during the recent Lassa fever outbreak in Tonkolili Northern Region of Sierra Leone (Overbosch et al., 2020).

Summary

Recent increases in emerging and re-emerging infectious diseases—driven by industrialisation and human encroachment into forests—have resulted in widespread outbreaks and significant social and economic disruption. To address this, Sierra Leone adopted the Integrated Disease Surveillance and Response (IDSR) strategy in 2004, with multiple updates, the most recent in 2020. The approach is now embedded across all levels of the health system and uses both paper-based and electronic reporting mechanisms.

Despite progress, the system continues to face significant implementation and health system challenges, limiting timely detection and response. These weaknesses contributed to repeated outbreaks, including the 2014 Ebola epidemic and the COVID-19 pandemic. Real-time monitoring is therefore essential to identify gaps and strengthen the system. Several studies have identified gaps and recommended ways to enhance them. However, none of them had used the available data to determine the most cost-effective function to prioritise to prevent the next epidemic. The cost of implementing IDSR functions is very high. With limited funds and resources due to donor funding constraints and increased needs from other activities, it is crucial to ensure these functions are prioritised. This study aims to examine these IDSR functions challenges and

develop a prioritised action plan to improve IDSR performance and enhance preparedness for future epidemics.

This study aims to evaluate the core and support functions and to examine the current state of the quality indicators and structures of the IDSR programme implementation in Sierra Leone. The validity and reliability of the questionnaires were determined using a test-retest design across the five districts and five health facilities. The reliability of the questionnaires for the health facilities and the districts was determined using Cronbach's alpha (α). The positive questions were recorded as one, and the negative questions were recorded as zero (0). IBM SPSS version 16 was used to determine Cronbach's alpha as 0.7 for the health facilities and 0.8 for the districts. This means that the data coming from the questionnaires can be analysed. They are the actual data that will tell whether the sum of the effects of the questions asked indicates that the stakeholders working in the IDSR programme have effectively engaged the health facilities and the district to prevent the subsequent infectious disease epidemics.

The study included 272 respondents across national, district, and health facility levels. Most participants were male ($n = 188$; 69.1%), while females represented 30.9% ($n = 84$) as shown in table 2. The majority of responses were obtained from health facility staff ($n = 93$), followed by district-level participants ($n = 16$), with the national level contributing the smallest proportion of respondents.

The first research question concerned the current state of the nine core functions at the national, district, and health facility levels.

The Hypothesis was that the stakeholders working in the IDSR programme in Sierra Leone had not effectively engaged the nine core functions at all levels, to the extent that they could prevent the next infectious disease epidemic in Sierra Leone.

The results at the national level indicated that most indicators for the core functions are effectively engaged by national-level staff and their partners. They are standard case definition guidelines available at the national level. Central public health laboratories can confirm some priority diseases, but they face challenges within the health system. The data for IDSR continue to be reported through DHIS-2 health information systems from the health facilities to the districts and, finally, to the national level. The data were analysed using the Person, place, and time structure at the national level. The data were presented as the presence of priority diseases over time, in a trend analysis. There is a challenge for early case investigation, as stakeholders said they have difficulty getting resources. If an epidemic occurs, it will take more than 48 hours to mount a complete response. The IDSR programme priority disease bulletin had not been produced for the past six months.

The district analysis of the core functions of IDSR, based on tables 10 and 31, showed that, after triangulating quantitative and qualitative data from stakeholder responses, the core functions have the potential to influence the acceptable case fatality rate of COVID-19 patients during the 2019 epidemic. Case detection and registration were the strongest predictors of acceptable case fatality ($\beta \approx .457$). However, case detection and registration were not statistically significant ($\beta = 1916$, $p = 0.269$). Western Area Urban, Port Loko, Kailahun, and Kono, which performed well, achieved acceptable case fatality rates during the COVID-19 epidemic in Sierra Leone, thereby preventing morbidity and mortality. This means that during the COVID-19 epidemic, the stakeholders of these districts implemented case detection and registration effectively to stop the outbreak from killing people. Resource and human-capacity gaps prevent this from being fully implemented, but it remains the most strategic core function for reducing deaths at the districts.

Outbreak investigation ($\beta = 28.533$, $p = .027$) and outbreak response ($\beta = 27.556$, $p = .036$) are the only core functions significantly associated with acceptable case fatality rates at district level, though their effect sizes are modest compared to case detection and registration. Their effectiveness was blunted by systemic and financial constraints, IPC and therapeutic shortages, supply-chain disruptions and weak digital surveillance and supervision.

Case reporting is the fifth predictor of acceptable case fatality rate and clearly necessary operationally, but resource constraints, limited technology and low community-worker motivation led to inconsistent implementation.

At the health facility level, the most effective core function was case detection and registration. It was the only core function with a statistically significant association with timeliness of reporting ($\beta = 108.989$, $p = .017$) and ranked fourth among the strongest predictors. Around three-quarters of clinicians (76%) reported using at least one standard case definition when diagnosing priority diseases, indicating that the basic clinical surveillance function is reasonably well embedded. However, qualitative data showed that this strength is fragile, undermined by a lack of standard registers and insufficient training in recognising priority diseases.

Laboratory support for case confirmation, although not statistically significant at the facility level, emerged as the strongest practical driver of timely reporting: facilities with functioning laboratories, specimen transport, and trained staff (e.g. Kenema Government and Choithram Memorial Hospitals) confirmed cases and reported faster than peripheral facilities. This indicates that, in operational terms, case confirmation and laboratory capacity are critical to making case detection “actionable”, but current human resource, infrastructure, transport and reagent gaps prevent this from translating into consistent system-wide effectiveness.

Case reporting was the second strongest predictor of timeliness, but it was not statistically significant. The evaluation shows that when reporting systems work, timeliness improves, but persistent shortages of registers, ICT tools, integration problems, and low motivation among community-based workers dilute their impact. Other core functions—data analysis, data interpretation, outbreak investigation, epidemic preparedness, outbreak response, and feedback—were uniformly weak at the facility level, with no meaningful impact on timeliness and major qualitative shortcomings in skills, tools, guidance, and system support.

In conclusion, the most effective core functions across levels are:

Health facilities: case detection and registration, with substantial practical contributions from case reporting and laboratory support for case confirmation.

Districts: case detection and registration, and outbreak investigation and response are key determinants of acceptable case fatality rate when resources and systems allow them to function.

The second research question was on support functions of IDSR at all levels.

The support functions at the national level are effectively engaged by the stakeholders at national level and their partners. However, there is challenge with the availability of resources and supervision. There are standards and guideline available, training is been done regularly by the Field Epidemiology Training Programme for the new staffs and refreshers for the continuing staff members. The stakeholders are satisfied with the implementation of the IDSR programme and the stakeholders are coordinating the partners to meet the government priorities.

At the district level minimal resource was the strongest predictor of the acceptable case fatality for COVID-19 and positively associated with better reporting and response. Where districts had more reliable funding, supplies, ICT and communication tools, they perform better.

Chronic under-funding, poor planning, lack of maintenance and reliance on partners undermine this function.

Standards and guidelines ($\beta = 46.406$, $p = .028$) and training ($\beta = 93.08$, $p = .034$) are both statistically significant predictors of better IDSR reporting. Districts with clear guidelines and more trained staff perform consistently better, though these gains are limited by uneven distribution of materials, weak refresher training and low retention of trained staff.

Supervision, stakeholder satisfaction and coordination are not statistically significant but rank highly as predictors of acceptable case fatality rate and are repeatedly highlighted qualitatively. A lack of funds, transport, electronic tools, inclusive governance, and functional communication channels between DHMTs, facilities, and communities constrained their impact. In conclusion, the district level most effective support functions where they are adequately resourced are: Minimum resource availability, Standards and guidelines and Training of district staff.

At the health facility level none of the support functions reached statistical significance, but minimum resource availability was the strongest predictor of timeliness of reporting ($\beta = 333.94$, $p = .285$). Facilities with more consistent resources, equipment and connectivity report faster. However, provision was ad hoc, equipment frequently breaks down, and ICT and the internet are not routinely maintained.

Supervision has relatively good performance coverage (~67%) yet shows no association with timeliness, mainly because it is irregular, under-funded and not supported by functional tools (electronic supervision, software, transport).

Standards and guidelines, training, and stakeholder satisfaction tend to improve reporting where they are present, but their effect is diluted by gaps in availability, high staff attrition, poor practical training, and weak feedback and communication systems.

In conclusion, at the facility level, resources are the most influential support function, but their impact is fragile because the underlying systems (supervision, training, guidelines, satisfaction) are not strong enough to sustain performance gains.

The third research question focused on the quality indicators of the IDSR programme. The completeness and timeliness of reporting across the 93 health facilities were analysed in Table 31, which showed that completeness reached 90% and timeliness reached 85%, both exceeding the technical guideline target of 80%.

The acceptability of the IDSR programme in Sierra Leone was assessed as high, given the high completeness and timeliness rates. However, acceptability among private facilities remained a challenge, as some refused to submit reports to the DHIS-2 system. For instance, private hospitals such as United Methodist Church Hospital, Sierra Rutile Hospital, and Love Bridge Hospital did not report throughout 2021.

The programme's sensitivity was recorded at 100%, as all epidemics that occurred in 2021 were detected through the IDSR system. Specificity was also considered strong, as no identified priority disease epidemics were found to be false positives.

Despite these strengths, data quality remained a concern. Some health facilities lacked reporting forms and, therefore, failed to submit reports. The programme demonstrated a good positive predictive value.

The fourth research objective related to the structure of the IDSR programme in Sierra Leone. The legislation supporting the IDSR programme had been incorporated into a draft Public

Health Bill, which was under review by parliamentarians for sensitisation and familiarisation. Stakeholders reported that there was no confirmed date or plan for the bill's ratification. They were also concerned that staffing the national public health commission would mainly come from the Ministry of Health and Sanitation, and that most of the proposed budget would be for the commission's administration.

The IDSR programme was integrated into the Ministry of Health and Sanitation's decentralised structure, with staff at the national, district, and health facility levels serving as key stakeholders. Data flow relied on the District Health Information System (DHIS-2), which enabled health facility staff to submit IDSR reports into the system. These submissions were then confirmed and validated by district-level monitoring and evaluation staff supporting the IDSR programme.

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CHAPTER 5: IMPLICATIONS, CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

The findings of this study, which examine prioritising the challenges of IDSR implementation for cost-effective implementation, are situated within a global context in which population growth, expanding human settlement, and increased mobility continue to heighten vulnerability to emerging and re-emerging infectious diseases. As human activity encroaches further into previously undisturbed ecological environments, interactions with wildlife reservoirs increase, creating new pathways for zoonotic transmission. Simultaneously, rapid international travel enables infectious agents to spread across continents within hours, underscoring how local outbreaks can quickly escalate into global health emergencies, leading to morbidity, mortality, and loss of developmental gains that usually warrant restrictions on international travel (Fenollar & Mediannikov, 2018). These dynamics highlight the critical need for strong, well-coordinated, and resilient public health emergency preparedness systems within and between countries.

The International Health Regulations (IHR), to which all Sub-Saharan African nations are signatories, provide a global framework for strengthening public health security, with Integrated Disease Surveillance and Response (IDSR) serving as the regional mechanism for operationalising these commitments (Buback et al., 2025). IDSR remains one of the most cost-effective strategies for detecting, reporting, confirming, and responding to priority diseases and public health events of international concern. Its objectives include improving the accuracy and timeliness of surveillance, strengthening laboratory capacity, enhancing epidemic preparedness and response, and ensuring systematic monitoring and evaluation of national surveillance systems (Jinadu et al., 2018). Conceptually, the implementation aligns with the Panopticon theory proposed by Jeremy Bentham in 1787, in which perceived oversight encourages compliance and improved

performance(Hafermalz, 2021; Hamalaw et al., 2022b; Wilson & Cartwright, 2020). In the public health context, the IHR monitoring framework serves as a supervisory mechanism that guides countries toward accountability, transparency, and preparedness.

In Sierra Leone, IDSR implementation began in 2004 following the adoption of the first WHO guideline. Despite substantial investments from national authorities and international partners, public health emergencies—including Ebola in 2014, COVID-19 in 2019, and the 2017 mudslide—have continued to occur(AlMossawi et al., 2019b; Fall et al., 2019b; Njuguna et al., 2019b). Persistent health system constraints, resource limitations, and implementation gaps have hindered optimal performance. As highlighted by Kardas-Nelson and Frankfurter (2018), frontline workers often prioritise reporting compliance over addressing structural challenges, underscoring the need for ongoing evaluation, improvement, and adaptive system strengthening. Several studies have shown that there are significant challenges to the implementation of IDSR, especially in Sub-Saharan Africa, where resources are limited and local mobilisation has stalled (T. Alemu et al., 2019a; Dureab et al., 2020; Fall et al., 2019b; Hamalaw et al., 2022b; Hemingway-Foday et al., 2020; Kallay et al., 2024; Kambalame et al., 2024). However, none of these studies had prioritised the challenges to provide the most impactful IDSR functions that can prevent the next epidemic.

This study aimed to assess the status of the IDSR programme in Sierra Leone across its core functions, support functions, quality indicators, and structural components, and to provide a prioritised IDSR function plan. A mixed-methods design was applied, using the WHO communicable disease monitoring and evaluation tool to combine quantitative metrics with qualitative insights to contextualise reporting outputs. Stakeholders were sampled across national, district, and health facility levels, representing the operational ecosystem of the surveillance system. Ethical approval was obtained from UNICAF University Research Ethics Committee and

the Sierra Leone Ethics and Research Committee, and informed consent was obtained from all participants.

While the study's sampling approach, particularly at the health facility level, may have omitted some operational nuances, the findings provide a comprehensive assessment of the IDSR system's current performance and its readiness to prevent and respond to future public health threats. The following sections present the implications of these findings, outline evidence-driven recommendations, and conclude with reflections aligned with the four research objectives.

Implications

The objectives of this research are as follows:

Core functions objectives at all levels

The first was to determine the current status of the IDSR programme's core functions at all levels. The core functions were prioritised based on their β coefficients for predicting the outcome indicator.

Sierra Leone had implemented the IDSR programme since 2004, and most activities related to its implementation had been carried out within the Ministry of Health and Sanitation. This is implemented globally and regionally (T. Alemu et al., 2019a; Hamalaw et al., 2022b; Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Chukwudi, et al., 2019; Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Okeibunor, et al., 2019).

Core functions implications.

National Level:

The findings of this study showed that, at the national level, stakeholders in Sierra Leone were effectively engaging the core functions of the IDSR programme, although several challenges remained unresolved. The detection and registration of priority diseases, conditions, and events

were guided by the third edition of the IDSR technical guidelines, developed by the national programme and distributed to districts and health facilities. A similar approach had been observed in other countries, including Nigeria, where the federal government had developed IDSR technical guidelines. It disseminated them to states and local government areas, leaving subnational authorities to adapt the guidelines to local contexts and distribute them to health facilities. Health facilities subsequently used these guidelines to support clinicians in identifying and managing priority diseases during patient care(Ibrahim et al., 2020a).

In neighbouring Liberia, a comparable process had been reported, whereby national stakeholders developed IDSR technical guidelines and distributed them nationwide to support disease identification, notification, and response(Nagbe, Yealue, et al., 2019). This dissemination process enabled district and health facility staff to familiarise themselves with standard case definitions for priority diseases, events, and conditions, and to apply them to detect, report, and respond to outbreaks before widespread transmission occurred.

At the national level, IDSR data reporting performance was strong, primarily due to the establishment of an electronic reporting platform that enabled reports to meet national targets for completeness and timeliness. However, significant data quality challenges were identified, particularly inconsistencies in reports from lower levels of the health system. These inconsistencies were most evident for malaria, maternal deaths, and measles in 2021. Statistical analysis showed no significant association at the health facility and district levels, and stakeholders reported persistent challenges related to resource constraints, limited access to technology, and low staff motivation. Poor data quality was recognised as having profound implications, including the potential to miss emerging epidemics, underestimate disease burden, and delay or prevent appropriate epidemic response.

Similar data quality challenges had been reported in the first national data quality audit conducted in 2020, where overcounting in private health facilities and undercounting in lower-level public facilities were identified as major contributors to discrepancies between facility registers and data submitted to the DHIS-2 platform(Njuguna et al., 2019b). The absence of IDSR registers and reporting forms was also cited as a contributing factor, a finding that was corroborated by the present study, which showed that shortages of forms and registers persisted in 2021 and had worsened over time.

At the national level, outbreak response teams were reported to meet regularly, although funding to support their activities remained a significant constraint. According to the surveillance manager, response teams had agreed to initiate public awareness activities, such as hand hygiene promotion, in response to increasing reports of diarrhoeal diseases and the potential risk of cholera. However, these activities could not be implemented due to the absence of dedicated resources, as some development partners required confirmation that epidemic thresholds had been reached before releasing funds. This challenge was highlighted by the Programme Manager for Health Emergencies, Pharm Fambuleh.

In contrast, a 2021 study conducted in Zanzibar, Tanzania, reported that all districts had established budget lines for epidemic response, functional rapid response teams, and defined action thresholds for priority diseases. Emergency drug supplies were available in 80% of districts, although 50% reported experiencing stockouts during recent epidemics(Saleh et al., 2021). Similarly, a study conducted in Baghdad in 2019 reported 100% effectiveness in epidemic preparedness and response at the national level during the period under review(Kadhumi, 2019). The absence of a dedicated budget line for epidemic response in Sierra Leone therefore, implied

that, while emergency response plans were developed, their implementation was constrained, increasing the risk of recurrent epidemics.

National-level feedback to lower-level health facilities was also limited in 2021, primarily due to competing priorities among national staff, who were heavily engaged in the COVID-19 pandemic response. This finding was consistent with evidence from Zanzibar, Tanzania, where only 50% of districts and 18% of health facilities reported receiving feedback from higher administrative levels (Saleh et al., 2021). The similarity between these findings suggested that inadequate feedback mechanisms limited lower-level health facilities' ability to use IDSR data to inform planning and resource allocation. As a result, resources may have been inefficiently utilised in lower-priority areas, while critical surveillance and response activities remained insufficiently addressed.

District Level core functions implications

At the district level, the analysis indicated that the detection and registration of priority diseases, conditions, and events were not statistically significantly associated with the acceptable case fatality of COVID-19 patients. This suggests that district-level stakeholders were ineffective in strengthening early detection processes, primarily due to persistent resource constraints and gaps in human resource development, as illustrated in Table 33. Although 63% of districts possessed the national technical manual for the IDSR programme, indicating partial adherence to required surveillance tools, these materials alone were insufficient to ensure optimal implementation.

Table 16 further showed that all districts had established standard guidelines for transporting specimens to higher-level laboratories, reflecting a foundational structure for case investigation and confirmation. For case registration, districts relied on the IDSR online database,

which is functionally integrated with the DHIS-2 platform to facilitate the review, approval, and submission of health facility data (Martin, Sloan, Gleason, de Wit, et al., 2020). While these systems are in place, the lack of significant statistical engagement suggests that the operationalisation of detection and registration processes remains constrained by broader systemic limitations that limit their full effectiveness in preventing or mitigating future epidemics.

District-level laboratory confirmation of priority diseases had not been implemented effectively, as evidenced by the absence of a functional specimen transport strategy, a shortage of specialist laboratory personnel, and inadequate laboratory infrastructure. Comparative evidence further underscores this deficit. For example, a 2021 assessment by Ng'etich et al., examining surveillance core and support functions for neglected tropical diseases in Kenya, reported that 84% of sub-counties possessed the capacity to transport and store specimens to higher-tier laboratories (Ng'etich, Voyi, & Mutero, 2021). When compared with the findings of the present study, it becomes evident that Sierra Leone is performing significantly below comparable regional benchmarks in case confirmation. This performance gap highlights a critical weakness within the IDSR system. It reinforces the need to prioritise investment in laboratory confirmation as the second-most-essential core function, requiring targeted funding and systemic strengthening at the district level.

Since 2020, IDSR reporting at the district level has been conducted electronically across all districts, with health facility data reportedly verified within approximately four hours and transmitted from the districts to the national level through the DHIS-2 platform, reflecting the scale-up of electronic surveillance systems. Despite this technological advancement, findings from this study indicate that stakeholders did not implement district-level reporting effectively and ranked only 5th among the strongest predictors of timeliness in IDSR data reporting. This suggests

that the transition to electronic reporting has not, in itself, translated into optimal surveillance performance. Stakeholders attributed these implementation gaps primarily to persistent resource constraints, limited human resource capacity at the district level, and low motivation among community health workers. The shortage of resources has led to the absence of structured strategies for procuring and distributing standard reporting forms and registers, leaving health facility staff to rely predominantly on improvised or exclusively electronic data-capture methods.

Consequently, reports submitted at the national level are often not backed by hard-copy records, increasing reliance solely on the DHIS-2 system. This overdependence on electronic reporting poses systemic risks. In the event of technical disruptions or data access challenges within the centrally hosted DHIS-2 database, critical decision-making processes may be delayed due to the absence of alternative data sources. One instance was mentioned by the manager for surveillance in 2020, when there was a challenge with the electronic copy in the DHIS-2 database hosted by Oslo, Norway; decisions were postponed due to a lack of data.

Furthermore, inconsistencies in district-to-national reporting of priority diseases, conditions, and events—particularly for indicators such as maternal mortality, malaria, and HIV treatment coverage—have been documented, reinforcing concerns about data reliability and completeness(Wolfe et al., 2021). These findings highlight the need for a balanced reporting system that integrates robust electronic platforms with adequate logistical, human resource, and documentation support at the district level.

District-level capacity for data analysis and interpretation did not demonstrate a statistically significant association with timeliness of reporting and ranked as the seventh- and eighth-strongest predictors, respectively. This indicates limited functional engagement of these core surveillance activities within district operations. The findings suggest that although district staff were generally

able to conduct fundamental descriptive analyses—such as presenting data by person, place, time, and trends—their analytical capacity did not extend to more advanced functions essential for epidemic prediction and preparedness.

In particular, districts lacked the technical expertise needed to forecast and model epidemic outbreaks, which are critical for transforming surveillance data into actionable early warning intelligence. Moreover, this analytical limitation was compounded by resource constraints, including insufficient access to computers, analytical software, and specialised tools required for advanced data analysis. As a result, district-level surveillance data were underutilised, primarily serving as a basis for retrospective reporting rather than informing proactive prevention and preparedness strategies. This restricted analytical capacity significantly weakens the effectiveness of district surveillance systems as early warning mechanisms for potential infectious disease outbreaks. A study by Mremi et al in 2022 revealed that two districts in Tanzania showed a high level of data analysis and interpretation amongst their staff at initial evaluation and their knowledge of data analysis and interpretation improved after training from Ilala (65.7% to 90.5%) and Kinondoni (74.0% to 89.1%). This means that these districts although they were doing better than Sierra Leone at the start of the training it was not enough and they had to invest in them to make them better(Mremi et al., 2022).

The district stake holders case investigation function showed a statistically significant ($\beta = 28.533$, $p = .027$) associating to the acceptable case fatality rate for COVID-19 patients. This highlights the critical role that case investigation plays in responding to epidemics. This finding was consistent with a study from Ghana that assessed IDSR and showed that districts with stronger case investigation and contact-tracing achieved improved outbreak response and acceptable case mortality rates during the COVID-19 and Ebola epidemic response(Adokiya et al., 2015; *Ebola*

Preparedness and Response in Ghana | WHO | Regional Office for Africa, 2025). Also, all the district had an action threshold figure for malaria, viral haemorrhagic fevers and it also ranked as the four predictors of the outcome variable at the districts. In a study in Nigeria, it was shown that effective district case investigation with clear action threshold for priority diseases was responsible for reduced case fatality and improved IDSR sensitivity during the Lassa fever and COVID-19 outbreak (Muyembe et al., 2024; Ogunniyi et al., 2025). This poor ranking was because case investigations activities are constrained by lack of financial affordability, limited supply chain for IPC materials, drugs and vaccines supply.

The stakeholders also said that there was weak supervisory feedback and digital surveillance systems. In a similar situation in Ethiopia the evidence indicates that financial constraints, supply chain challenges for infection prevention material and drugs supply frequently undermined the performance of case investigation despite the presence of trained personnel and an effective surveillance structure (T. Alemu et al., 2019b).

Epidemic preparedness showed no statistically significant association to the acceptable case fatality of COVID-19 patients and the reason was that resources constraint and limited knowledge in preparing the priority disease management manual at the districts. A study done in Tanzania, Zanzibar on the core and support functions of IDSR programme by Saleh and others in 2021 showed that 60% of the districts have epidemic preparedness and response plan and all of the districts have budget line, response teams and action thresholds for priority diseases (Saleh et al., 2021). Government has to provide local resources if they need IDSR programme to prevent the next public health emergency of international concern.

The district stakeholders implemented the epidemic response function. The outbreak response functions were statistically significantly associated ($\beta = 27.556$, $p = .036$) with the

acceptable case fatality for COVID-19 patients. This function however ranked at sixth predictor of the outcome indicator indicating a relatively weak functional performance at the district level. This type of pattern was shown by researchers in Ghana and Nigeria, where outbreak response activities were formally activated during COVID-19 and other epidemics but were frequently constrained by delayed funding flows, heavy reliance on development partners, and the late release of government emergency funds, thereby limiting the timeliness and effectiveness of response operations(*Ghana - COVID-19 Emergency Preparedness and Response Project*, 2020; *Nigeria Centre for Disease Control and Prevention*, 2020; Ogunniyi et al., 2025).

In another report that was done in Uganda, an evaluation was done that showed that although district rapid response teams were established in line with IDSR requirements, outbreak response effectiveness was undermined by logistical bottlenecks, including delays in mobilising transport, insufficient operational funds, and weak coordination between national and sub-national levels(Nakiire et al., 2019a). A similar study in Ethiopia showed that the lack or interruption of emergency drugs, vaccines and infection prevention and control material at the districts undermines the performance of outbreak response function of IDSR(Zemen et al., 2024). The constraints identified in this study namely, funding and logistical delays, dependence on partner support, late government disbursements, and shortages of IPC products, vaccines, and emergency drugs closely mirror these cross-country experiences.

The IDSR framework on feedback at the district level was not statistically significantly associated with the acceptable case fatality rate for COVID-19 patients ($\beta = 10.182$, $p = .252$). Despite its lack of association, it was ranked as the third strongest predictor of the acceptable case fatality of COVID-19 patients. This finding suggests that, while stakeholders did not effectively implement feedback, it retains substantial potential to influence outbreak outcomes if appropriately

operationalised. Two studies in Ghana and Nigeria found out that feedback strategies in these countries were implemented irregular, delayed and limited to reporting from lower levels to national or upper levels making feedback weakened in its contribution to the outcome variable (Adokiya et al., 2016; Ibrahim et al., 2020b).

In a similar situation in Uganda, researchers were able to show that ineffective feedback loop implementation that led to lack or limited communication between the communities, districts and health facility level would cause a limited use of IDSR data for local actions even if IDSR data was collected and submitted on time (Mbonye et al., 2014). In this study, stakeholders explained that the feedback function was mainly weak because of limited resources, inadequate supervision, and insufficient support for routine feedback activities. Communication among District Health Management Teams, health facilities, and communities was often fragmented, further disrupting information sharing and coordination. Taken together, these findings are consistent with regional evidence indicating that, although feedback is frequently underperforming within IDSR systems, it remains a vital enabling function.

Health facility Core functions implications

The case detection and registration of health facilities are not statistically significant in association to the timeliness of reporting. This study finding implies that the non-significant association between standards and guidelines and timeliness of reporting surveillance performance indicates that meeting availability indicators alone is insufficient. WHO IDSR monitoring should place greater emphasis on actual utilisation and adherence to guidelines during routine surveillance and outbreak investigation, rather than limiting assessment to physical availability at facilities. Table 11 shows that 76% of the health facility clinicians who were present at the time of data collection were able to use the IDSR technical guideline manual to make at least one priority

disease diagnosis. The same table shows that 79% of the health facilities had registers that were correctly filled by the clinicians present. This is good, but far below the target set by the national programme: at least 100% of health facilities should be able to identify and register priority diseases. Some health facilities may miss priority diseases because their health workers lack the capacity to recognise or register cases.

In the Zanzibar study, 51% of health facilities had the manual on case definition for priority diseases in Tanzania, 78% of the health facilities were able to correctly use the case definition to diagnose at least one priority disease, and 98% of health facilities had outpatient registers (Saleh et al., 2021). Another study conducted in a refugee camp in Uganda evaluated core and support functions during an emergency and found that the health facilities lacked standardised case definitions for identifying priority diseases in the camp. In fact, the health workers were using parallel forms provided by non-governmental organisations and other partners. The IDSR programme had a case detection rate of 55% and a case recording rate in health facilities of 79% (Ario et al., 2022). This implies that most African countries face similar challenges in case detection and registration at health facilities. This is why most outbreaks are detected after a cluster of deaths, with patients presenting with similar conditions. The norm should be that diseases are identified before they cause fatalities in animals or humans. However, in most African countries, it is the fatalities that lead to the identification of the diseases.

The case confirmation of priority diseases at the health facility level was not significantly associated with timeliness of IDSR reporting ($\beta = 108.989$, $p = .076$), suggesting limited statistical evidence of effective implementation at the facility level. The descriptive findings also supported qualitative findings showing that most health facilities lack the materials for specimen collection, transportation and laboratory testing. Despite this lack of statistical association case confirmation

was the strongest predictor of the timeliness of reporting with higher-capacity hospitals demonstrating faster confirmation and reporting than peripheral facilities (e.g., Kenema Government Hospital and Choithram Memorial Hospital outperforming lower-capacity like Gbolon MCHP). This facility-level inequity is consistent with evidence from Ghana, where IDSR performance assessments reported that laboratory confirmation capacity and access to diagnostics were uneven—often stronger in hospitals than in peripheral facilities—limiting routine confirmation and slowing public health action (Adokiya et al., 2015, 2016).

Similar constraints have been reported in Nigeria, where rapid assessments of IDSR implementation identified ongoing weaknesses in laboratory capacity, including recurrent supply shortages and limited diagnostic support at subnational levels. These gaps were found to delay case confirmation and compromise the timeliness of surveillance reporting, particularly during outbreak situations (Ibrahim et al., 2020a). Overall, these findings indicate that while laboratory capacity is central to IDSR case confirmation and timely reporting, persistent deficits in human resources, infrastructure, specimen transport, and reagent supply continue to limit functional performance across facilities. Consistent with regional evidence, strengthening laboratory networks, investing in specimen referral/transport systems, and ensuring reliable commodity and reagent supply chains are priority actions to improve the speed and reliability of confirmation and reporting within Sierra Leone's IDSR system.

Case reporting was not significantly associated with stakeholder engagement ($\beta = 178.536$, $p = .15$), suggesting a weak association with timeliness of reporting at the facility level. Nevertheless, case reporting emerged as the second strongest predictor of timeliness, suggesting that improvements in reporting performance could substantially enhance the speed of surveillance outputs. Indeed, higher levels of reporting performance at health facilities were associated with

marked improvements in reporting timeliness (β range = 206.71–402.09), underscoring the practical importance of this core IDSR function despite its lack of statistical significance.

Descriptive and qualitative findings revealed that resource shortages, particularly the persistent lack of standardised IDSR reporting registers and forms, resulted in inconsistent data capture across facilities. Similar challenges have been documented in Nigeria, where rapid assessments of IDSR implementation found that shortages of reporting tools and paper-based registers contributed to incomplete, delayed, and inaccurate reporting at the subnational level (Adokiya et al., 2015, 2016; Babatunde et al., 2016). Comparable findings were reported in Ghana, where inconsistent availability of IDSR forms at peripheral facilities undermined routine reporting and weakened early warning capacity, despite the existence of national reporting guidelines (Adokiya et al., 2015).

ICT-related limitations further constrained case reporting performance in this study. The absence of reliable internet connectivity and computer equipment hindered timely data entry, validation, and submission, thereby weakening the functionality of real-time surveillance systems. Similar technological constraints have been reported in Uganda, where limited access to electronic reporting infrastructure at lower-level facilities delayed data transmission and reduced the effectiveness of IDSR reporting systems (Mbonye et al., 2014). Evidence from Ethiopia also indicates that poor ICT infrastructure and limited integration of electronic platforms slowed reporting processes and contributed to delays in outbreak detection (Sule & Oluwayelu, 2020).

In addition, integration challenges, including the limited alignment of essential health commodities and indicators within the IDSR reporting framework, further weakened reporting effectiveness. This finding mirrors experiences from Nigeria and Ghana, where fragmented

reporting systems and parallel data streams were found to increase reporting burden and compromise data completeness and timeliness(Adokiya et al., 2016; Babatunde et al., 2016).

Finally, motivation-related challenges among community-based surveillance workers were identified as a critical barrier, leading to inaccurate or zero reporting. Inadequate incentives and weak feedback mechanisms were commonly cited as underlying factors. Similar motivational constraints have been documented in Uganda and Ethiopia, where the absence of regular feedback and financial or non-financial incentives reduced frontline surveillance workers' engagement and negatively affected reporting performance(T. Alemu et al., 2019a; Mbonye et al., 2014).

Overall, these cross-country comparisons indicate that while case reporting remains a pivotal core function within the IDSR framework, its contribution to timely surveillance is often undermined by systemic bottlenecks, including resource deprivation, technological inadequacy, weak system integration, and low workforce motivation.

Consistent with regional evidence, addressing these constraints through targeted investments in reporting tools, digital infrastructure, system integration, and incentive and feedback mechanisms is essential to strengthening IDSR reporting efficiency and enhancing early warning and outbreak response capacity.

At least one priority disease targeted for elimination was correctly filled in the registers and report by 48% of health facilities. This implies that more than half of the health facilities do not correctly fill their registers even though they are sending reports weekly which could be wrong reports.

For priority diseases targeted for eradication, elimination and epidemic prone 52%, 53% and 44% respectively of the registers in the health facilities are not filled correctly. This implies

that the records that are uploaded in the DHIS-2 data base are not correct. This will give a misdirection of the status of priority diseases in the country hence wrong response.

The completeness of report for the health facilities collected during the study showed that 75% of health facilities were able to submit their report three months prior to the data collection period as shown in table 3. The timeliness of the report was 72% for the most recent past three months. It is high but below the national target set for health facilities which is 80% and it should be submitted monthly. A similar finding was seen in Uganda refugee study, where the timeliness of reporting on the m-Track software was 71% from health facilities to the districts (Ario et al., 2022).

Most (80%) of health facilities use only electronic means of reporting weekly on IDSR data but some can use both electronics and telephones for reporting IDSR data as shown in table 13. Similar findings were seen with the Zanzibar study where 49% health facilities use telephones and 22% health facilities use electronic means for sending IDSR data to the next level. This finding means that although the electronic IDSR programme had been rolled out to the rest Sierra Leone, there are still some health facilities that use telephone calls to send data to the districts (Martin, Sloan, Gleason, de Wit, et al., 2020).

Data analysis was not significantly engaged by stakeholders of IDSR at the health facility level. This was confirmed by the fact that data analysis had the least predictive effect on the timeliness of reporting to the district level. Furthermore, Table 10 showed that only 17% of health facilities analyse data by person, 16% analyse data by place, 24% analyse data by time and 20% analyse data by trends. This means that most (81%) of the health facilities do not analyse their own data by person, place, time and trend analysis. In the Zanzibar study on table one (1), health facilities that analyse data by person are only 13%, 9% analyse data by place, 9% analyse data by

time and 7% do trend analysis (Saleh et al., 2021). This means that 90% of health facilities do not analyse their own data. The question now is how these health facilities use their data in their work plan and response to priority diseases. The answer is that they rely on the districts and national level to do analysis and respond to epidemics for them (Njuguna et al., 2019b; Wolfe et al., 2021).

The outbreak investigation was not significantly engaged by stakeholders ($\beta = 5.071$, $p = .995$) and ranked as the third weakest predictor of timeliness of reporting. This finding indicates that, at the health-facility level, improvements in outbreak investigation performance had minimal influence on reporting timeliness, suggesting limited decentralisation and suboptimal functional integration of investigation activities within routine surveillance processes. In practice, outbreak investigations were conducted mainly at the district level, with limited direct involvement of health facilities, which may explain the weak relationship observed between investigation performance and reporting timeliness.

Similar patterns have been reported in Nigeria, where IDSR assessments found that outbreak investigation responsibilities were predominantly centralised at district or state levels, resulting in delayed initiation of investigations at peripheral facilities and limited impact on early reporting timelines (Babatunde et al., 2016; Ibrahim et al., 2020a; Yinka-Ogunleye et al., 2019). Although investigation teams were activated once outbreaks were suspected, weak facility-level capacity and delayed information flow constrained the timeliness of surveillance outputs.

Evidence from Ghana and Sierra Leone likewise indicates that, while district rapid response teams were responsible for outbreak investigations, health facilities often lacked the skills, tools, and authority to conduct preliminary investigations, thereby reducing the contribution of outbreak investigations to early warning and rapid reporting (Adokiya et al., 2015, 2016; Osborne et al., 2025; Twene et al., 2024).

In contrast to the findings in Ghana, a study in Uganda finds that the involvement of health facilities in outbreak investigation by training and introduction of electronic surveillance systems led to a massive improvement in the speed and the quality of outbreak investigations and timeliness of reporting (Bakiika et al., 2023; Mbonye et al., 2014; Nakiire et al., 2019a). However, where such capacity building was absent, outbreak investigation remained reactive and had little effect on reporting timeliness, mirroring the findings of the present study.

Studies with evidence from Nigeria and Ethiopia highlights the role of digital surveillance platforms, such as the Surveillance, Outbreak Response Management and Analysis System (SORMAS), in decentralising outbreak investigation and enabling health facilities to participate more actively in case investigation, data entry, and real-time analysis (Shao et al., 2021; *Sixty-Eighth Session of the WHO Regional Committee for Africa | WHO | Regional Office for Africa*, 2019). The discussion of the study's findings and the contrasting evidence from other countries showed that health facilities should be prioritised to lead and conduct case investigations for possible prioritised diseases, conditions, or events. These health facilities need to be trained, equipped, and monitored with electronic surveillance platforms like SORMAS to improve IDSR performance, including the timeliness of data reporting and effective outbreak response.

Epidemic preparedness was not significantly engaged by stakeholders ($\beta = 16.497$, $p = .419$) and ranked sixth among predictors of timeliness of reporting. This finding suggests that the preparation and use of management protocols for priority diseases had limited or no effect on the timeliness of reporting, indicating a weak linkage between the preparedness of the management guideline and the real-time processing of the report.

The availability of management guidelines at health facilities was intended to speed up the identification of priority diseases and the preparation of IDSR reports. However, evidence from

this study suggested that it was not implemented on a large scale to affect the outcome indicator in the health facilities. Descriptive evidence indicated that many health facilities lacked the capacity to develop and operationalise management protocols for priority diseases, with limited technical and supervisory support from district authorities. As a result, preparedness tools were inconsistently developed or absent, particularly in facilities with limited human resources. Similar findings have been reported in Ghana, where IDSR evaluations showed that epidemic preparedness plans existed at national and district levels. Still, health facilities often lacked the skills, tools, and guidance to translate these plans into actionable protocols, thereby limiting their practical value for surveillance and early response(Adokiya et al., 2015, 2016).

Comparable challenges had also been documented in Nigeria, where studies reported that epidemic preparedness activities were centralised mainly, with limited facility-level involvement in preparedness planning and protocol development. Weak human capacity and insufficient district-level support were identified as significant barriers to effective preparedness implementation, leading to poorly integrated preparedness plans into routine surveillance and reporting systems(Babatunde et al., 2016; Ibrahim et al., 2020a).

Consequently, preparedness activities had minimal effect on reporting timeliness, mirroring the findings of the present study.

A study in Ghana showed evidence of IDSR evaluations were outbreak response mechanisms were activated during epidemics but were frequently delayed by insufficient operational funding, weak logistics, and dependence on external partners, thereby limiting their influence on surveillance timeliness and early response(*Ebola Preparedness and Response in Ghana* | WHO | Regional Office for Africa, 2025; Nuvey et al., 2019; Twene et al., 2024).

The Feedback at the health facility was not significantly engaged by the stakeholder ($\beta = 386.019$, $p = .893$). This means that there is a limited statistical association between the Feedback and the timeliness of reporting. Although Feedback to health facilities was measured as the fourth predictor of timeliness of reporting, it had a minimal effect on the speed of report transmission to the districts. The stakeholders revealed that feedback mechanisms were weak, irregular, and poorly structured, primarily due to limited financial resources, absence of a clear feedback strategy, and lack of dedicated mechanisms to relay analysed surveillance data to health facilities and communities.

A study from Zambia by Mandyata and others in 2017 showed that the greatest challenge to the effective implementation of the IDSR programme was an erratic feedback programme (Mandyata et al., 2017). 76% of the health facilities do not receive Feedback from their districts. In contrast to the findings of minimal effect of Feedback on the timeliness of reporting, a study in Sierra Leone showed evidence that implementing structured, electronic supportive supervision (a key feedback mechanism) led to significant improvements in reporting completeness (84.5% to 96%) and timeliness (80.3% to 92%)(Njuguna et al., 2022b).

In a study in Tanzania, Zanzibar, 18% of the health facilities reported receiving Feedback from higher levels (Saleh et al., 2021). The lack of, or limited number of, feedback bulletins from higher levels will prevent health facilities from using their own data for decision-making processes. In a study from Sudan, health facilities reported that they needed more supportive supervision and Feedback to perform effectively in their IDSR implementations (Rumunu, Wamala, Sakaya, et al., 2022).

In conclusion, these cross-country findings suggest that within the IDSR implementation, Feedback remains a critical but underperforming support function. There is clear evidence that

Feedback can improve reporting behaviour, motivation, and data use. However, its impact on reporting timeliness is minimal when it is infrequent, poorly resourced, and weakly institutionalised. To improve IDSR implementation, Feedback needs to be regular, there should be a strategic communications channel with allocated resources, and health facility data should be routinely disseminated to the health facilities. Without these enabling conditions, feedback is unlikely to translate into measurable improvements in reporting timeliness or overall surveillance performance.

Second research question implications

This is on the status of the support functions of IDSR programme implementations at all levels.

National Level findings implications for support functions

The national level IDSR support functions were effectively engaged by the stakeholders of IDSR and they did well with the IDSR indicators. The challenge at national level is the lack of domestic funds. Almost all their funds are provided by the donors and their partners. This means that most of their activities are donor driven. This was making it almost impossible to mount a quick response to any epidemic without the support of the donor's priority. The national level cannot plan an activity without the support of the partners.

The public health act was still not a law and this was preventing the national level to act on defaulting health facilities and organisations if they refuse to implement IDSR programme in their facilities.

In a study from Kurdistan Region of Iraq, there was budget line for the national level but the districts and health facilities do not have any budget line (Hamalaw et al., 2022b).

District Level findings implication for support functions

The availability of standards and guidelines at the district level was significantly associated with lower case fatality rates among COVID-19 patients ($\beta = 46.406$, $p = 0.028$). This means that districts with better access to standards and guidelines perform more effectively. This was because the guideline provides essential guidance on how to standardise case definitions, reporting forms, and protocols. This would eventually reduce ambiguities and errors, thereby improving the performance of the IDSR functions. Our study showed that districts with better access to standard guidelines and case definitions for all their priority diseases demonstrated stronger performance in achieving acceptable case fatality rates for COVID-19 patients within their districts.

A systematic review of IDSR programmes in Africa in 2021 found that the use of standard case definitions and guidelines is a core function that requires critical attention in the identification and confirmation of priority diseases (Wolfe et al., 2021a). The WHO IDSR framework also states that the availability and use of standards and guidelines lead to effective IDSR indicator performance (WHO, 2019). The stakeholders state that there were no resources to produce, distribute and train staff on standards and guidelines in the districts.

A review of health workers' perspectives after the revitalisation of IDSR programmes in Africa after 2010 showed similar challenges in implementing standards and guidelines, as reported in a study from Zambia (Mandyata et al., 2017). In Malawi, evidence showed that, despite publishing updated technical guidelines in 2014, significant implementation gaps persisted, affecting the timeliness of alerts. This shows that the availability of the standards and guidelines alone does not guarantee effective implementation of IDSR activities (T.-S. J. Wu et al., 2018).

The study and its comparison with other countries' evidence showed that the availability and effectiveness of standards and guidelines depend not only on their formal availability at the

district level but also on sustained investment in dissemination, routine refresher training, and supportive supervision.

Staff training significantly improved acceptable case fatality rates for COVID-19 patients in this study ($\beta = 93.08$, $p = 0.034$). Districts with a higher number of staff trained in IDSR implementation or field epidemiology had a lower case fatality rate among COVID-19 patients in our study. A similar finding was observed in Uganda, where staff reported that scaling up IDSR training was associated with improved completeness and timeliness of reporting (Nakiire et al., 2019b; Njuguna et al., 2024). The data from our study did not show much effect of training on predicting the acceptable case fatality of COVID-19 patients, most likely because of the challenges in implementing training in 2021. The stakeholders noticed that training was challenged by high attrition rates, a lack of practical exposure for lecturers and students in the Universities that train health workers, and financial resource gaps. These findings were also seen in studies from Sierra Leone, Uganda and Zambia, where challenges like an inadequate number of trained staff, high turnover of trained workers, and irregular supervision were mentioned (André et al., 2017; Nakiire et al., 2019b; Njuguna et al., 2024; Texila American University, & HakwiaKooma, 2019).

In conclusion, the quantitative and qualitative data demonstrating the value of training staff in IDSR implementation for responding to epidemics were validated by experiences from the African sub-region. Experiences from other studies showed that addressing training needs requires sustainable, integrated, and practical career-path training with dedicated financial resources.

Minimal resource availability to the district was positively associated with the surveillance performance ($\beta = 52.619$, $p = .087$). The data also showed that districts with higher levels of available minimal resources showed more prompt responses and reporting. Resource availability showed the strongest predictor of achieving the acceptable case fatality rates for COVID-19

patients. A WHO scientific brief explains that differences in case fatality ratios (CFR) between countries can be explained in part by differences in the quality of care and resource allocation during the illness (*Estimating Mortality from COVID-19*, 2020). Although the association with reporting performance did not reach conventional levels of statistical significance, the direction and magnitude of the relationship highlight the practical importance of resource sufficiency within the IDSR system. Descriptive and qualitative findings indicated that resource gaps were driven by fragmented strategic planning and inadequate financial allocation at the local level, resulting in inconsistent availability of IDSR supplies, absence of maintenance or replacement systems, and limited technological and communication infrastructure.

A health Economic study in 2024 showed that healthcare resource constraints influence the capacity to deliver care, affecting both costs and outcomes, and are a critical factor often missing from evaluations (Thokala et al., 2024). In conclusion, resource availability was the *strongest* predictor, suggesting it may be the foundational constraint upon which all other IDSR functions depend. Strengthening other areas without addressing core resource gaps—especially sustainable local financing, supply chain integrity, and infrastructure—may yield limited returns.

Stakeholders' satisfaction with the implementation of IDSR was not significantly associated with the acceptable case definition for COVID-19 patients at the districts ($\beta = 87.61$, $p = .262$). However, stakeholders' satisfaction was the third strongest predictor of the outcome indicators. This suggested that although stakeholders' satisfaction does not directly influence the reporting of outcome performance, motivated and engaged staff would do all they can to adhere to the response protocol to achieve an acceptable IDSR outcome indicator.

A similar finding was reported in a systematic review of IDSR in Africa, which showed that recommendations for improvement consistently focus on functions such as reporting and

training, which depend directly on a motivated workforce (Ng'etich, Voyi, Kirinyet, et al., 2021). Similar findings were reported in another study on digital IDSR in Ghana, which found that intrinsic user motivation was key and that national-to-community implementation without engagement can create significant barriers (Kaburi et al., 2023). In Nigeria, a study on the performance of the COVID-19 case-based surveillance system noted that health worker involvement is vital for system optimisation, and their perspectives are key to improvement (Umeozuru et al., 2022). In conclusion, the data showed that staff motivation and engagement were not merely administrative goals but critical determinants of survival during epidemics. The challenges were supported by findings from other countries, which presented a roadmap for building more inclusive, fair, and communicative systems that value frontline health workers.

The study showed that supervision was not significantly associated with the acceptable case fatality for COVID-19 patients ($\beta = 130.63$, $p = .239$). However, it emerged as the second strongest predictor of the outcome indicator, indicating its essential role in outbreak outcomes, likely through its influence on adherence to clinical protocols, infection prevention practices, and coordinated response activities. Studies have found that Inadequate supervision at peripheral levels is a commonly reported challenge that impedes IDSR implementation (Wolfe et al., 2021b). The stakeholders identified gaps in supervision, including insufficient dedicated funds, limited functional electronic tools, poor internet/reporting systems, district capacity gaps, transport challenges, rugged terrain, and competing duties.

A similar finding was reported in a 2024 study from Malawi: inadequate supervision and training, unstable electronic data transfers, and poor feedback were identified as significant gaps (Kambalame et al., 2024b). In another study following the post-revitalisation of the IDSR

programme in Uganda, the findings showed that ad hoc and irregular supervision continued after the programme had been revitalised. (Masiira et al., 2019).

In conclusion, supervision is crucial to the success of IDSR implementation. Ensuring that supervision is implemented as a robust pillar of the health system requires significant financial commitment.

The data showed that coordination was not a significant predictor of routine reporting but was the second strongest predictor of the acceptable case definition for COVID-19 patients in 2021. Effective coordination is often the difference between a fragmented response and a cohesive life-saving effort during an epidemic. This challenge is not unique; it is a recurring theme in IDSR implementation across multiple countries. In a study investigating 20 years of IDSR implementation, coordination was essential to linking surveillance to action at all levels of health (I. R. Mremi et al., 2021). The stakeholders noted that community participation was undermined by community engagement and limited structural support. Presenting as weak community governance, no formal communication channels, key stakeholders excluded from simulations, a lack of communication tools, and reactive partner funding. A review of IDSR programmes in West Africa showed that poor coordination led to delays in the development of surveillance infrastructure and in outbreak detection (Eneh et al., 2025; Overbosch et al., 2020).

In conclusion, this study highlights coordination as an amplifier of IDSR implementation and, when effectively implemented, can lead to reduced morbidity and mortality during outbreaks. Addressing the challenges identified in this study would requires hugh government allocations in structures, communication technology, and inclusive planning to transform coordination from a fragmented activity into a reliable pillar of the health system.

The health facility support findings implications

Availability standards and guidelines at the health facilities favour better timeliness of reporting, but stakeholder engagement was not significant ($\beta = 26.46$, $p = 0.743$). A similar finding was seen in a study in Ghana, where they found out that Health workers able to apply case definitions were twice as likely to contribute to an effective IDSR system (AOR = 1.94, 95% CI 1.17–3.21, $p = 0.013$)(Twene et al., 2024). The stakeholders identified the following gaps that inhibit their engagement with the standard and guidelines: limited availability and training limit effective use at health facilities. A study on health workers' perspectives on the IDSR strategy in Ghana showed similar findings: key success was adopting the WHO guidelines, but challenges included inadequately trained human resources, poor infrastructure, and coordination issues (Mandyata et al., 2017).

In conclusion, the data from this study and its comparative analysis have shown that the availability of standards and guidelines improves the effectiveness of IDSR. Still, gaps in availability, training, and practical application can lead to ineffective IDSR implementation.

Training had a positive but statistically non-significant effect on IDSR performance, undermined by high attrition and poor pre-service preparation, findings that align with challenges reported across multiple African countries. A similar finding was shown in a systematic review of African IDSR programmes. Inadequate skill-based training for personnel was a persistent challenge that weakens IDSR implementation (Wolfe et al., 2021).

Stakeholders identified gaps that explained why training was not effectively implemented—high staff attrition, resulting in frequent replacement of experienced personnel with untrained or inexperienced new staff. In addition, limited practical exposure during pre-service university training, attributed to lecturers' lack of field experience and low motivation, further reduced workforce preparedness for IDSR implementation. These factors collectively diluted the

potential impact of training on surveillance performance. Similar findings were seen in a study from Uganda, where health workers reported an inadequate number of trained staff and high turnover of trained workers as significant constraints to the effective implementation of IDSR(Nakiire et al., 2019b). In summary, training needs to be done in a multifaceted approach of theory and practice.

The availability of minimal resources at the health facilities was not significantly engaged by the stakeholders ($\beta = 333.94$, $p = 0.285$). Still, it was the strongest predictor of the speed of IDSR reporting to the districts. This means that health facilities with higher levels of resources were found to submit their IDSR report quickly to the districts. The stakeholder said that resource provision at the health facilities was done on an ad hoc basis, with frequent equipment breakdowns due to the absence of maintenance systems and irregular replenishment of essential inputs, including ICT equipment and internet connectivity. These challenges limited the facilities' ability to sustain timely reporting and weakened the functionality of electronic surveillance systems.

A study in the Democratic Republic of Congo found that 36% of health facilities lack case definition documents and 53% lack blank reporting forms. This resulted in low performance outcomes at the health facilities, with severely limited case identification and reporting. The IDSR case completeness was only 53%, far below the national target of 80%(Kallay et al., 2024). Similar findings were also observed in a study from Cameroon, which found that only 31% of health facilities had IDSR technical guidelines. This led to limited coverage and inconsistent implementation of surveillance across diseases ((Tchio-Nighie et al., 2025).

The findings from this study and the comparative analysis showed that resource availability is critical for the effective implementation of IDSR, especially at the health facility level. However, most programmes in Sub-Saharan Africa do not value their contribution, and they are

not prioritised. This study has shown that it was the strongest contributor to the effective implementation of IDSR programmes.

The study found that dissatisfaction of the stakeholders at the health facilities was linked to poor speed of reporting IDSR data to the districts ($\beta=18.87$, $p=0.276$). This was because dissatisfied stakeholders do not understand the value of IDSR programme implementation, and there are limited or no feedback channels to address this dissatisfaction. A 2024 study in Ghana found that 52% of health workers received no feedback from the next level in the past year. Lack of feedback made an effective IDSR system 52% less likely ($AOR=0.48$)(Twene et al., 2024). This finding is similar to ours: limited feedback led to ineffective IDSR implementation.

Another study from Zanzibar in 2021 showed that inadequate support functions, such as feedback, and low motivation among health workers led to ineffective IDSR implementation(Saleh et al., 2021). Although experienced staff had shown that they found the IDSR programme more acceptable, knowledge comes with beliefs. A study in South Africa found the opposite, as more experienced staff found the IDSR programme less acceptable. This could be because their experience has led them to see more problems than are present and to know what will happen in the future(Benson et al., 2016).

In summary, the study showed that stakeholders' satisfaction was important for the effective implementation of IDSR but was influenced by complex documented gaps, such as feedback, communication channels, and practical engagement.

Supervision at the health facilities was evident as the second strongest predictor of timeliness of reporting, even though it was not found to be statistically significantly implemented by the stakeholders ($\beta = 4818$, $p = 0.93$). Also, the effect of supervision on timeliness was minimal, suggesting that supervision alone does not improve timeliness. Factors like ad hoc supervision,

driven by limited financial allocations and inadequate human capacity at the district level. The absence of essential supervisory tools, including functional electronic software and standardised checklists, further constrained the effectiveness and consistency of supervision.

As a result, supervisory visits were irregular, primarily administrative, and provided limited practical guidance to frontline staff. However, a study in Sierra Leone showed that when supervision was adequate, completeness rose from 84.5% (2016) to 96% (2021), and timeliness from 80.3% to 92%(Njuguna et al., 2022). A systematic review in Africa found that Inadequate supervision from the next level” was cited as a common, systemic challenge that impedes IDSR implementation (Wolfe et al., 2021). Supervision was shown to be very important, as it showed a high beta value 67% for timeliness of reporting at the health facilities, but the challenges were systematic.

Coordination among health facilities, other programmes, and communities was shown to be important, but it was not fully realised compared to what was happening in different African countries. Coordination had a positive impact on reporting timeliness, but the effect was not statistically significant ($\beta=28.64$, $p=0.637$). In Uganda, after the revitalisation of its IDSR programme, the timeliness of reporting improved following the scaling up of coordination activities, although it still faced some challenges(Masiira et al., 2019).

The qualitative data found weak community governance, political interference, dysfunctional health committees, the exclusion of community leaders, and a lack of formal communication channels. These findings were also seen in Zambia, where poor infrastructure and coordination challenges were identified as significant obstacles to a robust system from a health worker perspective(Mandyata et al., 2017).

Our study found gaps in the formal structures with no functional protocols for reporting alerts or stock levels. No training or simulation exercises for the community leaders. Somalia was able to create its own coordination mechanism as a key step toward improving IDSR(Ssendagire et al., 2023). Zanzibar found support functions, including communication and coordination, “inadequate at the facility level(Saleh et al., 2021). The challenges stemmed from gaps in formal systems, such as the absence of bylaws governing community leaders’ participation in health committees. This was found in many regional literatures: weak coordination as a systemic challenge linked to poor infrastructure and insufficient training for health facilities and communities(Eneh et al., 2025; Wolfe et al., 2021). In order to improve communication and community governance, Sierra Leone implemented rapid, cascaded training to facilitate coordinated actions in 2021(Njuguna et al., 2025).

The Findings of the Third Research Question

The third research question was focused on the quality attributes of the IDSR programme activities.

Acceptability of the IDSR programme was found to be good; however, some private health facilities continued to experience challenges in fully accepting and participating in the programme. Health facilities that did not report data into the IDSR database were likely to miss priority diseases, thereby increasing the risk of undetected outbreaks and subsequent epidemics. A comparable study conducted in refugee camps in Uganda reported similar challenges, where health facilities initially struggled with the use of government reporting forms but later accepted and transitioned to their use following targeted engagement(Ario et al., 2022).

The completeness and timeliness of IDSR reports were calculated to be above the national target of 80%. This performance was primarily attributed to the introduction of the electronic

IDSR (eIDSR) system in 2019. In contrast, the Ugandan study reported a weekly reporting rate of 71%, indicating comparatively lower reporting performance despite the use of electronic systems(Ario et al., 2022). A similar report was found in a regional review of IDSR programmes in 2025, where timeliness remains a significant issue, with only about 20% of African countries consistently reporting weekly data on time(Eneh et al., 2025).

There is a challenge with data quality, as the study found that only 47% of health facilities had consistent reporting to districts and the national level. The main reason for the poor quality is missing records, as DHIS-2 is often offline, and there are no reporting forms in the health facilities. The magnitude of the priority disease outbreak cannot be accurately estimated with poor-quality data. This can lead to delayed action, as the action thresholds will not be met for partners to provide financial resources that the national and district offices do not hold. A study in Zanzibar found that data analysis was inadequate at all levels. Only 13% of the health facilities analysed and presented data, crippling its use for action(Saleh et al., 2021).

The IDSR programme had a good positive predictive value, as all outbreaks in Sierra Leone were eventually identified through the IDSR system. This finding underscored the central role of the national IDSR programme as the sole functional surveillance mechanism for epidemic detection in the country. Consequently, any epidemic that occurred was ultimately detected, even if detection occurred after some morbidity or mortality had already occurred. In contrast, the refugee camp study in Uganda reported a positive predictive value of 64%, indicating that a proportion of outbreak cases were missed(Ario et al., 2022; Opio et al., 2021). These findings highlighted the need for the IDSR programme to strengthen its early warning and detection capacity in order to prevent avoidable loss of life.

Stakeholders reported that the IDSR programme was simple to use, as case definitions were clear and well understood at both health facility and community levels. Nevertheless, the programme did not achieve several nationally defined performance targets. This indicated the need for additional efforts to address persistent implementation gaps and strengthen epidemic prevention. In contrast to the refugee study in Uganda, the system was found to be complicated; many health workers were unaware of standard case definitions, and forms were not readily available(Ario et al., 2022; Nakiire et al., 2019b; Opio et al., 2021). Stakeholders further emphasised that IDSR programme staff needed to routinely monitor national IDSR indicators at all levels to identify reasons for underperformance and implement corrective actions, particularly in relation to inadequate funding, which was identified as a significant contributing factor.

The IDSR programme was also found to be unstable. This instability was evident in the repeated establishment of temporary emergency response structures during major outbreaks, such as the Ebola virus disease and COVID-19 epidemics, rather than relying on a fully institutionalised surveillance and response system(Fall et al., 2019b). The system relies on partner funding that can only be released after an outbreak confirmation in the country. Similar evidence was observed in a study from Uganda, where the system was unstable due to paper-based data, difficulty tracing reports, and funding released only after an outbreak was confirmed(admin, 2017).

In terms of usefulness, the IDSR programme was found to be highly valuable at national and district levels, where surveillance data were routinely used to develop emergency preparedness and response work plans. However, health facilities rarely used IDSR data for local planning, mainly because most did not develop routine work plans. This finding indicated a need for stronger district-level support to enable health facilities to undertake routine planning and to integrate epidemic preparedness and response activities into their work plans. A similar finding was seen

in Uganda, where a 2023 study found that only about 50% of health professionals had a good level of IDSR practice. Factors such as a lack of feedback, supervision, and resources were key barriers(Yusuf et al., 2023).

Finally, the sensitivity and specificity of the IDSR programme were found to be good, indicating that the system was effective in detecting true epidemics while appropriately identifying and excluding false outbreak signals.

The quality functions of the IDSR framework analysis clearly explain the challenges in implementation across the public and private sectors, in data collection and use, and in emergency response and routine surveillance. Experiences from other countries clearly state that to improve the quality of IDSR, all reporting streams need to be integrated, capacity for data use needs to be built, surveillance needs to be institutionalised within core health systems, and local resource financing needs to be secured.

The implications of the fourth research question

The Integrated Disease Surveillance and Response (IDSR) programme in Sierra Leone was fully integrated into the routine health-care delivery system at national, district, and health-facility levels. This level of structural integration was comparable to that reported in Liberia, Nigeria, Ghana, and Uganda, where IDSR had similarly been embedded within existing health system structures rather than operating as a parallel surveillance system(Ibrahim et al., 2020a; Nagbe, Naiene, Rude, Mahmoud, Kromah, Sesay, Okeibunor, et al., 2019; Nuvey et al., 2019). A study in Zambia showed that the operational structure from the community to the national level was integrated with the Health Management Information System (HMIS) (Mandyata et al., 2017; Simusika et al., 2020; texila american university. & HakwiaKooma, 2019). Such integration

supported institutional ownership of surveillance activities and facilitated routine generation and use of surveillance data across levels of the health system.

The Public Health Act for Sierra Leone had not been passed into law in 2021. The director said that the parliamentary health committee was conducting community awareness and had parliamentary sections to popularise the bill before it would be sent to the well for enactment and ascent by the president of Sierra Leone. In contrast, Zambia had mandated the Public Health Act of 1995 and the 2011 Technical Guidelines, which were in use(Mandyata et al., 2017).

The IDSR programme in Sierra Leone was also integrated into the One Health strategy, which involved collaboration among the Health, Agriculture, and Environmental sectors. Dedicated focal persons had been appointed within the three ministries to facilitate intersectoral coordination. This multisectoral approach aligned with global recommendations on emergency preparedness and response, which emphasised that effective surveillance systems should operate collaboratively across human Health, animal health, environmental, meteorological, microbiological, and entomological surveillance platforms to enable timely detection and prevention of epidemics and disasters(Belfroid et al., 2020). Similar One Health-aligned IDSR structures had been documented in countries such as Ghana and Uganda, where multisectoral surveillance strengthened early warning and response capacity(Nuvey et al., 2019).

Data collection within the IDSR programme in Sierra Leone had transitioned from a paper-based system to an electronic platform interoperable with the District Health Information Software-2 (DHIS-2). This transition contributed to improvements in reporting timeliness and completeness, which exceeded the national target in 2021, as demonstrated in Chapter Four. In contrast, studies conducted in Tanzania reported that IDSR reporting from health facilities to

districts remained predominantly paper-based, with DHIS-2 mainly utilised at district and national levels, contributing to delays and reporting inconsistencies(Saleh et al., 2021).

The IDSR programme in Sierra Leone was supported by multiple development partners working through the Directorate of Health Security and Emergencies within the Ministry of Health and Sanitation. Partner contributions provided financial, technical, and human resources that supported programme implementation. However, this study found that many core, support, quality, and structural indicators of IDSR implementation were not fully met. This shortfall was mainly attributed to insufficient domestic financing for public health emergencies, particularly at the district and health facility levels, leading to continued reliance on partner support rather than sustainable government funding.

Overall, while Sierra Leone had achieved structural alignment with regional IDSR implementation models—particularly in system integration, multisectoral collaboration, and electronic reporting-the absence of sustainable domestic financing and enforceable legal frameworks significantly weakened the effectiveness and long-term resilience of the IDSR programme.

Conclusions

The theory on which this study is based is the Panopticon Theoretical Framework, which holds that a person who believes they are constantly watched by their superior will always do the right thing because they think they can be called out if they do wrong. The IDSR programme in Sierra Leone needs to be continually evaluated so that the challenges faced by stakeholders can be addressed to prevent the next epidemic. The research is acting as a watchtower for stakeholders, identifying when the IDSR programme is not working well so it can be corrected. Stakeholders will use the results of this research to make changes with solid evidence and examples from the

sub-region and the rest of the world. The study investigated the IDSR programme at national, district and health facility levels. The study examined the core functions, support functions, quality attributes and structural integration. This study did not limit its investigation to a superficial evaluation of guidelines and reporting rates; instead, it evaluated the functional performance and operational resilience of the IDSR programme.

The study found that the IDSR programme in Sierra Leone had achieved significant successes, including integrating most individual disease surveillance programmes into a single system called the Integrated Disease Surveillance and Response Programme. This programme is hosted entirely by the Ministry of Health and Sanitation, the government of Sierra Leone's health arm. The IDSR programme had a one health strategy that uses a multicentric coordination approach in its implementation(Fall et al., 2019b; Martin, Sloan, Gleason, de Wit, et al., 2020).

The research found that the IDSR programme had moved from paper-based to electronic-based systems. The IDSR programme in Sierra Leone is decentralised across the five provinces, integrated with the Ministry of Health and Sanitation(Njuguna et al., 2019b). The core functions, support functions, quality attributes, and structural integration faced serious challenges that require the commitment of stakeholders to address them, so that Sierra Leone can prevent the next epidemic. These gaps are financial, operational capacity and decentralised functionality. Preparing to prevent the next outbreak is a process, and it needs to be supervised in real time so that challenges are solved as they are identified, investigated, and reported.

At the national level, the study found that Sierra Leonean stakeholders had effectively engaged the core functions guided by standardised technical guideline distributions across the country, just like Liberia and Nigeria(Ibrahim et al., 2020a; Nagbe, Naiene, Rude, Mahmoud,

Kromah, Sesay, Chukwudi, et al., 2019). However, this national success does not translate into the district and the health facility levels.

The findings of the statistical and qualitative data suggested that they are struggling to implement the core functions. Core functions such as case detection, laboratory confirmation, data analysis, and epidemic preparedness showed weak or non-significant associations with key outcome indicators, such as the timeliness of reporting and acceptable case fatality rates. At the district level, data analysis and epidemic preparedness were among the least effective predictors, which indicated that the system was more passive and retrospective than proactive and intelligence-driven (Mremi et al., 2022; Saleh et al., 2021).

The failure of the core functions is not due to the way the IDSR programme was designed, but to failures in the health systems. The study identified scarce minimal resources as the strongest predictor of IDSR outcome performance at both district ($\beta = 52.619$, $p = 0.087$) and health facility ($\beta = 333.94$, $p = 0.285$) levels. The study identified scarce resources as shortages of reporting forms, inadequate ICT infrastructure, broken specimen transport systems, and a lack of dedicated budget lines for epidemic response, forcing a reactive reliance on external partner funding.

Another conclusion was that the study showed a central paradox: acceptance of the IDSR programme alongside stakeholders' dissatisfaction. This study has shown that programme acceptance at the national, district ($\beta = 87.61$, $p = .262$), and health facility ($\beta = 18.87$, $p = .276$) levels does not indicate that stakeholders at the district and health facilities were satisfied with its implementation. The reason for this dissatisfaction was poor reporting speed and an acceptable case fatality rate among COVID-19 patients in 2021.

The qualitative data in this study showed that dissatisfaction stemmed from poor communication at lower levels, which breeds misconceptions and excludes frontline stakeholders

from IDSR activities. This politically motivated exclusion leads to low motivation and trust. The study also found that there was no law mandating community stakeholders to participate in IDSR activities. The proposed Public Health Act would be passed by parliament and address those issues. Consequently, the IDSR remains a “donor-driven,” centrally accepted directive rather than a locally owned and valued public health practice.

The most unique finding of this study was the prioritisation of IDSR functions using the beta coefficient and qualitative data, mostly prioritising support functions over core functions. No IDSR evaluation had ever shown this finding, making it unique for this PhD dissertation. This study utilised regression analysis based on the strength of the beta(β) coefficient to prioritise health system strengthening as the most crucial function for the data collected. The regression analysis showed that the performance strength of the core function was entirely dependent on the support function. The stronger the support functions, the better the core function.

The most powerful predictors of positive outcomes of IDSR were not surveillance activities but the enablers of the health system. At the district level, the strongest predictors of acceptable case fatality rate for COVID-19 patients in 2021 were minimal resource availability, followed by supervision, and thirdly, stakeholders’ satisfaction. The study found that training, standards, and guidelines were statistically significant ($p < 0.05$), indicating their relevance, but their impact on performance was diluted by high staff attrition and inconsistent distribution. At the health facilities, the strongest predictors were also minimal resource availability and supervision, which were far more overwhelming than case confirmation and reporting.

The findings of this study showed that although most stakeholders focus resources on support for core activities like training on case definition and introducing new software, which are mostly cheaper to fund, a greater impact would be seen if those resources were placed on health

system functions like resource availability, procuring and distributing reporting forms, and supervision.

The theoretical implication of this study is that the linear input-output model, which is commonly used in surveillance evaluations, does not hold in real-world settings(Doraiswami & Cheded, 2015). It demonstrated that successful implementation of the surveillance programme is not a matter of technical input alone but a complex mix of health system dynamics, including governance, financing, human resource management, and organisational culture. The findings of this study follow the complex dynamic model, which shows that the system adapts to a changing environment(Jerab, 2025). Political interference and weak feedback loops can stifle a system's adaptability and resilience.

This study provides a practical, evidence-based approach to transforming the implementation of the IDSR programme in Sierra Leone. Using the beta(β) coefficient from the regression analysis and the qualitative data from the stakeholders, the study said that the stakeholders should strengthen the foundation of the IDSR programme starting with passing the public health act that would mandate them to involved in IDSR activities and support the establishment of the National Public Health Agency that would use their allocated budget to strengthen early warning activities. This would create a stable legal and resource environment. The second priority would be strengthening core and support systems, guaranteeing minimum resource availability (forms, ICT, specimen transport, laboratory infrastructure), decentralising case investigation, and institutionalising regular, supportive supervision from districts to facilities. The third priority would be to sustain the IDSR improvement, known as the performance enhancement stage. The investment would be in retaining training for health workers and in building stakeholder satisfaction through official, easy communication channels and fair technical

recognition of hard-working stakeholders. This would improve feedback and outbreak response functions.

Finally, the dissertation confirms that after twenty (20) years of IDSR programme implementation in Sierra Leone, stakeholders had built the structural integration structures, but, as the evidence shows, there were still significant gaps in the functional ownership of the programme. The effectiveness of IDSR programmes is challenged not by gaps in their design but by the health system challenges they were meant to address. The path forward requires a paradigm shift from monitoring technical compliance to building a resilient, motivated, and well-resourced surveillance ecosystem. By re-prioritising investments towards the support functions that district and facility staff have identified as most critical, Sierra Leone can bridge the gap between acceptance and effectiveness, transforming its IDSR from a fragile reporting mechanism into a trusted, locally owned pillar of national health security. This fits perfectly with the theoretical framework of this study, the panopticon theory, with the study acting as a watchtower supervising the paradigm shift toward resilience rather than a reactive response to outbreaks. The districts and health facilities can use the data to evaluate their systems and prioritise support for the IDSR programme.

Recommendations For Application

The recommendation was described in light of the study's objectives and findings on integrated disease surveillance and response in Sierra Leone. These recommendations addressed the gaps identified by the study in the core (Research question one), support (Research question two), quality (Research question three), and structural (Research question four) functions of IDSR. These recommendations aim to strengthen the effectiveness of IDSR programme

implementation, maintain its sustainability, and enhance its resilience at the national, district, and health facility levels.

The first set of recommendations would focus on strengthening the core functions of IDSR implementation at all levels. This can be done by enhancing data quality and utilisation at the district, health facility, and community levels.

The districts and the national level should create and maintain a budget line from the government allocation for the procurement, distribution, and mentoring and supervision of registers and reporting forms for IDSR implementation. This is to improve the quality of data that is entered into the DHIS-2 system. This process would improve the quality of data sent to the electronic systems. Stakeholders should build analytical capacity among district and health facility staff. Stakeholders should invest in building analytical and interpretive skills at the district and health facility levels.

The collection and interpretation of data should not be left to descriptive data analysis; they should also include training in epidemic forecasting and modelling of possible outbreaks. This would allow the data to be used proactively rather than retrospectively.

Feedback loops should be strengthened by institutionalising regular structures and meaningful feedback from national and district levels to the health facilities and communities. This would foster local data use, build staff motivation and self-confidence, and ensure timely data verification.

The core functions can be strengthened by fortifying case confirmation and laboratory investigation. This would be done by developing a functional specimen transport system. In which a locally resource transport system would be established to transport specimens from health facilities to districts and national laboratories, and the results are sent back quickly.

Laboratory infrastructure to confirm priority diseases must be strengthened, and staffing gaps must be addressed. Stakeholders should support and enhance the decentralised approach to case investigation at the health facility level. Staff should be trained and equipped with electronic case investigation software, such as SORMAS, to perform initial investigations and report them through this system to all levels.

Core functions should be strengthened by institutionalising epidemic preparedness and response. This can be done by establishing a national public health agency or commission tasked solely with early warning, preparedness, and response. A dedicated budget line should be established by an act of parliament to support this commission. This commission should be able to work with all the One Health ministries' departments and agencies to prepare for and respond to outbreaks. This commission should be decentralised from the national to district and community levels, with staff and costed implementation plans at all levels. These should ring-fence emergency budgets and stockpile emergency commodities, including vaccines, drugs, and infection prevention and control materials.

The second recommendation would be to strengthen the support functions of IDSR implementation. The government should increase its budget allocation to early warning, preparedness, and response so that its reliance on donor- and partner-defined priority funds and objectives decreases. This government allocation should be used for preparedness and response activities. Resources to the district and health facilities should be costed and planned. The plan should focus on providing resources to peripheral health centres, including all hospitals.

The stakeholders should strengthen staff retention and capacity by moving from ad hoc training to integrating field epidemiology training for health training Universities. The training should include more practical, field-based sessions so that the health workers who complete it can

practice without needing a refresher session. The staff can be retained by fairly recognising their hard work through transparent, competency-based systems that score their work. Staff can be motivated by providing career development support, such as scholarships and fellowships, to winners of transparent, competency-based recognition. The support should go toward staff becoming leaders in the IDSR programme.

The staff can also be motivated by supportive supervision and feedback from higher levels to peripheral health centres. The support functions can be further strengthened by institutionalising supportive supervision and coordination. There should be a budget for supervision, and staff should focus on mentoring and problem-solving rather than assigning blame. Coordination at the lower level can be improved by using the One Health approach involving community structures. This can be done by improving communication channels, such as creating and operating WhatsApp groups, emails, and TikTok community chat rooms for IDSR implementation. Community stakeholders should be involved in simulation exercises and be part of the leaders who develop the communication protocols.

The last recommendation was on the legal framework and system integration. On this, the Public Health Act should be enacted and enforced. The parliament should expedite the passage of the Public Health Act and ensure that the law mandates the reporting and surveillance of priority diseases by all health facilities, whether private or public. The roles and responsibilities of facility staff are clearly spelt out in the act.

To deepen coordination, systems integration, and interoperability, all data from animal health, environmental, meteorological, and human health should be integrated. A sustainable budget line should be provided so that Sierra Leone can own the data and the decisions made from

it. The one-health strategy data should be interoperable with the DHIS-2, and this system should be locally funded.

The successful implementation of the IDSR programme in Sierra Leone requires a shift from a donor-supported project to a sustainably financed, legally grounded, and functionally integrated component of the national health system. Prioritising domestic resource mobilisation, workforce development, data quality, and legal enforcement will address the core dissatisfactions and functional gaps identified at district and health facility levels, ultimately strengthening national health security and epidemic preparedness.

Recommendations For Future Research

This research has produced numerous findings on the preparedness of the IDSR programme to prevent and control health emergencies in Sierra Leone. Programme professionals and partners will use these research findings. It will also be used by researchers interested in working in Sierra Leone and elsewhere, as the context is similar in some countries.

This research found that there is no budget line allocated for health emergencies at all levels, and the recommendation was for the enactment of the public act, which will bring about the establishment of the public health agency, standing as an agency that is mandated by parliament to receive financial allocation, like any ministry department or agency. This finding can be used by other countries with similar challenges. Countries like Uganda, Malawi, Ghana, and Botswana faced identical challenges. They can use Sierra Leone's findings to design their own health policies and conduct systemic research to examine pathways to sustainable domestic financing and their impact on legal frameworks. The findings of this study can support advocacy for establishing an effective public health agency (Wolfe et al., 2021). The study finds that stakeholders are dissatisfied with the implementation of IDSR at the district ($\beta = 87.61, p = .262$) and health facility

($\beta = 18.87$, $p = .276$) levels, but satisfied at the national level. However, the IDSR programme was highly acceptable to the national, district, and public health facilities, as they consistently reported. This suggests that dissatisfaction may stem from implementation barriers rather than a total rejection of the IDSR strategy. Our study's qualitative findings indicated that the barrier may be due to inconsistent communication channels, which may have led to misconceptions about IDSR processes, reduced trust, and undermined motivation.

We recommend a mixed-methods study to distinguish acceptability, satisfaction, and trust as separate constructs and to test whether dissatisfaction predicts operational behaviours, such as delayed reporting, incomplete documentation, or zero reporting, among both public and private providers. Our study identified politically motivated exclusion from IDSR activities, especially at lower levels of implementation, including planning, simulation exercises, and review processes. Our study recommended selecting participants based on competency and technical expertise, with a clear, transparent process publicly available for everyone to access and understand.

Future research is needed to investigate whether transparent inclusion mechanisms that improve perceived fairness, ownership, and motivation would lead to better reporting and response performance. The response of the IDSR programme to epidemics of infectious diseases, events and conditions is feeble at the national level, in most districts and worst at the health facility level. This is primarily because outbreak investigation is still done on paper, and the electronic software that is interoperable with DHIS-2 focuses on numbers rather than on investigating individual cases. It usually takes time to find resources to support staff investigating the outbreak, more time for the investigators to go to the communities and write down what they saw, and then bring it back to the districts and finally to the national level for a response to be mounted. This response process is the most critical component of the IDSR programme because it ends epidemics and prevents them

from happening. However, the data from this research showed that the IDSR programme is very weak in that area.

We recommend a pilot study to introduce surveillance outbreak response management and analysis systems (SORMAS) in Sierra Leone (Tom-Aba et al., 2020). This is a prospective study in which the surveillance outbreak response is determined at the start and end of the pilot study. Based on the implementation's success, Sierra Leone can decide whether to proceed with a rollout of this software or abandon it. This surveillance outbreak management analysis system is free web software used by health supervisors at the health facility and community levels to notify higher health authorities about epidemic-prone diseases, events, and conditions. They report them and manage the response to these conditions in real time. With this software, the supervisor supports a multifunctional system that integrates surveillance, laboratory networks, and data from health facilities, district, national, and international laboratories. They use contact tracing and disease detection to prevent and manage the next epidemic. This system has an automated online feedback loop that allows bidirectional information flow.

With SORMAS, all surveillance and disease control activities are managed within a single system. Information is publicly available to all public health actors in the country to support an adequate response. There is a task distribution for everyone in the surveillance system, as different professions are involved in controlling epidemics caused by infectious diseases, events, and conditions. Clinicians, laboratory staff, disease notification officers, epidemiologists and others take responsibility in the prevention and control of epidemics. Information on infections, events or conditions is entered into SORMAS by health facility staff, community health workers, port health officers, and event surveillance officers under the lead of the surveillance supervisor. The

surveillance officers and laboratories will validate this information. Contact supervisors, case supervisors, and case officers will now control the spread of the disease.

Through SORMAS, these staff are connected via a single system and receive updates in real time. For the system to work, health facility staff, community health workers, port health officers, and event surveillance officers all need devices with the SORMAS application installed. There is no need for a continuous internet connection. SORMAS collects information without an internet connection, and when personnel have access to the internet, the system automatically uploads to the cloud so all can see the information. Supervisors can track everything on their desktop computers at the district and national levels. They will have a view of epidemiology curves, the geospatial positions of diseases, events, or conditions in the field, and summary statistics, and they can assign tasks to all the players in the field. International partners like the WHO and CDC can look into the data in real time. SORMAS is compatible with most m-health and e-health tools, such as DHIS-2, that have been used in Sierra Leone (Tom-Aba et al., 2020; Yinka-Ogunleye et al., 2019).

The surveillance attributes in this study were based on the WHO questionnaire and DHIS-2 data. The WHO questionnaire asked unscaled questions, making it difficult to estimate the strength of interviewees' responses. This makes it challenging to prioritise the interviewees' answers. Questions like whether the IDSR programme indicators are simple to understand? We were asking for a yes-or-no answer, and the strength of the answer was not quantified. We are recommending a descriptive study using a Likert-type questionnaire to assess stakeholders' perceptions of the 12 quality indicators for Sierra Leone's IDSR programme. The questionnaire will assess the demographic status of the stakeholders and their years of experience working with the IDSR programme in Sierra Leone. The questionnaire will assess five questions on the quality

indicators for the IDSR programme implementation. Starting from strongly agree, agree, not agree, disagree, strongly disagree. To prevent stakeholders who are afraid to answer questions or want to sit on the fence from staying away, I will add “not applicable” and “do not know.” During the analysis stage, not applicable and do not know responses will be treated as missing data and excluded from the response. It will be assumed that their opinion is a random selection and will not alter the study’s results when removed.

The response will be coded as follows: strongly agree will carry five marks, and strongly disagree will carry one mark. Totals will be taken for each response under each attribute for the IDSR programme, and the analysis will be computed over these totals. Respondents who provide a valid response will be divided into two groups: those above or equal to 50% and those below 50%. The ones that are above or equal to 50% are those that are described as sufficient, saying that the attributes are good, and those that are below 50% are saying that the attributes are bad(Ng’etich, Voyi, Kirinyet, et al., 2021).

After collecting some pre-test data, a factor analysis will be conducted to reduce the attribute variables that have little impact on the IDSR programme in Sierra Leone. This will ensure that the Cronbach’s Alpha calculated will have robust internal validity for the results obtained.

PRIORITIZED RECOMMENDATIONS

This research has identified numerous challenges and made recommendations to address them in Sierra Leone and the rest of the world. In practice, stakeholders would find it difficult to

find the resources to address all these challenges. Therefore, we are proposing three strong recommendations to stakeholders in Sierra Leone to prevent the next public health emergency.

The prioritisation was based on the relative contribution of IDSR core and support functions to key outcome indicators, which were measured by the beta (β) coefficient from the parametric regression analysis. This was supported by qualitative research findings from stakeholders' statements and triangulated with the global and regional IDSR literature. There were functions with stronger predictive power, but those that were not statistically significant were prioritised because they provide operational leverage for the IDSR programme. This shows that in the real world, complex public system functions are not determined by statistical significance but by practical situations, feasibility, and system-wide dependencies.

Priority one: focuses on functional enablers that address the core systemic gaps. These priorities should be implemented in the first year. These functions are prerequisites for all the other functions to be sustainable when resources are spent on them.

Establishing a public health agency with access to government budget allocations to provide sustainable local resources for early warning in epidemic prevention and control.

Justification: The absence of an allocated budget for most of the IDSR programme's core functions and the lack of a supporting law were evident in the qualitative results. This was triangulated with the literature from other countries (Saleh et al., 2021; Ssendagire et al., 2023; Thokala et al., 2024). The quantitative data from this study in table 33 showed that limited resource availability was the strongest predictor of outcomes at both the district ($\beta = 52.62$) and the health facility ($\beta = 333.94$) levels.

Step-by-Step Process: To achieve the functional enablers, stakeholders need to advocate for the Parliament to pass the Public Health Act and for the President to sign it into law. The law

would mandate the use of the IDSR programme by all health-related facilities, define the roles of stakeholders in the health sector, and provide legal actions that can be taken against those who refuse to perform IDSR activities, such as reporting (Mandyata et al., 2017).

Also, they would advocate for the establishment of the National Public Health Agency with an adequately allocated budget line from the Ministry of Finance. The funds would support surveillance activities and health system strengthening.

The stakeholders would develop a domestic resource mobilisation strategy outlining activities to reduce donor contributions to IDSR activities progressively.

Case Investigation: The second enable would be the decentralisation of case investigation for diseases, events, and conditions using functional digital tools such as SORMAS.

Justification: This study ranked it as the most critical core function across all levels (National, district, and health facilities) as shown in 33. At the district level, it was statistically significantly associated with the acceptable case fatality rates of COVID-19 patients ($\beta = 28.533$, $p = 0.027$). It was consistently ranked among the strongest predictors of IDSR programme outcomes. Its effectiveness, however, was hindered by inadequate financing, insufficient supply of IPC materials, drugs, and vaccines, and limited supportive supervision.

Step-by-step process: The IDSR stakeholders in Sierra Leone should invest in decentralising case investigation by supporting districts, especially health facilities, with trained staff, digital platforms (SORMAS), transport for staff to communities, IPC commodities, and vaccines. The health facilities should be able to conduct preliminary case investigation and inform the next level through the digital platform for further investigation and approval.

Case Confirmation: The third enabler would be to support laboratory confirmation by strengthening laboratory networks and referrals.

Justification: This was the third most crucial core function of IDSR at the district and health facilities as shown in table 33. However, there was a weak, statistically significant association with substantial predictive value for reporting timelines and outbreak control among districts and health facilities. There were marked inequalities between hospitals and peripheral centres.

Step-by-step process: The stakeholders should allocate funds to develop a specimen transport system. This is why the availability of a financial enabler was the first to be prioritised. The government needs to build an effective supply chain system for laboratory reagent procurement, distribution, monitoring, and audit. The laboratory should be staffed to support its ability to produce support for the health facility. The investment in laboratory support should be distributed equally in the country.

The second Priority recommended the strengthening of the other core and support functions, which should be implemented. The timeline should be between one (1) and three (3) years of implementation after the first priority is completed.

Minimum Resource availability: The first and second priority would be ensuring minimum resource availability for both districts and health facilities.

Justification: Minimum resource availability was the strongest predictor of acceptable case fatality at the district level ($\beta = 52.619$, $p = 0.087$) and was positively associated with the timeliness of reporting at health facilities ($\beta = 333.94$, $p = 0.285$), although the association was statistically weak and insignificant shown in table 33. Districts with greater resource availability had better acceptable case fatality rates among COVID-19 patients. Despite limited resources at the district and health facility levels, significant needs remain that could cripple the system. The study identified a lack of reporting forms, ICT materials, and specimen transport containers.

Step-by-step process: Implement an official functional supply chain management for resources such as IDSR registers, reporting forms, IPC materials, ICT materials, and specimen transport and collection kits. Ensuring the needs of frontline services are quantified and catered to prevent resource shortages.

Develop and fund a strategy to transport specimens from communities to health facilities and national laboratories.

Feedback: This enabler would be to establish official communication channels in a bidirectional way to all levels, serving as a feedback loop.

Justification: The study showed that feedback ($\beta = 10.182$, $p = 0.252$) was ineffective. Also, it was the third predictor of the outcome indicator at the district level. However, it was shown to be responsible for stakeholders' dissatisfaction and lack of interest in IDSR implementation at the community level, due to eroded trust, reduced motivation, and limited data use as shown in table 33.

Step-by-step process: The first action would be to establish a mandatory regular feedback bulletin that presents the analysed, approved IDSR data, identifies trends, recognises performance, and outlines actions to improve the effectiveness of the IDSR programme.

The second action would be to establish a formal platform, like a formal email group, WhatsApp group, Instagram, or TikTok group, where stakeholders can reach each other at any time with a team to manage the flow of information and keep the regulations for establishing the forum, keeping political interference and involvement away from it.

Digital platforms like DHIS-2 can be used as closed-loop channels for alerts, clarifications and supportive supervision at all levels.

Supportive supervision and training are among the strongest predictors of outbreak indicators at both district and health facility levels. However, its implementation was ad hoc and lacked financial resources, according to the stakeholders.

Justification: Supportive supervision was not statistically significant for the acceptable case fatality at the district level ($\beta = 130.625$, $p = 0.239061$); training was statistically significant at the district level but was diluted by high attrition and weak preservice implementation at the health facilities. However, it ranked second among the strongest predictors of the outcome indicator. The statistical deficit was due to a lack of funds, intermittent interruptions to electronic systems, a lack of transportation to attend field activities, and competing district activities seen in table 33.

Step-by-step process: The government should provide a dedicated local budget for supportive supervision. A strategic plan for supportive supervision should be implemented fully and monitored.

Support a functional digital platform for supportive supervision that can be used to get feedback.

Trained and retrained the staff at the district and national levels to be mentors and not be punitive in their approach to supervision. The supervision should focus on IPC compliance, response readiness and prevention compliance rather than administrative compliance. Enhance integration of the field epidemiology programme into health university programmes, making them more practical.

A strategy for On-the-job mentoring and micro-training during supervision would make a much bigger difference than large, formal training after university.

Create a career pathway for staff being trained by the university for the Health Service Commission.

The third priority of recommendation should focus on system integration and coordination, with a long-term impact. The timeline should be from three (3) to five (5) years.

Coordination: Stakeholder coordination at the community level

Justification: Although coordination was not statistically significant at the district and health facility levels, it would be a force multiplier for the core and support functions at the community level as seen in table 33.

Step-by-step process: Strengthen coordination at the community level through robust governance structures. Inclusive simulation exercises that are not politically motivated. Ensure that bylaws mandate that community leaders participate in IDSR activities.

Standards and guidelines, stakeholder satisfaction, data analysis, interpretation, and use are all support functions that should be carried out to sustain the resilience of the IDSR programme.

In conclusion, the prioritised recommendations provide the government of Sierra Leone and its partners with a clear pathway for which recommendations to start and which to follow next. The data from this study showed that priority one recommendations should be the first to be funded by the government.

ORIGINALITY OF THIS RESEARCH

This thesis provides the first comprehensive, system-wide evaluation of Sierra Leone's IDSR programme since its 2004 implementation, uniquely employing a multi-level (national, district, health facility) and multi-functional (core, support, quality, structural) analytical framework. Its originality stems not from examining single components in isolation, but

from integrating quantitative prioritisation (β -coefficients) with qualitative contextual analysis to identify the precise, hierarchical drivers of system performance and failure within a post-Ebola, COVID-19 context. This moves beyond descriptive gap analyses to provide an evidence-based roadmap for prioritised investment.

Originality by Core Research Objectives and Analytical Levels

Originality in Assessing Core Functions

New Prioritisation Methodology: While other studies list challenges, this research statistically ranks core functions by their predictive power (β -coefficients) for outcome indicators (timeliness, acceptable case fatality). This reveals, for instance, that at the health facility level, case confirmation is the strongest predictor of timeliness. This finding mandates a re-prioritisation of laboratory investment over other, less statistically influential functions.

Contextualised Multi-Level Disaggregation: The study uniquely identifies that core function failure has different primary causes at each level: The study uniquely identifies that core function failure has different primary causes at each level:

National: Strategic gaps (e.g., lack of dedicated epidemic budget lines for IDSR activities at all levels, no law mandating the stakeholders to implement IDSR activities, and feedback disrupted by COVID-19).

District: Systemic and logistical constraints (e.g., non-functional specimen transport, weak data analysis capacity for forecasting).

Health Facility: Foundational resource gaps (e.g., absence of reporting forms, ICT limitations, low motivation).

Community: Non-functional community governance structures due to political interference and exclusion of community stakeholders from IDSR activities.

Originality in Assessing Support Functions

Identification of Foundational Constraints: The research establishes that Minimal Resource Availability` is the strongest predictor of performance at both district and facility levels. This original finding positions resource scarcity not as one among many challenges, but as the foundational bottleneck upon which all other improvements depend.

Nuanced Analysis of Human Factors: It moves beyond noting “training is needed” to show why training fails: high attrition, poor pre-service preparation, and lack of practical field exposure in curricula. It also uniquely analyses stakeholder satisfaction as a predictor, links motivation to outcomes, and identifies the lack of feedback as a key demotivator.

Originality in Evaluating Quality Attributes

System-Wide Quality Audit: It provides a rare holistic quality assessment across acceptability, completeness, timeliness, data quality, predictive value, simplicity, stability, usefulness, sensitivity, and specificity.

Critical Paradox Identification: It uncovers a crucial paradox: while the system has high sensitivity and positive predictive value (eventually detecting all outbreaks because there is no other programme that prioritises surveillance of priority diseases, events, and conditions in Sierra Leone), it suffers from instability and poor data quality. This original insight explains how outbreaks are detected but not prevented, as delayed action due to inadequate data and ad-hoc funding leads to preventable morbidity and mortality.

Focus on Data Use vs. Data Collection: The research makes the original and critical distinction that high reporting completeness does not equate to data utility. The study shows that

at the health facilities the data that are collected are not analysed for actions to be taken at that level so that early warning activities can be implemented.

Originality in Structural & Integration Analysis

Diagnosis of Institutional Fragility: The study offers an original structural critique: despite being “integrated,” the system’s stability is hollow. It is propped up by donor funding and lacks enforceable legal backing (due to the stalled Public Health Act). This creates a “reactive integration” that collapses into parallel emergency structures during crises (such as Ebola and COVID-19).

One Health Integration as an Unfulfilled Framework: While noting the formal One Health structure, it initially highlights that operational integration across human, animal, meteorological and environmental sectors remain weak, identifying this as a critical frontier for genuine epidemic prevention rather than just response.

This PhD research makes an original contribution to global health security literature by:

Providing a Diagnostic Hierarchy: Using empirical data to create a prioritised list of interventions for Sierra Leone’s IDSR, moving from a “shopping list” of needs to a strategic investment plan.

Offering a Replicable Analytical Model: The multi-level, multi-functional framework coupled with predictive statistics presents a novel methodology for evaluating complex public health systems in other low-resource settings.

Challenging Assumptions of Digital Health and Integration: It provides critical, evidence-based cautions that technological rollouts and structural integration are insufficient without addressing foundational resource constraints, human factors, and sustainable financing.

Contextualising knowledge within the Mano River Union: It delivers the most comprehensive analysis of IDSR in Sierra Leone to date, with deliberate comparisons to Liberia, Ghana, and Nigeria, thus generating regionally specific, actionable knowledge for a high-risk, epidemic-prone region.

In conclusion, the originality of this research lies in its systemic depth, methodological rigour, and its generation of context-specific, prioritised evidence that bridges the gap between academic evaluation and practical health system strengthening. It transforms the understanding of IDSR performance from a catalogue of gaps into a dynamic model of interdependent functions, where targeted investment in the highest predictors of success could yield disproportionate returns for epidemic preparedness.

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APPENDICES

APPENDIX A: INFORMED CONSENT FORM



UU_IC - Version 2.1



Informed Consent Form

Part 1: Debriefing of Participants

Student's Name: Sulaimn Gbonnie Conteh

Student's E-mail Address: conteh4722@gmail.com

Student ID #: R1812D7000435

Supervisor's Name: Professor Victor E. Adamu

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: SIERRA LEONE'S INTEGRATED DISEASE SURVEILLANCE AND RESPONSE PROGRAMME

Date: 30-Jul-2021

Provide a short description (purpose, aim and significance) of the research project, and explain why and how you have chosen this person to participate in this research (maximum 150 words).

The increase in incidence of infectious diseases has led to several economic loss and travel restrictions due to epidemics. The strategy to prevent or control such spread of infectious disease is to rapidly detect the infection and respond to it using Integrated Disease Surveillance and Response (IDSR) strategy.

Sierra Leone is implementing electronic IDSR programme from national through to health facility and community levels. This programme can only work at its maximum if it is regularly evaluated in order to build public health emergency preparedness in Sierra Leone.

The aim of this cross sectional study is to assess the core and support functions of the IDSR program. You are a participant because you are holding a key position with a responsibility that allows you to make IDSR work at the national, district, health facility or the community in Sierra Leone. You are to provide information so as to achieve the study objectives.

The above named Student is committed in ensuring participant's voluntary participation in the research project and guaranteeing there are no potential risks and/or harms to the participants.

Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, data collected will be deleted.

All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

I, Sulaimn Gbonnie Conteh, ensure that all information stated above is true and that all conditions have been met.

Student's Signature: sulaimanconteh



UU_IC - Version 2.1

Informed Consent Form

Part 2: Certificate of Consent

This section is mandatory and should to be signed by the participant(s)

Student's Name: Sulaimn Gbonnie Conteh

Student's E-mail Address: conteh4722@gmail.com

Student ID #: R1812D7000435

Supervisor's Name: Professor Victor E. Adamu

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: SIERRA LEONE'S INTEGRATED DISEASE SURVEILLANCE AND RESPONSE PROGRAMME

I have read the foregoing information about this study, or it has been read to me. I have had the opportunity to ask questions and discuss about it. I have received satisfactory answers to all my questions and I have received enough information about this study. I understand that I am free to withdraw from this study at any time without giving a reason for withdrawing and without negative consequences. I consent to the use of multimedia (e.g. audio recordings, video recordings) for the purposes of my participation to this study. I understand that my data will remain anonymous and confidential, unless stated otherwise. I consent voluntarily to be a participant in this study.

Participant's Print name:

Participant's Signature:

Date:

If the Participant is illiterate:

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had an opportunity to ask questions. I confirm that the aforementioned individual has given consent freely.

Witness's Print name:

Witness's Signature:

Date:

APPENDIX B: GATEKEEPER LETTER



UU_GL - Version 2.0



Gatekeeper letter

Address: Ministry of Health and Sanitation

Date: 30-Jul-2021

Subject: Request for Access to conduct Research

Dear Director,

I am a **postgraduate, doctoral** student at Unicaf University **Zambia**.

As part of my degree I am carrying out a study on **SIERRA LEONE'S INTEGRATED DISEASE SURVEILLANCE AND RESPONSE (IDSR) PROGRAMME**.

I am writing to enquire whether you would be willing to **give permission to recruit participants** in this research.

Subject to approval by Unicaf Research Ethics Committee (UREC) this study will be using **questionnaire to interview stakeholders to IDSR in Sierra Leone**.

I will require that the district medical officers and their teams be informed about the start of this study so that the enumerators will gain access to the IDSR data and stakeholders in the districts, health facilities and laboratories. The stakeholders will be asked to give voluntary consent to the study by signing the consent form. The interview will take one hour maximum if the enumerators are give full access.

The aim of this study is to assess the core and support functions of IDSR in Sierra Leone to know if the IDSR programme can respond to outbreak of epidemic prone diseases especially now that donors are re-directing their support. The functionality of the IDSR programme depends on the six core functions which are detection, registration, confirmation, reporting, data analysis and provision of feedback at all levels. This core function is supported by communication, training, supervision, and resource-provision to the IDSR programme.

Thank you in advance for your time and for your consideration of this project. Kindly please let me know if you require any further information or need any further clarifications.

Yours Sincerely,

Dr Sulaiman Gbonnie Conteh

Student's Name: Sulaiman Gbonnie Conteh

Student's E-mail: conteh4722@gmail.com

Student's Address and Telephone: 22 Victoria Street Regent Freetown Sierra Leone; +23278789609

Supervisor's Title and Name: Professor Victor E. Adamu

Supervisor's Position: Supervisor

Supervisor's E-mail: v.adamu@unicaf.org

APPENDIX C: SIERRA LEONE ETHICS COMMITTEE LETTER



GOVERNMENT OF SIERRA LEONE
Office of the Sierra Leone Ethics and Scientific Review Committee
Directorate of Training and Research
5th Floor, Youyi Building Brookfields, Freetown
Ministry of Health and Sanitation

6th February, 2020

To: **Dr Sulaiman Gbonnie Conteh**
7 Victoria Street
Regent Village, Western Area Rural
conteh4722@gmail.com
+23278 789608

Principal Investigator

Study Title: Assessing Sierra Leone's Integrated Disease Surveillance and Response Programme

Version: 08 January 2020

Submission Type: First protocol version submitted for review

Support: Directorate of Health Security and Emergencies

Committee Action: Expedited Review

Approval Date: 06 February, 2020

The Sierra Leone Ethics and Scientific Review Committee (SLESRC) having conducted an expedited review of the above study protocol and determined that it presents minimal risk to subjects, **hereby grants ethical and scientific approval for it to be conducted in Sierra Leone.** The approval is valid for the period, **06 February, 2020 – 05 February, 2021.** It is your responsibility to obtain re-approval/extension for any on-going research prior to its expiration date. The request for re-approval/extension must be supported by a progress report.

For further enquiries please contact: efoday@health.gov.sl



GOVERNMENT OF SIERRA LEONE
Office of the Sierra Leone Ethics and Scientific Review Committee
Directorate of Training and Research
5th Floor, Youyi Building Brookfields, Freetown
Ministry of Health and Sanitation

Review Comments:

- **Amendments:** Intended changes to the approved protocol such as the informed consent documents, study design, recruitment of participants and key study personnel, must be submitted for approval by the SLESRC prior to implementation.
- **Termination of the study:** When study procedures and data analyses are fully complete, please inform the SLESRC that you are terminating the study and submit a brief report covering the protocol activities. Individual identifying information should be destroyed unless there is sufficient justification to retain, approved by the SLESRC. All findings should be based on de-identified aggregate data and all published results in aggregate or group form. A copy of any publication be submitted to the SLESRC for its archive.


Professor Hector G. Morgan
Chair

For further enquiries please contact: efoday@health.gov.sl

APPENDIX D: QUESTIONNAIRE FOR THE STUDY

DRAFT QUESTIONNAIRE FOR ASSESSING SIERRA LEONE'S INTEGRATED DISEASE SURVEILLANCE AND
RESPONSE PROGRAMME.

DRAFT QUESTIONNAIRES

NATIONAL LEVEL QUESTIONNAIRE

Identifiers

Assessment team:

Date:

Interviewer:

Country:

Surveillance System :

O. General

I. Availability of legal mechanism to enforce surveillance

C0.1 Is there mandatory surveillance for any diseases? Yes No
Unknown
Not applicable

C0.1.2 List diseases, *if yes*:

I. Availability of a national surveillance manual

C0.2 Is there a national manual for surveillance? Yes No
Unknown
Not applicable

C0.2.2 *If yes*, describe (last update, diseases included, case definitions, surveillance and control, integrated or different for each disease):

I. Case detection and registration

I. Existence of standardised case definitions for the country's priority diseases

C1.1 Do you have standard case definitions for the country's priority diseases? Yes No
Unknown
Not applicable

C1.2 Obs [1 to n priority diseases]
Observed the standard case definition for (each priority disease) Yes No
Unknown
Not applicable

II. Data reporting

I. Presence of recommended reporting forms in the country at all times over the past 6 months

C2.1 Is the central level responsible for providing surveillance forms to the health facilities? Yes No
Unknown
Not applicable

C2.2 *If yes*, have you lacked appropriate surveillance forms at any time during the last 6 months? Yes No
Unknown
Not applicable

I. Percent of district reports (either directly or through an intermediate level) received each reporting period at the central level during the past 3 months:						
Number of reports in the last 3 months compared to expected number						
C2.31N	Weekly:	/12 times the number of districts				
C2.32N	Monthly:	/3 times the number of districts				
I. On time (use national deadlines)						
C2.41N	Number of weekly reports received on time:	/12 times the number of districts				
C2.42N	Number of monthly reports received on time:	/3 times the number of districts				
I. Reporting to WHO						
C2.5Obs	Does the Ministry of Health share surveillance data with the WHO? [Observe reports at WR's Office]	Yes	No			
		Unknown				
		Not applicable				
I. Capacity to report to next level by e-mail, telephone, fax or radio						
C2.6	How do you report:					
	Mail	Fax	Telephone	Radio	Electronic	Other
III. Data analysis						
I. Does the central level:						
Describe data by person (case based, outbreaks, sentinel)?						
C3.1Obs	Observed description of data by age and sex	Yes	No			
		Unknown				
		Not applicable				
I. Describe data by place?						
C3.2Obs	Observed description of data by district (tables, maps)	Yes	No			
		Unknown				
		Not applicable				
I. Describe data by time?						
C3.3Obs	Observed description of data by time	Yes	No			
		Unknown				
		Not applicable				
I. Perform trend analysis?						
C3.4Obs	Observed line graph of cases by time	Yes	No			
		Unknown				
		Not applicable				
C3.4T	List disease(s) for which line graph is observed					
I. Have an action threshold defined for each priority disease?						
C3.5	Do you have an action threshold defined for any of the country priority diseases?	Yes	No			
		Unknown				
		Not applicable				

C3.6	Do you have an action threshold for any diseases targeted for eradication or elimination?	Yes	No
		Unknown	
		Not applicable	
C3.7	<i>If yes</i> , what is it? cases	% increase	rate
	(Ask for two priority diseases)		
C3.71N	Eradication		
C3.72N	Epidemic prone		
I.	Have appropriate denominators?		
C3.8Obs	Observed presence of demographic data (E.g. population by district and <u>hard to reach</u> groups)	Yes	No
		Unknown	
		Not applicable	
I.	Use appropriate denominators?		
C3.9Obs	Observed rates derived from demographic data	Yes	No
		Unknown	
		Not applicable	
I.	Use appropriate source of denominators?		
C3.10T	What is the source of your denominator?		
IV. Outbreak investigation			
I.	Percent of suspected outbreaks that were investigated in the past 1 year		
C4.11N	Number of outbreaks suspected in the past year		
C4.12T	List the diseases		
C4.13N	Of those, number investigated (Observe reports and take copies if possible)		
I.	Of the investigated outbreaks in the past 1 year, percent in which risk factors were looked for		
C4.2N	Number of outbreaks in which risk factors were looked for		
I.	Of the investigated outbreaks in the past 1 year, percent in which findings were used for action		
C4.3N	Number of outbreaks in which findings were used for action [Observe report]		
V. Epidemic preparedness (relevant for epidemic prone diseases)			
I.	Existence of a national plan for epidemic preparedness and response		
C5.1Obs	Observed a written plan of epidemic preparedness and response	Yes	No
		Unknown	
		Not applicable	
I.	Existence of emergency stocks of drugs, vaccines, and supplies at all times in past 1 year		
C5.2	Has the country had emergency stocks of drugs, vaccines, and supplies at all times in past 1 year?	Yes	No
		Unknown	
		Not applicable	

C5.2Obs	Observed the adequacy of stocks of drugs, vaccines and supplies at time of assessment	Yes Unknown Not applicable	No
I. Experience of a shortage of drugs, vaccines or supplies during the most recent epidemic (or outbreak)			
C5.3	Has the country experienced shortage of drugs, vaccines or supplies during the most recent epidemic (or outbreak)?	Yes Unknown Not applicable	No
I. Existence of a standard case management protocol for epidemic prone diseases			
C5.4Obs	Observed the existence of a written case management protocol for at least 1 priority disease		
C5.4T	<i>If yes, list:</i>		
I. Presence of a budget line for epidemic response			
C5.5	Is there a budget line for epidemic response?	Yes Unknown Not applicable	No
I. Existence of a central epidemic management committee			
C5.6	Observed minutes (or report) of meetings of epidemic management committee	Yes Unknown Not applicable	No
I. Existence of a central rapid response team for epidemics			
C5.7	Does the country have a rapid response team for epidemic?	Yes Unknown Not applicable	No
VI. Response to epidemics			
I. Ability of the central level to respond within 48 hours of notification of most recently reported outbreak			
C6.1Obs	Observed that the central level responded within 48 hours of notification of most recently reported outbreak (from written reports with trend and intervention)	Yes Unknown Not applicable	No
I. Ability of the central level to monitor mass vaccination (meningitis and yellow fever) campaign coverage evaluations			
C6.2Obs	Does the central level monitor mass vaccination campaign coverage evaluations (Observe report to confirm check for coverage by age group, logistics and costing)?	Yes Unknown Not applicable	No
I. Ability of the national epidemic management committee to evaluate its preparedness and response activities			
C6.3Obs	Has epidemic management committee evaluated its preparedness and response activities during the past year (Observe written report to confirm)?	Yes Unknown Not applicable	No

VII. Feedback

I. Existence of capacity for publication of health and surveillance information

Is there at the MoH for publications

C7.0	An editorial board?	Yes	No
		Unknown	
		Not applicable	
C7.1	An editor?	Yes	No
		Unknown	
		Not applicable	
C7.2	An annual budget?	Yes	No
		Unknown	
		Not applicable	

I. Existence of a report or bulletin that is regularly produced to disseminate surveillance data

C7.3N	How many feedback bulletin or reports has the central level produced in the last year?		
C7.3Obs	Observed the presence of a report or bulletin that is regularly produced to disseminate surveillance data	Yes	No
		Unknown	
		Not applicable	

VIII. Supervision

I. Percent of supervisors that made the required number of supervisory visits in the past 6 months

C8.1N How many supervisory visits have you made in the last 6 months?

C8.2N Obtained required number of visits from central level

The most usual reasons for not making all required supervisory visits. (Text)

C8.3T

C8.4T

C8.5T

IX. Training

I. Percent of health personnel trained in disease surveillance

C9.1N What percent of your subordinate personnel have been trained in surveillance

C9.2	Have you been trained in disease surveillance?	Yes	No
		Unknown	
		Not applicable	

C9.2T If yes, specify when, where, how long, by whom?

I. Percent of health personnel that have received post-basic training in disease surveillance

C9.3	Have you received any post-basic training in disease surveillance?	Yes	No
		Unknown	
		Not applicable	

C9.3T If yes, specify when, where, how long, by whom?

I. Percent of health personnel that have received post-basic training in epidemic management

C9.4 Have you received any post-basic training in epidemic management? Yes No
 Unknown
 Not applicable

C9.4T *If yes, specify when, where, how long, by whom?*

Obtain and analyse the content of the surveillance and epidemic management training

C9.5T Strengths

C9.6T Weaknesses

C9.7T Opportunities

C9.8T Threats

I. Major strength and weaknesses of existing training schools and programmes' materials

C9.9T Strengths

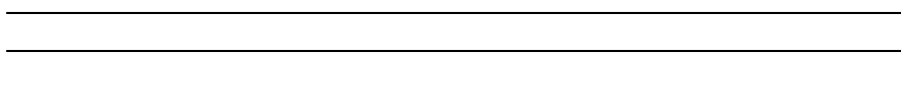
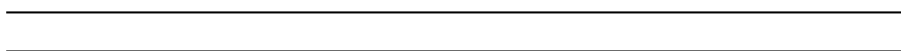
C9.10T Weaknesses

C9.11T Opportunities

C9.12T Threats

I. Presence of a functional Epidemiology/Public Health Society

C9.13 Is there a national Epidemiology/Public Health Society? Yes No
 Unknown
 Not applicable



C9.13N How often do they meet?**I. Percent of sites that have:****Data management**

- Computer
 — Printer
 — Photocopier
 — Data manager
 — Statistical package

Communications

- Telephone service
 — Fax
 — Radio call
 — Satellite phone
 — Computers that have modems

Budget line**Logistics**

Data management	(Yes = Y No = N Unknown = U Not applicable = N/A)					Number if available
X Computer	C10.1	Y	N	U	N/A	C10.1N
X Printer	C10.2	Y	N	U	N/A	C10.2N
X Statistical package	C10.3	Y	N	U	N/A	
X Data manager	C10.4	Y	N	U	N/A	C10.4N
X Photocopier	C10.5	Y	N	U	N/A	C10.5N
X Telephone service	C10.6	Y	N	U	N/A	
X Fax	C10.7	Y	N	U	N/A	
X Radio call	C10.8	Y	N	U	N/A	
X Computers that have modems	C10.9	Y	N	U	N/A	C10.9N

Logistics**I. Have a functional computerised surveillance network**

C10.10 Do you have a computerised surveillance network at this level? Yes No
 Unknown
 Not applicable

C10.10T If yes, Describe (closed network, central database server, data storage and analysis, feedback through system etc)

C10.11T Links with other levels (list)

C10.12T Link to specialised computerised systems (ex. Outbreak notification system). List:

I. Budget for surveillance

C10.13	Is there a budget line for surveillance in the MoH budget?	Yes	No
		Unknown	
		Not applicable	

C10.13N *If yes, what is the proportion:* %

I. Opportunities for strengthening surveillance

C11T How could surveillance be improved?

I. Existence of a surveillance co-ordination body at MOH central level

C12.1	Is there a surveillance co-ordination body at MOH central level?	Yes	No
		Unknown	
		Not applicable	

C12.1T *If yes, describe its composition, function and links to various sectors including the laboratory*
[Observe minutes/reports of the co-ordination committee to confirm]

I. Existence of focal unit for surveillance at MOH central level

C12.2Obs	Is there a focal unit for surveillance at the MOH central level?	Yes	No
	[Observe organogramme of MoH to confirm]	Unknown	Not applicable

I. Opportunities for integration

C13T	What opportunities are there for integration of surveillance activities and functions (core activities, training, supervision, guidelines, resources etc.)?

DISTRICT (INTERMEDIATE LEVEL) QUESTIONNAIRE

Assessment team:

District:

Date:

Region/Area:

Interviewer:

Country:



I. Percent of districts with available national surveillance manual

D0.1 Is there a national manual for surveillance at this site?

D0.1Obs Observe national surveillance manual

I. Case confirmation

I. Percent of districts that have the capacity to transport specimens to a higher level lab

D1.1	Does the district have the capacity to transport specimens to a higher level lab?	Yes	No
		Unknown	
		Not applicable	

I. Percent of districts with guideline for specimen collection, handling and transportation to next level

D1.2	Does the district have guidelines for specimen collection, handling and transportation to the next level?	Yes	No
		Unknown	
		Not applicable	

II. Data reporting

I. Percent of sites that have forms recommended for the country for that site at all times over the past 6 months

D2.1	Have you lacked forms recommended for the country at any time during the last 6 months?	Yes	No
		Unknown	
		Not applicable	

I. Percent of health facilities that reported each reporting period to the district level during the past 3 months

Number of reports received in the last 3 months compared to expected number

D2.21 Weekly: /12 times the number of health facilities

D2.22 Monthly: /3 times the number of health facilities

I. On time (use national deadlines)						
D2.31	Number of weekly reports submitted on time:			/12 times the number of health facilities		
D2.32	Number of monthly reports submitted on time:			/3 times the number of health facilities		
I. Percent of districts that reported each reporting period to the next higher level during the past 3 months						
Number of reports in the last 3 months compared to expected number						
D2.41	Weekly:			/12 times the number of health facilities		
D2.42	Monthly:			/3 times the number of health facilities		
I. On time (use national deadlines)						
D2.51	Number of weekly reports submitted on time:			/12 times the number of health facilities		
D2.52	Number of monthly reports submitted on time:			/3 times the number of health facilities		
I. Percent of districts that have means for reporting to next level by e-mail, telephone, fax or radio						
D2.6	How do you report:					
	Mail	Fax	Telephone	Radio	Electronic	Other
I. Strengthening reporting						
How can reporting be improved?						
D2.7T						
III. Data analysis						
I. Percent of sites that:						
Describe data by person (case based, outbreaks, sentinel)						
D3.1Obs	Observed description of data by age and sex			Yes	No	
				Unknown		
				Not applicable		
I. Describe data by place						
D3.2Obs	Observed description of data by place (locality, village, work site etc)			Yes	No	
				Unknown		
				Not applicable		
I. Describe data by time						
D3.3Obs	Observed description of data by time			Yes	No	
				Unknown		
				Not applicable		
I. Perform trend analysis						
D3.4Obs	Observed line graph of cases by time			Yes	No	
				Unknown		
				Not applicable		
D3.4T	List:					

I. Have an action threshold for each priority disease			
D3.41	Do you have an action threshold for any of the country priority diseases?	Yes Unknown Not applicable	No
D3.42	<i>If yes, what is it?</i> (Ask for 2 priority diseases)	cases	% increase rate
D3.51N	Eradication		
D3.52N	Epidemic prone		
I. Have appropriate denominators			
D3.6Obs	Observed presence of demographic data at site (E.g. population <5 yr. population by village, total population)	Yes Unknown Not applicable	No
I. Use appropriate source of denominators			
D3.7T	What is the source of your denominator?		
I. Percent of sites that compare current with previous incidence for early detection of epidemics			
D3.8Obs	Observed visible line graph of cases by time for epidemic prone diseases	Yes Unknown Not applicable	No
D3.8T	List:		
IV. Outbreak investigation			
I. Percent of suspected outbreaks that were investigated in the past year			
D4.1N	Number of outbreaks suspected in the past year		
D4.1Obs	Of those, number investigated (Observe reports and take copies if possible)		
I. Percent of districts that have ever conducted an outbreak investigation			
[Number of districts assessed that have ever conducted an outbreak investigation Number of districts assessed to obtain indicator]			
D4.2	Has your district ever investigated an outbreak?	Yes Unknown Not applicable	No
I. Of districts that investigated an outbreak, percent that looked for risk factors			
D4.3N	Number of districts that looked for risk factors [observe in reports]		
I. Of districts that investigated an outbreak, percent that used the data for action (action include containing outbreak, improving surveillance, community actions)			
D4.4N	Number of districts that used the data for action [observe in final report]		
V. Epidemic preparedness			
I. Percent of districts that have a plan for epidemic preparedness and response			
D5.1Obs	Observed a written plan of epidemic preparedness and response		

I. Percent of districts that have emergency stocks of drugs and supplies at all times in past 1 year

D5.2 Has the district had emergency stocks of drugs and supplies at all times in past 1 year?

D5.2Obs Observed the stocks of drugs and supplies at time of assessment

Yes No
Unknown
Not applicable

List what is available:

I. Percent of districts that experienced a shortage of drugs, vaccines or supplies during the most recent epidemic (or outbreak)

D5.3 Has the district experienced shortage of drugs, vaccines or supplies during the most recent epidemic (or outbreak)?

Yes No
Unknown
Not applicable

I. Presence of a budget line for epidemic response or access to funds for epidemic response

D5.4 Is there a budget line or access to funds for epidemic response?

Yes No
Unknown
Not applicable

I. Percent of districts that have an epidemic management committee

D5.5Obs Observed minutes (or report) of meetings of epidemic management committee

Yes No
Unknown
Not applicable

I. Percent of districts that have rapid response team for epidemics

D5.6 Does the district have a rapid response team for epidemics?

Yes No
Unknown
Not applicable

VI. Responses

I. Percent of sites that implemented prevention and control measures based on local data for at least one reportable disease or syndrome

D6.1 Has the district implemented prevention and control measures based on local data for at least one reportable disease or syndrome?

Yes No
Unknown
Not applicable

I. Percent of districts that responded within 48 hours of notification of most recently reported outbreak

D6.2Obs Observed that the district responded within 48 hours of notification of most recently reported outbreak (from written reports)

Yes No
Unknown
Not applicable

I. Percent of districts that achieved acceptable case fatality rates (e.g. 10% for Meningococcal CSM 1% for Cholera) during the most recent outbreak

D6.3Obs Observed that the district achieved an acceptable case fatality rate for most recent outbreak (Observe from outbreak report)

Yes No
Unknown
Not applicable

I. Percent of districts that have performed mass vaccination (meningitis and yellow fever) campaign coverage evaluations

D6.41	Has the district ever performed mass vaccination campaigns?	Yes	No
		Unknown	
		Not applicable	
D6.42Obs	If yes, has the district ever calculated vaccination coverage? (observe report to confirm)	Yes	No
		Unknown	
		Not applicable	

I. Percent of epidemic management committees that have evaluated their preparedness and response activities during the past year

D6.5Obs	Has epidemic management committee evaluated their preparedness and response activities during the past year? (observe written report to confirm)	Yes	No
		Unknown	
		Not applicable	

VII. Feedback

I. Percent of sites that have written report that is regularly produced to disseminate surveillance data

D7.1N	How many feedback written reports has the district produced in the last year?		
D7.1Obs	Observed the presence of a written report that is regularly produced to disseminate surveillance data (district and higher)	Yes	No
		Unknown	
		Not applicable	

I. Percent of sites that have received a report or bulletin from a higher level during the past year on the data they have provided

D7.2N	How many feedback bulletin or reports has the district received in the last year?		
D7.2Obs	Observed at least 1 report or bulletin at district from a higher level during the past year on the data they have provided	Yes	No
		Unknown	
		Not applicable	

VIII. Supervision

I. Percent of individuals supervised in the past 6 months

D8.1N	How many times have you been supervised in the last 6 months?		
D8.1Obs	Observed supervision report or any evidence of supervision in last 6 months		

I. Of those supervised in the previous 6 months, percent of individuals for which the supervisor from the next higher level reviewed surveillance practices appropriate to their level

D8.2Obs	Observed supervision report or any evidence for appropriate review of surveillance practices		

I. Percent of supervisors that made the required number of supervisory visits in the past 6 months

D8.31N	How many supervisory visits have you made in the last 6 months?		
D8.32N	(Obtain required number of visits from central level)		

The most usual reasons for not making all required supervisory visits. (Text)

D8.41T Reason 1

D8.42T Reason 2

D8.53T Reason 3

IX. Training

I. Percent of health personnel (in position of responsibility) trained in disease surveillance

D9.1 Have you been trained in disease surveillance? Yes No
 Unknown
 Not applicable

D9.1T *If yes, specify when, where, how long, by whom?*

I. Proportion of districts with staff trained in surveillance and epidemic management

D9.2 What percent of your personnel in the district have been trained in surveillance and epidemic management

D9.2N

I. Percent of health personnel (in position of responsibility) that have received post-basic training in disease surveillance

D9.3 Have you received any post-basic training in disease surveillance? Yes No
 Unknown
 Not applicable

D9.3T *If yes, specify when, where, how long, by whom?*

I. Percent of health personnel that have received post-basic training in epidemic management

D9.4 Have you received any post-basic training in epidemic management? Yes No
 Unknown
 Not applicable

D9.4T *If yes, specify when, where, how long, by whom?*

X. Resources

I. Percent of sites that have:

Logistics

☒ Electricity
☒ Bicycles
☒ Motor cycles
☒ Vehicles

Data management

☒ Stationery
☒ Calculator
☒ Computer
☒ Printer
☒ Statistical package

Communication						
☒	Telephone service					
☒	Fax					
☒	CB radio					
☒	Computers that have modems					
Information education and communication materials						
☒	Posters					
☒	Megaphone					
☒	Flipcharts or Image box					
☒	VCR and TV set					
☒	Generator					
☒	Screen					
☒	Projector (Movie)					
☒	Other:					
Hygiene and sanitation materials						
☒	Spray pump					
☒	Disinfectant					
Protection materials (list)						
Logistics		(Yes = Y No = N Unknown = U Not applicable = N/A)				Number if applicable
☒ Electricity	D10.1	Y	N	U	N/A	
☒ Bicycles	D10.2	Y	N	U	N/A	D10.2N
☒ Motor cycles	D10.3	Y	N	U	N/A	D10.3N
☒ Vehicles	D10.4					D10.4N
Data management						
☒ Stationery	D10.5	Y	N	U	N/A	
☒ Calculator	D10.6	Y	N	U	N/A	D10.6N
☒ Computer	D10.7	Y	N	U	N/A	D10.7N
☒ Printer	D10.8	Y	N	U	N/A	D10.8N
☒ Statistical package	D10.9	Y	N	U	N/A	
Communications						
☒ Telephone service	D10.10	Y	N	U	N/A	
☒ Fax	D10.11	Y	N	U	N/A	
☒ Radio call	D10.12	Y	N	U	N/A	
☒ Computers that have modems	D10.13	Y	N	U	N/A	D10.13N
Information education and communication materials						
☒ Posters	D10.14	Y	N	U	N/A	
☒ Megaphone	D10.15	Y	N	U	N/A	
☒ Flipcharts or Image box	D10.16	Y	N	U	N/A	
☒ VCR and TV set	D10.17	Y	N	U	N/A	
☒ Generator	D10.18	Y	N	U	N/A	
☒ Screen	D10.19	Y	N	U	N/A	
☒ Projector (Movie)	D10.20	Y	N	U	N/A	
☒ Other:	D10.21T	Y	N	U	N/A	

Hygiene and sanitation materials

X Spray pump	D10.22	Y	N	U	N/A
X Disinfectant	D10.23	Y	N	U	N/A
X Protection materials (list)	D10.24T	Y	N	U	N/A

XI. Surveillance co-ordination
I. Existence of a surveillance co-ordination focal unit or person at district level

D11.1 Is there a surveillance co-ordination focal point within the district epidemic management committee?

XII. Satisfaction with surveillance system
I. Satisfaction with the surveillance system

D12.1 Are you satisfied with the surveillance system? Yes No
 Unknown
 Not applicable

D12.1T If no, how can the surveillance system be improved?

I. Opportunities for integration

D13T What opportunities are there for integration of surveillance activities and functions (core activities, training, supervision, guidelines, resources etc.)

HEALTH FACILITY QUESTIONNAIRE

Identifiers

Assessment team:	Type of Health Facility:
Date:	District:
Interviewer:	Region/Province:
	Chiefdom:
Name of Health Facility:	

I. Percent of health facilities with national surveillance manual

HF0.1 Is there a national manual for surveillance at this site?

HF0.1Obs Observe national surveillance manual

I. Case detection and registration

I. Percent of health facilities that have a clinical register

HF1.1Obs Observed the existence of a clinical register	Yes	No
	Unknown	
	Not applicable	

I. Percent of health facilities that correctly register cases

HF1.2Obs Observed the correct filling of the clinical register during the previous 30 days	Yes	No
	Unknown	
	Not applicable	

I. Percent of health facilities that have standardised case definitions for the country's priority diseases

HF1.3 Do you have a standard case definition for: (each priority disease)?	Yes	No
	Unknown	
	Not applicable	

HF1.3Obs Observed the standard case definition for: (each priority disease)	Yes	No
	Unknown	
	Not applicable	

I. Percent of health facilities that use standardised case definitions for the country's priority diseases

HF1.4Obs Observed the respondent correctly diagnosing one of the country's priority diseases using a standard case definition	Yes	No
	Unknown	
	Not applicable	

(Select one of the priority diseases in the facility's clinical register and ask how they diagnosed it — interviewer should have the standard case definition from MOH)

II. Case confirmation *

I. Percent of health facilities that have the capacity to collect specimens (sputum stool, blood/serum and CSF)

HF2.1	Are you able to collect sputum	Y	N	U	N/A
	Stool	Y	N	U	N/A
	Blood	Y	N	U	N/A
	CSF at this facility?	Y	N	U	N/A
HF2.1Obs	Observed the presence of materials required to collect	Y	N	U	N/A
	Stool	Y	N	U	N/A
	blood/serum	Y	N	U	N/A
	CSF	Y	N	U	N/A

I. Percent of health facilities that have the capacity to handle specimens until shipment

HF2.2	Do you have the capacity to handle sputum, stool, blood/serum and CSF until shipment at this facility?	Yes Unknown Not applicable	No
HF2.2Obs	Observed presence of functional cold chain at health facility	Yes Unknown Not applicable	No

I. Percent of health facilities that have the capacity to ship specimens to a higher level lab

HF2.3Obs	Observed presence of transport media for stool at health facility	Yes Unknown Not applicable	No
HF2.4Obs	Observed presence of packing materials for shipment of specimens at health facility	Yes Unknown Not applicable	No

III. Data reporting

I. Percent of sites that have appropriate surveillance forms for that site at all times over the past 6 months

HF3.1	Have you lacked appropriate surveillance forms at any time during the last 6 months?	Yes Unknown Not applicable	No

I. Percent of sites that reported accurately cases from the registry into the summary report to go to higher level

Observed that the last monthly report agreed with the register for 4 diseases (1 for each targeted group [eradication; elimination; epidemic prone; major public health importance])

HF3.21Obs	Eradication	Y	N	U	N/A
HF3.22Obs	Elimination	Y	N	U	N/A
HF3.23Obs	Epidemic prone	Y	N	U	N/A
HF3.24Obs	Major Public Health Importance	Y	N	U	N/A

May have to develop table for the diseases

I. Percent of sites that reported each reporting period to the next higher level during the past 3 months

Number of reports in the last 3 months compared to expected number

HF3.31Obs Weekly: /12 times the number of sites

HF3.32Obs Monthly: /3 times the number of sites

I. On time (use national deadlines)

HF3.41Obs Number of weekly reports submitted on time: /12 times the number of sites

HF3.42Obs Number of monthly reports submitted on time: /3 times the number of sites

I. Percent of HF that have means for reporting to next level by e-mail, telephone, fax or radio

HF3.5 How do you report:

Mail	Fax	Telephone	Radio	Electronic	Other

I. Strengthening reporting

How can reporting be improved?

HF3.6T

IV. Data analysis
I. Percent of sites that:

Describe data by person (outbreaks, sentinel)

HF4.1Obs Observed description of data by age and sex	Yes	No
	Unknown	
	Not applicable	

I. Describe data by place

HF4.2Obs Observed description of data by place (locality, village, work site etc)	Yes	No
	Unknown	
	Not applicable	

I. Describe data by time

HF4.3Obs Observed description of data by time	Yes	No
	Unknown	
	Not applicable	

I. Perform trend analysis

HF4.4Obs Observed line graph of cases by time	Yes	No
	Unknown	
	Not applicable	

I. Have an action threshold for each priority disease

HF4.5 Do you have an action threshold for any of the country priority diseases?	Yes	No
	Unknown	
	Not applicable	

H4.50	<i>If yes, what is it?</i> (Ask for 2 priority diseases)	cases	% increase	rate
HF4.51N (Eradication)				
HF4.52N (Epidemic prone)				
I. Have appropriate denominators				
HF4.6Obs	Observed presence of demographic data at site (E.g. population <5 yr., population by village, total population)	Yes Unknown Not applicable	No	
I. Use appropriate denominators				
HF4.7Obs	Observed rates derived from demographic data	Yes Unknown Not applicable	No	
I. Use appropriate source of denominators				
HF4.8T	What is the source of your denominator?			
V. Epidemic preparedness				
I. Percent of health facilities that have a standard case management protocol for epidemic prone diseases				
HF5.1Obs	Observed the existence of a written case management protocol for 1 epidemic prone disease	Yes Unknown Not applicable	No	
VI. Epidemic response				
I. Percent of sites that implemented prevention and control measures based on local data for at least one epidemic prone disease				
HF6.1	Has the health facility implemented prevention and control measures based on local data for at least one epidemic prone disease?	Yes Unknown Not applicable	No	
I. Percent of sites that achieved acceptable case fatality rates (e.g. 10% for Meningococcal CSM 1% for Cholera) during the most recent outbreak				
HF6.2Obs	Observed that the health facility achieved an acceptable case fatality rate for most recent outbreak	Yes Unknown Not applicable	No	
VII. Feedback				
I. Percent of sites that have received a report or bulletin from a higher level during the past year on the data they have provided				
HF7.1	How many feedback bulletin or reports has the health facility received in the last year?			
HF7.1Obs	Observed at least 1 report or bulletin at the health facility from a higher level during the past year on the data they have provided	Yes Unknown Not applicable	No	

I. Percent of health facilities that conducted at least semi-annual meetings with community members to discuss results of surveillance or investigation data

HF7.2 How many meetings has this health facility conducted with the community members in the past six months?

HF7.2Obs Observed the minutes or report of at least 1 meeting between the health facility team and the community members within the six months	Yes	No
	Unknown	
	Not applicable	

HF8.1 How many times have you been supervised in the last 6 months?

HF8.1Obs Observed supervision report or any evidence of supervision in last 6 months	Yes	No
	Unknown	
	Not applicable	

I. Of those supervised in the previous 6 months, percent of individuals for which the supervisor from the next higher level reviewed surveillance practices appropriate to their level

HF8.2Obs Observed supervision report or any evidence for appropriate review of surveillance practices	Yes	No
	Unknown	
	Not applicable	

management

HF9.1 Have you been trained in disease surveillance and epidemic management?	Yes	No
	Unknown	
	Not applicable	

HF9.1T *If yes, specify when, where, how long, by whom?*

Logistics

☒ Electricity

☒ Bicycles

☒ Motor cycles

☒ Vehicles

Data management

☒ Stationery

☒ Calculator

☒ Computer

☒ Software

☒ Printer

☒ Statistical package

Communications

☒ Telephone service

☒ Fax

☒ Radio call

☒ Computers that have modems

Information education and communication materials						
☒ Posters ☒ Megaphone ☒ Flipcharts or Image box ☒ VCR and TV set ☒ Generator ☒ Screen ☒ Projector (Movie) ☒ Other:						
Hygiene and sanitation materials						
☒ Spray pump ☒ Disinfectant						
Protection materials (list)						
Logistics	(Yes = Y No = N Unknown = U Not applicable = N/A)					Number if applicable
☒ Electricity	HF10.1	Y	N	U	N/A	
☒ Bicycles	HF10.2	Y	N	U	N/A	HF10.2N
☒ Motor cycles	HF10.3	Y	N	U	N/A	HF10.3N
☒ Vehicles	HF10.4	Y	N	U	N/A	HF10.4N
Data management						
☒ Stationery	HF10.5	Y	N	U	N/A	
☒ Calculator	HF10.6	Y	N	U	N/A	HF10.6N
☒ Computer	HF10.7	Y	N	U	N/A	HF10.7N
☒ Printer	HF10.8	Y	N	U	N/A	HF10.8N
☒ Statistical package	HF10.9	Y	N	U	N/A	
Communications						
☒ Telephone service	HF10.10	Y	N	U	N/A	
☒ Fax	HF10.11	Y	N	U	N/A	
☒ Radio Call	HF10.12	Y	N	U	N/A	
☒ Computers that have modems	HF10.13	Y	N	U	N/A	
Information education and communication materials						
☒ Posters	HF10.14	Y	N	U	N/A	
☒ Megaphone	HF10.15	Y	N	U	N/A	
☒ Flipcharts or Image box	HF10.16	Y	N	U	N/A	
☒ VCR and TV set	HF10.17	Y	N	U	N/A	
☒ Generator	HF10.18	Y	N	U	N/A	
☒ Screen	HF10.19	Y	N	U	N/A	
☒ Projector (Movie)	HF10.20	Y	N	U	N/A	
☒ Other:	HF10.21T	Y	N	U	N/A	
Hygiene and sanitation materials						
☒ Spray pump	HF10.22	Y	N	U	N/A	
☒ Disinfectant	HF10.23	Y	N	U	N/A	
☒ Protection materials (list)	HF10.24T	Y	N	U	N/A	

XI. Satisfaction with surveillance system

I. Satisfaction with the surveillance system

HF11.1 Are you satisfied with the surveillance system? Yes No
Unknown
Not applicable

HF11.1T *If no*, how can the surveillance system be improved?

I. Opportunities for integration

HF12T What opportunities are there for integration of surveillance activities and functions (core activities, training, supervision, guidelines, resources etc.)

LABORATORY ASSESSMENT

LABORATORY ASSESSMENT TOOL

Checklist for diagnostic laboratory assessment

Name of the laboratory	
Address of the laboratory Telephone/fax/e-mail	
Level of the laboratory	Health Facility Provincial/District/Regional National
Affiliation of the Laboratory (more than one may be applicable, e.g. Private and Academic)	
Public Private Academic Institution NGO or Religious Institution	

How is the state of the building	good	medium	poor
Is the laboratory in a free-standing building	or part of larger structure		
Does the laboratory perform tests for:			
Bacteriology	Yes	No	
Virology	Yes	No	
Mycobacteriology	Yes	No	
Parasitology	Yes	No	
Mycology	Yes	No	
Cell culture facility?	Yes	No	
Is the laboratory connected to hospital service?	Yes	No	
How many rooms with bench space are there in the laboratories checked above?	Number:		
What % of the working day do you have the following services available?			
Electricity	<50%	50-95%	95-100%
Running water	<50%	50-95%	95-100%
Gas (including bottled)	<50%	50-95%	95-100%

Is there a back-up power source in case of power failure (e.g. emergency generator)?	Yes	No
<i>If yes, what systems are protected?</i>		
Refrigerators/freezers	Yes	No
Ventilation/AC	Yes	No
Computers	Yes	No
Other	Yes	No
	Not applicable	
What ventilation is provided?		
Windows	Yes	No
Electrically-powered ventilation (exhaust, not fans) system or air-conditioning	Yes	No
What types of communications systems are available?	all applicable	
Post	Yes	No
Telephone	Yes	No
Fax	Yes	No
Satellite phone	Yes	No
E-mail (no. computers)	Yes	No
Internet (no. computers)	Yes	No
	Number	

Refrigerator	Yes	No
Freezing at -20°C	Yes	No
Freezing at -70°C	Yes	No
Microscope with oil-immersion objective	Yes	No
Slides and coverslips	Yes	No
Scale or balance	Yes	No
Candle jars	Yes	No
Other Anaerobe jar	Yes	No
Magnifying lens	Yes	No
Loop/needle handles	Yes	No
0.01 and 0.001ml calibrated loops	Yes	No
Bunsen burner	Yes	No
If no Bunsen burner, Electric heater or alcohol lamp to sterilise loops and needles	Yes	No
Petri dishes (glass)	Yes	No
Petri dishes (disposable)	Yes	No
Test tube racks	Yes	No
Staining facilities-sink and slide rack	Yes	No
Adequate glassware for media preparation (flasks, graduated cylinders, etc.)	Yes	No
Wash bottles	Yes	No
pH paper	Yes	No
pH meter	Yes	No
Manual pipettes (e.g. Eppendorf)	Yes	No
Water distillation system	Yes	No

Type and number of items available in your laboratory	Present		Number
Low-speed centrifuge (hand or electrically powered)	Yes	No	
Autoclave - manually controlled	Yes	No	
Autoclave - electrically controlled	Yes	No	
Hot air oven	Yes	No	
Inverted microscope	Yes	No	
Fluorescent microscope	Yes	No	
Electron microscope	Yes	No	
ELISA plate reader	Yes	No	
Electrically-powered waterbath	Yes	No	
Warm air incubator	Yes	No	
CO ₂ incubator	Yes	No	
CO ₂ tanks	Yes	No	
Liquid nitrogen storage	Yes	No	
ELISA washer	Yes	No	
Safety cabinet- level 1 (operator protection. Open-fronted, unrecirculated airflow away from operator)	Yes	No	
Safety cabinet- level 2 (protects operator and material from contamination. Open fronted, filtered supply and exhaust air)	Yes	No	
Safety cabinet- level 3 (protects operator, material and environment from contamination-enclosed, negative pressure, HEPA filtered air supply and exhaust)	Yes	No	
Are all equipment functioning? (Ask this question after each equipment item, if response is NO, record below)	Yes	No	
If no, what items of equipment are not functioning?			

Laboratory staff and supervision for all microbiology and serology labs

Number of staff in each category	Number		% of staff available in lab
Supervisors — Medical/Scientific			
Supervisors — Technical			
Technologist/Technical (doing tests)			
Laboratory assistants (not doing tests)			
Clerical			
What is the highest level of microbiology training achieved by technical staff performing diagnostic tests? (state number of staff for each option)			
In-laboratory training only			
Diploma course or specific training course			
Degree level			
Other (briefly describe):			
Has training been conducted for your laboratory staff in the past year?	Yes	No	

Number of staff in each category	Number		% of staff available in lab
<i>If yes, indicate the type of training and the number of staff trained</i>			
Formal training at national lab	Yes	No	
Formal training on-site	Yes	No	
International training	Yes	No	
Laboratory staff supervision			
Who usually decides which tests to perform when the samples first arrive in the laboratory?			
The requesting clinician	Yes	No	
The technician	Yes	No	
Microbiologist/supervisor	Yes	No	
Laboratory protocol	Yes	No	
Who makes decisions about further testing if indicated?			
The technician	Yes	No	
Microbiologist/supervisor	Yes	No	
Are ALL tests reviewed before results sent for reporting?	Yes	No	
<i>If yes, who reviews the results of tests (or test runs)?</i>			
Only the technician performing the test	Yes	No	
Another member of the technical staff	Yes	No	
A supervisor/medical microbiologist	Yes	No	
Are ALL tests reviewed before results sent for reporting?	Yes	No	
<i>If yes, who reviews the final report before it is sent to the requesting clinician or other appropriate recipient?</i>			
Only the technician performing the test	Yes	No	
Another member of the technical staff	Yes	No	
A supervisor/medical microbiologist	Yes	No	

A commercial supplier	%	
From another laboratory	%	
Prepared in-house	%	
What type of water is used for preparation of media and reagents?		
Deionized	Yes	No
Distilled	Yes	No
Distilled and deionized	Yes	No
Tap water	Yes	No

Tests performed at the laboratory

The following table lists a number of diseases and diagnostic tests. Please note which tests are performed in your laboratory. For each disease, note whether or not you test any of the named specimens by any of the listed tests. (If you do not perform any tests for meningitis, for example, in the "No" column for all. If you perform a Gram stain on CSF for meningitis, but none of the other tests, in the "Yes" column for Gram stain, and "No" for the other meningitis tests.) Please give the approximate number/month of each test you perform.

Disease	Specimen type	Assay Performed	Yes	No	Number/ Month
Meningitis	CSF <i>S. pneumoniae</i> <i>N. meningitidis</i> <i>H. influenzae</i> Blood	a. Cell count b. Latex agglutination c. Gram stain d. Culture e. Identification tests f. A-M susceptibility Optochin disks Sugar fermentations X, V, XV factors Blood Culture and tests b, e, f above			
Dysentery	Faeces	Microscopy of wet preparation Culture Identification tests A-M susceptibility			
Watery diarrhea (cholera)	Faeces	Microscopy of wet preparation Culture-TCBS Culture-Alk. Peptone Serotyping			
Plague	Bubo aspirate, sputum, blood	Stain Culture A-M susceptibility			
Tuberculosis	Sputum, CSF	Z-N staining Rhodamine/Auramine staining and fluorescent microscopy Culture A-M Susceptibility			
Malaria	Blood	Thick/Thin film microscopy			

Measles	Serum Throat swab, conjunctival swab	IgM by EIA Other serological test Virus isolation			
Yellow fever	Serum Blood, post-mortem liver	IgM Virus isolation			
FUO/PUO (suspect typhoid or brucellosis)	Blood, faeces Serum	Culture Identification tests A-M susceptibility Serological tests (Widal, brucella agglutinins)			
Hepatitis	Serum	Anti-HAV IgM Anti-HBc IgM Anti-HbsAg Anti-HCV IgM Anti-HEV IgG			
Viral haemorrhagic fevers (any)	Serum Serum, other tissue specimens	IgM Virus detection			
Acute flaccid paralysis	Faeces	Virus isolation Virus typing			
HIV	Serum Blood	IgG by EIA Viral load Virus isolation			

Number of days per week	<5	5	6	7	
Hours per day	<6	6-10	11-23	24	
If no 24-hour service, is out-of-hours or emergency service available?					Yes No
If there is 24-hour service, number of staff at the following times:					Number
5 PM to 12 AM					
12 AM to 7 AM					
How does the laboratory inform existing or potential clients about the services it offers?					
Verbally only (informal)					Yes No
Printed list/Brochure					Yes No
Does the technical staff have access to typed or written protocols (Standard Operating Procedures) for performing each test?					Yes No

Specimen collection, labelling and handling

Proportion of samples collected on site	<20%	20-50%	50-80%	>80%
Does the laboratory use standardised request forms to order laboratory tests?			Yes	No
Do request forms contain ALL of the following patient information: specimen source, date and time of collection, type of test requested?			Yes	No
Do request forms provide details or a link which enable the lab to contact the patient?			Yes	No
Are specimens that are received labelled with the patient's name and unique identifiers?			Yes	No
Does the laboratory provide a unique accession number for all specimens?			Yes	No
Does the laboratory have a logbook/electronic record of all specimens sent for diagnostic testing?			Yes	No
Are specimens discarded after testing, or are they stored?			Discarded	Stored
Are standard criteria used for discarding specimens with prolonged transit times (time of collection to time of processing in lab)?			Yes	No
Does the laboratory during evening/night shifts accept specimens?			Yes	No
<i>If yes, how are the following samples handled?</i>				
Specimen	Plated immediately		<i>If no, held at (one)</i>	
CSF	Yes	No	4° Ambient temp.	
Blood culture	Yes	No	35° 4° Ambient temp.	
Urine	Yes	No	35° 4° Ambient temp.	
Does your laboratory refer bacteriology isolates or serum samples to the Ministry of Health or a reference laboratory?			Yes	No
<i>If yes, reason for referral (all)</i>				
Confirmation			Yes	No
Identification of unknown organism			Yes	No
Test not performed on site			Yes	No
<i>If yes, then by what method?</i>				
By regular post service			Yes	No
By special messenger			Yes	No
Courier service			Yes	No
Other (describe):				
<i>If yes, number of sample sent per month?</i>				
Types of transport media used (all that apply)				
Trans-isolate			Yes	No
Amies			Yes	No
Stuart			Yes	No
Cary and Blair			Yes	No
Blood agar slants			Yes	No
Viral transport medium			Yes	No
Other (describe):				

Reporting procedures		
Are records kept of the number and type of tests performed and results?	Yes	No
Does the laboratory use standardised forms to report lab results?	Yes	No
Does the laboratory have a list of diseases that are supposed to be reported to the Ministry of Health?	Yes	No
<i>If no</i> , does the lab staff know what diseases should be reported?	Yes	No
Does the lab provide regular reports of patients with notifiable diseases to any of the following Ministry of Health offices/institutions? (all that apply)		
District Health Office	Yes	No
State Health Office	Yes	No
Central Laboratory	Yes	No
National Communicable Disease Program	Yes	No
If reports are submitted, how frequently?		
Weekly	Yes	No
Monthly	Yes	No
Quarterly	Yes	No
Other	Yes	No
If reports are submitted, by what means are they sent?		
Line list	Yes	No
Telephone	Yes	No
FAX	Yes	No
Other (describe):		
Do you keep register of persons with notifiable diseases?	Yes	No
<i>If yes</i> , is the register computerised?	Yes	No
If computerised, are back-up copies (hard copies or disc) of data made and archived?	Yes	No
Quality control procedures and programs		
Is information gathered about laboratory turn-around times for specimens (time from receipt of specimen to issue of the report)?	Yes	No
Does the laboratory use any system for internal quality control?	Yes	No
Are internal controls included in each test run?	Yes	No
<i>If yes</i> , is the performance of these internal controls recorded and monitored over time?	Yes	No
Does the laboratory participate in any external quality assurance or proficiency schemes?	Yes	No
<i>If yes</i> , what programs?		
Bacteriology unknowns	Yes	No
HIV/Hepatitis panels	Yes	No
Antimicrobial susceptibility	Yes	No
Other (specify)	Yes	No

Does your laboratory keep records of deliveries of reagents and materials?	Yes	No
Does your laboratory have a system for regularly monitoring of quantities of reagents and materials so that there is warning if stocks become low?	Yes	No
Does the laboratory have problems obtaining and maintaining most supplies of essential reagents and materials?	Yes	No
<i>If yes, what is the most important reason for not maintaining an adequate stock of reagents and supplies?</i>		
Information about how to obtain materials	Yes	No
Long delay ordering and delivery of materials	Yes	No
Lack of funds	Yes	No
Inconsistent demand for test from physicians	Yes	No
Is the functioning of ALL electrical or mechanical equipment routinely monitored and recorded (e.g. microscope calibration, checking temperatures of refrigerators or incubators, calibration of pipettes or handling devices, autoclave function, etc.)?	Yes	No
Are calibration, maintenance and service records kept?	Yes	No
Safety		
Does the laboratory staff receive training in laboratory safety?	Yes	No
Is there a safety manual easily accessible to the laboratory the staff?	Yes	No
What methods are used for solid waste disposal?		
Autoclaving	Yes	No
Incineration	Yes	No
Burial with no pre-treatment	Yes	No
Other (briefly describe):		
What methods are used for liquid waste disposal?		
No treatment	Yes	No
Autoclaving	Yes	No
Chemical disinfection	Yes	No
Other (briefly describe):		
Is there a safety officer	Yes	No
Is there a safety SOP	Yes	No
Are new staff offered immunisation	Yes	No
What protective clothing/equipment is available for laboratory staff? (all)		
Gloves - latex	Yes	No
Gloves - other	Yes	No
Lab coats	Yes	No
Safety glasses/visors	Yes	No
Other (briefly describe):		
Are gloves worn for all manipulations of specimens, organisms, and reagents?	Yes	No
<i>If yes, type of gloves</i>		

Latex	Yes	No	
Other	Yes	No	
<i>If no</i> , are they worn			
Only for designated procedures OR	Yes	No	
By the decision of the technician performing a test?	Yes	No	
If the respondent has said YES to any question for Antimicrobial (A-M) susceptibility testing, please indicate which method was used:			
Disk diffusion	Yes	No	
Agar dilution	Yes	No	
Broth dilution	Yes	No	
E-Test	Yes	No	
Any anti-TB susceptibility testing method	Yes	No	
Do use any internationally recognised standards for definitions of resistance/susceptibility (e.g., NCCLS, Stokes, DIN, SGRA)	Yes	No	
<i>If yes</i> , then which one(s)?			
If the laboratory performs tests for any sexually transmitted diseases, e.g. syphilis, gonorrhoea, chancroid, please enter the information in the following table			
Disease	Specimen type	Assay performed	Number/Month
If the laboratory performs any other virological assays using enzyme immunoassay, other serological assays, virus isolation or detection (including molecular tests, e.g., PCR), please list on the table below. Please append sheet if too numerous to fit on table			
Disease	Specimen type	Assay performed	Number/Month

LABORATORY INSPECTION

Laboratory Inspection

Inspect the laboratory and complete the following form. Be courteous by first asking permission to open refrigerators, freezers, media storage closets and incubators to examine items contained therein. Some of the information collected during a walk-through will be used to verify information provided on the questionnaire. Make additional Notes as required, e.g. general cleanliness and organization of the laboratory, staff activity level, workload (specimens and inoculated plates present), and special facilities. Obtain copies of standard forms where indicated.

Accessioning and reporting

Review accessioning logbook(s) if available. Roughly calculate the number of specimens submitted over a one-month period. Record number: <i>samples/month</i>				
Review forms submitted with specimens. What proportion of specimens received are labelled with the patient's name and unique identifiers?			<50%	> 50%
Are copies of report forms available?			Yes	No
<i>If yes</i> , obtain copies of standardised reports forms that are used				
Manuals				
Type of manual	Available		Date of last revision	
Test Procedures	Yes	No	< 1 year >5 years	2-5 years no date
Safety	Yes	No	< 1 year > 5 years	2-5 years no date
Quality control	Yes	No	< 1 year > 5 years	2-5 years no date
Equipment and reagents				
Briefly look to see if reported number and type of equipment items is consistent with those reported on the questionnaire. Are findings generally consistent with responses above?			Yes	No
Inspect equipment to see if performance indicators (e.g., temperatures) are regularly recorded				
Equipment item	Sheet present		Temps. Recorded (per cent complete)	
Refrigerators	Yes	No	0%	1-50% >50%
Freezers	Yes	No	0%	1-50% >50%
Incubators	Yes	No	0%	1-50% >50%
Inspect prepared reagents, dehydrated media, antibiotic susceptibility disks and prepared media to see if dates are recorded for the date prepared or opened and to see if expiration dates have passed.				
Proportion of reagents labelled appropriately?			None	< 50% >50%
Expiration dates found?			None	< 50% >50%
For reagents with dates - percent outdated?			None	< 50% >50%
Inspect bacteriological media, both prepared and dehydrated, and reagents for signs of deterioration, e.g. drying, discoloration, hemolysis				

/

Deterioration noted in bacteriological media	None	< 50%	>50%
Safety			
If biosafety hood is present, is it operational?	Yes	No	No hood
Is a certification/inspection sticker present?	Yes	No	Not applicable
<i>If yes</i> , date of certification?	< 1 year	>1 year	Not applicable
Inspect laboratory for presence of biosafety equipment (gloves, sharps containers, safety glasses)			
Gloves present	Yes	No	
Sharps containers	Yes	No	
What proportion of staff are wearing gloves while performing procedures?	<1-50%	>50%	Unknown
Inspect equipment used for the disposal of biological wastes, e.g. autoclaves, incinerator. Is the hazardous waste disposal system operational?	Yes	No	

A S S E S S M E N T O F

D A T A B A S E S A N D G I S R E S O U R C E S

QUESTIONNAIRE ON DATABASES AND GIS/MAPPING RESOURCES

Assessment team
Date
Country
Sector/Ministry/Agency
Address
Telephone
Fax
Email

I. General information

1. Is GIS used within your sector? Yes No
2. *If yes*, which departments/programmes are using GIS, for what purpose and at what level?

PROBE

For each sector, ask what the system is being used for (e.g., assessing spatial distribution by region of a disease; monitoring results of disease surveillance; planning/targeting interventions etc.)

Specifically ask at what level the GIS is operational (e.g., region, district, village etc.).

Name of Department	Purpose of GIS	Level (e.g. National, district, village, health facility level)

II. Digitised basemap

1. Are digitised basemaps available of administrative boundaries? Yes No

If yes, please complete the following table.

PROBE

Firstly find out the administrative structure of the country (the name and number of admin level 1, 2 etc.)

Then find out if digitised maps are available for each (often a digitised map may only be available for all of 10 Regions but only for 2 of the 20 districts)

For each variable, ask the format that in which it is available

Specifically ask for the source for each.

Administrative Boundaries	Name	Total Number	Digitised map available	Format	Source
<i>Administrative Level 1</i>					
<i>Administrative Level 2</i>					
<i>Administrative Level 3</i>					
<i>Administrative Level 4</i>					
<i>Administrative Level 5 (if exists)</i>					
<i>Health District (if different from administrative)</i>					
<i>School District (if different from administrative)</i>					

2. Are digitised basemaps available of other geographic features such as roads, rivers, elevation? Yes No
- If yes*, please complete the following table:

	Digitised map		Format	Source
	Yes	No		
<i>Road network</i>				
<i>Rivers</i>				
<i>Forest</i>				
<i>Land Use</i> (e.g. rice fields, cultivated areas, swamps etc.)				
<i>Elevation</i>				

III. Geo-referenced databases

1. Are geo-referenced village databases available? Yes No

If yes, complete the following table:

PROBE

Explain what is meant by geo-referenced village database (i.e., a database of either villages or health facilities or schools in a country with geographic coordinates for each village/facility/school)

For each indicator (villages, schools, population etc.) ask the following questions:

Ask if an official list of (villages) exist

For each indicator ask what is the year of survey or last date of update

Ask if an official code is available for each (village/school/health facility)

Specifically ask if geographic coordinates are available for each (sometimes geographic coordinates are available for only the health facilities and not all villages)

Ask if the data are available in a computerised database

Ask what is the source of each dataset

Note on *Population*; Specifically ask if population data are available for the village level (i.e., population census survey data)

Note on *Source*; If the source provided is different from the sector of the respondent) make arrangements to visit the source and administer the same questionnaire

Ask if any other *Other* information is collected with geographic coordinates that are not included in this list (for ex. Markets, dams) and obtain the same information for each additional indicator.

	Official list available		Year	Official Code Available		Geographic Coordinates Available		Exist in computerised database?		Source of data
	Yes	No		Yes	No	Yes	No	Yes	No	
Villages										
Population										
Health Facilities										
Schools										
Safe Water										
Other:										
Other:										

2. What is the procedure required to obtain a copy of part or all of the existing geo-referenced databases?

PROBE

Present again objectives of using GIS for a Multi-disease approach to surveillance and desire for co-ordinated approaches to data management and mapping

Ask how one can obtain a copy of any/part of the data available (e.g., through an official request to the Ministry or programme?)

IV. Technical/Human resources

1. If GIS is being used in your office/sector, which software is used?

Please ✓

ArcView	Idrisi
AtlasGIS	ArcInfo
MapInfo	PopMap
EpiMap	Other (Please specify)

-
2. Do you have/use GPS units
(Global Positioning Units)?
- Yes No

If yes, what data are being collected? (Please list)

-
3. How many people have been trained in GIS in your sector? Please specify discipline of persons trained and the software on which they were trained.

Number of persons trained	Discipline of persons trained	Software

4. Who is the GIS focal point in your sector/department/agency?

PROBE

Specify that the GIS focal point should be the person to contact on technical follow up activities/queries etc.

Name	
Sector	
Address	
Tel	
Fax	
Email	

-
5. Have you any further technical assistance needs in GIS/Mapping?
Please complete the table below:

	Yes Please ✓	No	<i>If yes, please provide details</i>
<i>Training in GIS use</i>			
<i>Assistance in database design/development</i>			
<i>Database standardisation</i>			
<i>GPS surveying of villages</i>			
<i>Need for basemaps of boundaries/rivers etc.</i>			
<i>Other: Specify</i>			
<i>Other: Specify</i>			

**APPENDIX E: UNICAF UNIVERSITY ZAMBIA RESEARCH EHICS APPLICATION
FORM FOR DOCTORAL STUDENTS**



REAF_DS - Version 3.1AP



**UNICAF UNIVERSITY
RESEARCH ETHICS APPLICATION FORM
DOCTORAL STUDIES**

UREC USE ONLY:

Application No:

Date Received:

Student's Name: Sulaiman Conteh**Student's E-mail Address:** conteh4722@gmail.com**Student's ID #:** R1812D7000435**Supervisor's Name:** Victor E. Adamu**University Campus:** Unicaf University Zambia (UUZ)**Program of Study:** UUZ: PhD Doctorate of Philosophy**Research Project Title:** SIERRA LEONE'S INTEGRATED DISEASE SURVEILLANCE AND RESPONSE PROGRAMME**1. Please state the timelines involved in the proposed research project:**

Estimated Start Date: 02-Jan-2021

Estimated End Date: 2-Jan-2022

2. External Research Funding (if applicable):**2.a. Do you have any external funding for your research?**
☐

YES

☒

NO

If YES, please answer questions **2b** and **2c**.

2.b. List any external (third party) sources of funding you plan to utilise for your project. You need to include full details on the source of funds (e.g. state, private or individual sponsor), any prior / existing or future relationships between the funding body / sponsor and any of the principal investigator(s) or co-investigator(s) or student researcher(s), status and timeline of the application and any conditions attached.

2.c. If there are any perceived ethical issues or potential conflicts of interest arising from applying or and receiving external funding for the proposed research then these need to be fully disclosed below and also further elaborated on, in the relevant sections on ethical considerations later on in this form.

3. The research project

3.a. Project Summary:

In this section fully describe the purpose and underlying rationale for the proposed research project. Ensure that you pose the research questions to be examined, state the hypotheses, and discuss the expected results of your research and their potential.

It is important in your description to use plain language so it can be understood by all members of the UREC, especially those who are not necessarily experts in the particular discipline. To that effect ensure that you fully explain / define any technical terms or discipline-specific terminology (use the space provided in the box).

The increase in global population and urbanization has reduced the distance between people leading to an increase in evolution of infectious disease epidemic and pandemic. The era of emerging infectious diseases have seen a huge rise in the incidence and prevalence of epidemics and pandemics like HIV, Malaria, Ebola and the current COVID 19 pandemic. The twenty first (21ST) has seen several economic loss and travel restrictions due to epidemics caused by emerging infectious diseases. The most effective strategy to prevent or control such spread of infectious disease is to rapidly detect the infection and respond to it using Integrated Disease Surveillance and Response (IDSR) strategy so that it does not spread to the rest of the world. Sierra Leone is implementing electronic IDSR programme from national through to health facility and community levels. This programme can only work at it maximum if it regularly evaluated in other to build public health emergency preparedness in Sierra Leone.

The purpose of this cross sectional study is to assess the core and support functions of the IDSR programme so as to bring out the challenges and to draw up a strategy to respond to these challenges so that it has maximum public health emergency preparedness.

The research questions are as follows:

1. What is the state of the nine core functions at all level in 2020and 2021?
2. What is the state of the six support functions at all level in 2020and 2021?
3. What is the state of the thirteen qualities of the IDSR programme?
4. Which support structures works for IDSR programme in Sierra Leone?
5. What prioritized strategies can be used by MOHS and partners to prevent the next epidemic in Sierra Leone?

The research will benefit Sierra Leone by examining the core and support functions of IDSR and suggesting review of the technical guideline to make a policy change. It prevent huge economic loss by strengthening the IDSR programme that will prevent future epidemics. It will reduce morbidity and mortality, advocate for more resources to IDSR



3.b. Significance of the Proposed Research Study and Potential Benefits:

Outline the potential significance and/or benefits of the research (use the space provided in the box).

The results of this study will be used internationally to support other countries with similar challenges to respond to their problems. A study showed numerous challenges were highlighted with core, support, structures and qualities in IDSR implementation in other countries globally and regionally. This study will propose solutions that other countries can use in their implementation.

Policy change: This study can lead to revision of the technical guidelines for IDSR so that it can be able to respond to the challenges that are seen in some of the core functions like case detection, notification, investigation, analysis, reporting, and feedback.

Economy: The huge economic loss of developmental activities in the country can be stopped. This research will help to advocate for more resources to be given to the IDSR programme so that they can stop the spread of epidemics

General population: As this study will stop future epidemics, it will reduce morbidity and mortality. This will improve the standard of living of the general populations as it will move to reduce epidemics that can lead to a halt in economy development.

Partners to MOHS: Partners will know specific challenges in the IDSR programme so that prioritize expenditure of financial resources.

Staffs working in IDSR will be able to correct their mistakes and appreciate their work.

4. Project execution:

4.a. The following study is an:

- ☒ experimental study (primary research)
- ☐ desktop study (secondary research)
- ☐ desktop study using existing databases involving information of human/animal subjects
- ☐ Other

If you have chosen 'Other' please Explain:

4.b. Methods. The following study will involve the use of:

Method	Materials / Tools
Qualitative:	☒ Face to Face Interviews ☐ Phone Interviews ☐ Face to Face Focus Groups ☐ Online Focus Groups ☐ Other *
Quantitative:	☒ Face to Face Questionnaires ☐ Online Questionnaires ☐ Experiments ☐ Tests ☐ Other *

*If you have chosen 'Other' please Explain:

Mixed Method research. The single questionnaire will contain quantitative questions followed by qualitative questions. These questions will be administered to stakeholders who are doing the day to day runnings of the IDSR programme in Sierra Leone

5. Participants:

5 a. Does the Project involve the recruitment and participation of additional persons other than the researcher(s) themselves?

- ☒ YES If YES, please complete all following sections.
☐ NO If NO, please directly proceed to Question [7](#).



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5 b. Relevant Details of the Participants of the Proposed Research

State the number of participants you plan to recruit, and explain in the box below how the total number was calculated.

Number of participants

All the stakeholders at the national and district levels running the IDSR programme will be included in the study. All the public and private hospitals at the national and district level will be part of the study. For the peripheral health facilities (PHU), 10% of the chiefdoms will be selected in all the sixteen (16) districts by random sampling. In each of the selected chiefdoms 10% of all the PHU in the chiefdoms will be selected.

Describe important characteristics such as: demographics (e.g. age, gender, location, affiliation, level of fitness, intellectual ability etc). It is also important that you specify any inclusion and exclusion criteria that will be applied (e.g. eligibility criteria for participants).

Age range From To

Gender ☒ Female
☒ Male

Eligibility Criteria:

- Inclusion criteria

1. The health worker must be responsible for IDSR activities in the health facility and must have worked for a minimum of one year.
 2. Health workers who give voluntary consent to the study
- Exclusion criteria

1. Health workers who are not responsible for IDSR activities.
 2. Health workers who are responsible for IDSR activities but have not worked in that capacity for at least, 1 year
 3. Health workers who don't give voluntary consent to the study.

Disabilities

Participants with disabilities will be excluded from the study because they will not be able to give voluntary consent

Other relevant information (use the space provided in the box):

5 c. Participation & Research setting:

Clearly describe which group of participants is completing/participating in the material(s)/ tool(s) described in 5b above (use the space provided in the box).

I will visit the sixteen districts of Sierra Leone to collect the data. The stakeholders that are responsible for the day to day implementation of the IDSR programme will be participating in the interview in all the sixteen districts and the national level. At the national level the following people are going to participate, the director, The programme manager and the Monitoring and Evaluation (M&E) Officer of the Health security and emergencies. The Programme manager, deputy programme manager and the M&E of the surveillance programme. The director of planning and information and his M&E. At the district level the district medical officer, district health sister and the M&E. At the health facilities, the Medical superintendent, Matron and focal point for IDSR. At the Peripheral health unit, the in-charge, focal point for IDSR will be interviewed by me. I will also collect data from the national data base to calculate the quality indicators.

5 d. Recruitment Process for Human Research Participants:

Clearly describe how the potential participants will be identified, approached and recruited (use the space provided in the box).

The study will involve voluntarily convincing stakeholders of IDSR programme to be interviewed. I will set up meetings with the top management of ministry of health and sanitation who are involve in the daily implementation of IDSR. In these meeting i will set up appointment that is convenient by their work schedules. I will also ask them to give me liaisons in their officers that i will work with to know when they are free if their appointments schedules were missed. During the meeting with these stake holder i will ask them to sign a consent form voluntarily if they accept to take part in the study. At the district and the health facilities the same will happen. they will also sign a consent form to be part of the study voluntarily.

5 e. Research Participants Informed Consent.

Select below which categories of participants will participate in the study. Complete the relevant Informed Consent form and submit it along with the REAF form.

Yes	No	Categories of participants	Form to be completed
☒	☐	Typically Developing population(s) above the maturity age *	Informed Consent Form
☐	☐	Typically Developing population(s) under the maturity age *	Guardian Informed Consent Form

* Maturity age is defined by national regulations in laws of the country in which the research is being conducted.



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5 f. Relationship between the principal investigator and participants.

Is there any relationship between the principal investigator (student), co-investigators(s), (supervisor) and participant(s)? For example, if you are conducting research in a school environment on students in your classroom (e.g. instructor-student).

☐ YES ☒ NO

If YES, specify (use the space provided in the box).

6. Potential Risks of the Proposed Research Study.

6 a. i. Are there any potential risks, psychological harm and/or ethical issues associated with the proposed research study, other than risks pertaining to everyday life events (such as the risk of an accident when travelling to a remote location for data collection)?

☐ YES ☒ NO

If YES, specify below and answer the question 6 a.ii.

6 a.ii Provide information on what measures will be taken in order to exclude or minimise risks described in 6.a.i.

6 b. Choose the appropriate option

		Yes	No
i.	Will you obtain written informed consent form from all participants?	☒	☐
ii.	Does the research involve as participants, people whose ability to give free and informed consent is in question?	☐	☒
iii.	Does this research involve participants who are children under maturity age? If you answered YES to question iii, complete all following questions. If you answered NO to question iii, do not answer Questions iv, v, vi and proceed to Questions vii, viii, ix and x.	☐	☒
iv.	Will the research tools be implemented in a professional educational setting in the presence of other adults (i.e. classroom in the presence of a teacher)?	☐	☒
v.	Will informed consent be obtained from the legal guardians (i.e. parents) of children?	☐	☒
vi.	Will verbal assent be obtained from children?	☐	☒
vii.	Will all data be treated as confidential? If NO, explain why confidentiality of the collected data is not appropriate for this proposed research project, providing details of how all participants will be informed of the fact that any data which they will provide will not be confidential.	☒	☐
viii.	Will all participants /data collected be anonymous? If NO, explain why and describe the procedures to be used to ensure the anonymity of participants and/or confidentiality of the collected data both during the conduct of the research and in the subsequent release of its findings.	☒	☐

		Yes	No
ix.	Have you ensured that personal data and research data collected from participants will be securely stored for five years?	☒	☐
x.	Does this research involve the deception of participants? If YES, describe the nature and extent of the deception involved. Explain how and when the deception will be revealed, and who will administer this debrief to the participants:	☐	☒

6 c. i. Are there any other ethical issues associated with the proposed research study that are not already adequately covered in the preceding sections?

☐ Yes ☒ No

If YES, specify (maximum 150 words).

6.c.ii Provide information on what measures will be taken in order to exclude or minimise ethical issues described in 6.c.i.

A consent form will be given to the participants of the study for them to understand and voluntarily sign up to the study.
The participant's personal details will be masked in the data collection, analysis and reporting. This is to allow them to be able to response well to the research question without fear of reprisals.
The data collection forms that are completed will be owned by the MOHS and will be under lock at the office of the directorate of health security and emergencies. Access to

6 d. Indicate the Risk Rating.

☐ High ☒ Low



7. Further Approvals

Are there any other approvals required (in addition to ethics clearance from UREC) in order to carry out the proposed research study?

☒

YES

☐

NO

If YES, specify (maximum 100 words).

Ethical approval need to be obtained from the Government of Sierra Leone Ethics and Scientific review committee. They will require that the university provide a letter stating that i am a PhD student and support from my supervisor.

8. Application Checklist

Mark ✓ if the study involves any of the following:

☐

Children and young people under 18 years of age, vulnerable population such as children with special educational needs (SEN), racial or ethnic minorities, socioeconomically disadvantaged, pregnant women, elderly, malnourished people, and ill people.

☐

Research that foresees risks and disadvantages that would affect any participant of the study such as anxiety, stress, pain or physical discomfort, harm risk (which is more than is expected from everyday life) or any other act that participants might believe is detrimental to their wellbeing and / or has the potential to / will infringe on their human rights / fundamental rights.

☐

Risk to the well-being and personal safety of the researcher.

☐

Administration of any substance (food / drink / chemicals / pharmaceuticals / supplements / chemical agent or vaccines or other substances (including vitamins or food substances) to human participants.

☐

Results that may have an adverse impact on the natural or built environment.

9. Further documents

Check that the following documents are attached to your application:

		ATTACHED	NOT APPLICABLE
1	Recruitment advertisement (if any)	☐	☒
2	Informed Consent Form / Guardian Informed Consent Form	☒	☐
3	Research Tool(s)	☒	☐
4	Gatekeeper Letter	☒	☐
5	Any other approvals required in order to carry out the proposed research study, e.g., institutional permission (e.g. school principal or company director) or approval from a local ethics or professional regulatory body.	☒	☐



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10. Final Declaration by Applicants:

- (a) I declare that this application is submitted on the basis that the information it contains is confidential and will only be used by Unicaf University for the explicit purpose of ethical review and monitoring of the conduct of the research proposed project as described in the preceding pages.
- (b) I understand that this information will not be used for any other purpose without my prior consent, excluding use intended to satisfy reporting requirements to relevant regulatory bodies.
- (c) The information in this form, together with any accompanying information, is complete and correct to the best of my knowledge and belief and I take full responsibility for it.
- (d) I undertake to abide by the highest possible international ethical standards governing the Code of Practice for Research Involving Human Participants, as published by the UN WHO Research Ethics Review Committee (ERC) on <http://www.who.int/ethics/research/en/> and to which Unicaf University aspires to.
- (e) In addition to respect any and all relevant professional bodies' codes of conduct and/or ethical guidelines, where applicable, while in pursuit of this research project.



I agree with all points listed under Question 10

Student's Name: Sulaiman Conteh

Supervisor's Name: Victor E. Adamu

Date of Application: 24-Jul-2021

Important Note:

Save your completed form (we suggest you also print a copy for your records) and then submit it to your UU Dissertation/project supervisor (tutor). **In the case of student projects, the responsibility lies with the Faculty Dissertation/Project Supervisor.** If this is a student application, then it should be submitted via the relevant link in the VLE. Please submit only electronically filled in copies; **do not** hand fill and submit scanned paper copies of this application.

APPENDIX F: GUARDIAN INFORMED CONSENT FORM



UU_GIC - Version 2.1



Guardian Informed Consent Form

Part 1: Debriefing of Participants

Student's Name: Sulaimn Gbonnie Conteh

Student's E-mail Address: conteh4722@gmail.com

Student ID #: R1812D7000435

Supervisor's Name: Professor Victor E. Adamu

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: SIERRA LEONE'S INTEGRATED DISEASE SURVEILLANCE AND RESPONSE PROGRAMME

Date: 30-Jul-2021

Provide a short description (purpose, aim and significance) of the research project, and explain why and how you have chosen this person to participate in this research (maximum 150 words).

The increase in global population and urbanization has reduced the distance between people leading to an increase in evolution of infectious disease epidemic and pandemic. The era of emerging infectious diseases have seen a huge rise in the incidence and prevalence of epidemics and pandemics like HIV, Malaria, Ebola and the current COVID 19 pandemic. The twenty first (21ST) has seen several economic loss and travel restrictions due to epidemics caused by emerging infectious diseases. The most effective strategy to prevent or control such spread of infectious disease is to rapidly detect the infection and respond to it using Integrated Disease Surveillance and Response (IDSR) strategy so that it does not spread to the rest of the world. Sierra Leone is implementing electronic IDSR programme from national through to health facility and community

The above named Student is committed in ensuring participant's voluntarily participation in the research project and guaranteeing there are no potential risks and/or harms to the participants.

Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, data collected will be deleted.

All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

I, Sulaimn Gbonnie Conteh, ensure that all information stated above is true and that all conditions have been met.

Student's Signature: sulaimanconteh



Guardian Informed Consent Form

Part 2: Certificate of Consent

This section is mandatory and should to be signed by the participant's legal guardian

Student's Name: Sulaimn Gbonnie Conteh

Student's E-mail Address: conteh4722@gmail.com

Student ID #: R1812D7000435

Supervisor's Name: Professor Victor E. Adamu

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: SIERRA LEONE'S INTEGRATED DISEASE SURVEILLANCE AND RESPONSE PROGRAMME

I have read the foregoing information about this study, or it has been read to me. I have had the opportunity to ask questions and discuss about it. I have received satisfactory answers to all my questions and I have received enough information about this study. I understand that the participant is free to withdraw from this study at any time without giving a reason for withdrawing and without negative consequences. I consent to the use of multimedia (e.g. audio recordings, video recordings) for the purposes of the participation to this study. I understand that all data will remain anonymous and confidential, unless stated otherwise.

I, [redacted], the legal guardian
of [redacted] allow and provide consent
that [redacted] can willingly participate in the study.

I, [redacted], the legal guardian
of [redacted] have been ensured that verbal consent
given by [redacted] will also be taken before the study.

