

# Capacities in Laboratory-Based Epidemiological Surveillance in Cameroon's Littoral Region: A Cross-Sectional Study

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**Background:** Laboratories are a critical part of epidemiological surveillance implementation through their participation in cases' detection and investigation. The Integrated Disease Surveillance and Response (IDSR) strategy is implemented in Cameroon since 2003 although weaknesses in terms of low detection, timeliness and reporting rates are reported. The present study was conducted to assess the implication of health facilities' laboratories in epidemiological surveillance by evaluating the activities conducted, the availability of resources and communication pathways.

**Methods:** A cross-sectional descriptive study was conducted in laboratories of health facilities in the Littoral region of Cameroon selected from health districts by stratified random sampling from April to May 2024. Data were collected using a face-to-face structured questionnaire administered to head of each laboratory. Collected data included health facilities' characteristics, epidemiological surveillance activities conducted in the laboratories, availability of supplies and equipment, data reporting and availability of energy supply.

**Results:** Out of the 302 laboratories reached, 273 (90.4%) consented to participate in the survey. Most (198 [72.53%]) of the laboratories declared being involved in samples' collection while only 61 (22.34%), 18 (6.59%) and 93 (34.07%) declared to be involved in screening of suspected cases during outbreaks, case confirmations during outbreaks and notification of suspected cases respectively. Regarding the availability of transport supplies/equipment, out of the 273 laboratories, 43 (15.8%), 105 (38.5%) and 123 (45.1%) laboratories had Cary Blair medium, isothermal carrying cases and safety bags respectively. It is noted that 26 (9.5%) laboratories reported not communicating their results with surveillance units. A total of 263 (96.3%) laboratories declared to have the national distribution electricity service as their main source of energy and 78 (29.7%) laboratories had an alternative energy source.

**Conclusion:** The present study revealed gaps in terms of participation of health facilities' laboratories in key epidemiological surveillance such as case confirmation and results' reporting. Weakness in terms of supply chain are also noted. Efforts to strengthen laboratory surveillance capacities must prioritize investments in reliable supply chains and sustainable infrastructure.

**Keywords:** laboratory surveillance, public health surveillance, Cameroon, Africa

## Background

Epidemiological surveillance is a fundamental component of disease control which is conducted to enable the early detection of epidemic prone diseases, confirmation, and timely response to outbreaks.<sup>1,2</sup> The implementation of the system involves the participation of several stakeholders from the community to the central levels of the health systems to ensure a complete flow of data, feedback and processing.<sup>1,3,4</sup> For the diseases under surveillance, the circuit includes case detection based on monitored events, confirmation and investigations mainly in the laboratory, and organisation of the response.<sup>5</sup> Within this system, laboratories play a critical role, particularly in the confirmation of suspected cases.<sup>6</sup> In addition to their role in confirming suspected cases, they also play a role in the triggering of health alerts and the continuous routine monitoring of epidemic-prone diseases.<sup>7</sup> Without adequate diagnostic capacity, the surveillance chain remains incomplete and fragile, compromising effective outbreak detection and response.



The World Health Organization (WHO) emphasizes the importance of strengthening laboratory capacities as a core requirement under the International Health Regulations (2005) for improving preparedness and response to public health emergencies.<sup>8</sup> The guidelines recommend to countries to make use of the established national health laboratory system for laboratory confirmation of priority diseases of public health importance at each level of the tiered system, that may include referral of samples to national reference laboratories for specialised testing.<sup>9</sup> In sub-Saharan Africa, many countries continue to face persistent challenges in laboratory capacity, often due to weaknesses in infrastructure, shortages of qualified personnel, inadequate equipment, and frequent stockouts of essential supplies.<sup>2,10–13</sup> In Cameroon, the implementation of the Integrated Disease Surveillance and Response (IDSR) strategy has been effective since 2003 and has led to significant improvements, although there are still some weaknesses in terms of low detection, timeliness and reporting rates.<sup>14</sup> The Integrated Disease Surveillance and Response (IDSR) guideline in Cameroon presents 50 events under routine surveillance accompanied by any other health event of international or national significance.<sup>3</sup> The national technical guide for epidemiological surveillance does not provide specific attributions to each type of laboratory with respect to the level of health facilities hosting the laboratory. However, it does state that health facilities are responsible for collecting, processing and transporting samples for laboratory confirmation in the framework of surveillance.<sup>3</sup> Globally, laboratory capacity and the accompanying logistics are limited in Cameroon, with more critical situations in remote areas. As in other Sub-Saharan African countries, this limitation is linked to a lack of infrastructure and frequent stockouts of essential supplies.<sup>14,15</sup>

Cameroon has reported in recent years several outbreaks with high morbidity and mortality rates with the most recent major outbreak being cholera and measles.<sup>16–19</sup> The Littoral region is one of the country's regions that is known to generate and accelerate the propagation of most of outbreaks. In such a setting, health facilities' laboratories are expected to ensure timely, reliable, and standardized diagnostic services to support surveillance and outbreak management.<sup>20</sup> The present study was conducted to generate evidence needed to guide decision aimed at improving laboratories preparedness for diseases' surveillance.

## Methods

### Study Design

A cross-sectional descriptive study was conducted in laboratories of health facilities in the Littoral region of Cameroon selected from health districts by stratified random sampling. Data were collected by trained surveyors using a face-to-face structured questionnaire administered to head of each laboratory.

### Study Area and Period

The study was carried out from April to May 2024 in health facilities of selected health districts of the Littoral region of Cameroon. The Littoral region is one of the Cameroon regions with the highest number of inhabitants and, one of the most densely economically active areas. It is particularly exposed to recurrent epidemic threats such as cholera, measles, and typhoid fever.<sup>18</sup> It comprises 24 health districts organised into urban, semi-urban and rural. The study was conducted in 8 health districts.

### Study Population

Targeted were laboratories of health facilities situated in selected health districts of the region. The health districts include Deido, New Bell, Bonassama, Cité des Palmiers, Njombe Penja, Nkongsamba, Edea and Manoka. All health facilities officially existing in the targeted health districts were eligible for participation. Public health facilities are hospitals owned by the government through the Ministry of Health, mainly financed by state budget. Private health facilities are for-profit institutions owned and managed by individuals or private institutions while private confessional are non-profit health institutions established and managed by religious organizations.

## Sampling

Eight health districts out of the 24 existing health districts were selected by probabilistic sampling and stratified per type of health districts type (urban, rural and semi-urban). In each health districts, health facilities were selected randomly and their laboratories targeted for the present study.

## Sample Size

The minimum sample size was estimated at 211 laboratories assuming 50% of health facilities' laboratories implement laboratory activities related to epidemiological surveillance, a precision of 5%, 95% confidence interval and that each of the 463 health facilities existing in the targeted health districts have a laboratory.

## Data Collection Tool

Data were collected using a questionnaire designed based on the survey's objectives. The questionnaire was integrated on Kobo Toolbox and administered by trained surveyors to heads of laboratories. The questionnaire was pretested with heads of 6 health facilities' laboratories in Yaoundé Cameroon. The questionnaire was designed to capture information on the health facilities' characteristics, epidemiological surveillance activities conducted in the laboratories, availability of supplies and equipment, data reporting and availability of energy supply.

## Data Collection Procedures

After introduction to heads of health facilities to request permission, heads of laboratory department were approached to present aims, targets and procedure of the survey. Consenting heads of laboratory or their designated representative willing to participate provided written consent prior to inclusion in the study.

## Data Management and Analysis

Prior to data analysis, data were cleaned to correct any inconsistencies and prepared for various estimations. The main indicators estimated include the proportion of laboratories conducting epidemiological surveillance activities, the proportion of health facilities with key supplies and diagnostic equipment, proportion of laboratories reporting to surveillance units.

## Ethical Considerations

The present study was conducted to assess the preparedness of laboratories for epidemiological surveillance activities. All participants were informed of the objectives and procedures of the survey and only those who consented to participate were included and interviewed. No personal data was collected from respondents. The research protocol of the study was approved by the Littoral Regional Ethics Committee for Human Health Research (N 2023/0017/CE/CRERSH-LITTORAL).

## Results

### Distribution and Characteristics of Laboratories

Out of the 302 laboratories reached, 273 (90.4%) consented to participate in the survey, including 218 (79.8%), 33 (12.1%), and 22 (8.1%) private, private confessional and public health facilities respectively. [Table 1](#) presents the distribution of included laboratories per health districts, health facilities' category and type.

### Surveillance Activities Conducted by Laboratories

[Table 2](#) presents the activities conducted by laboratories in the framework of surveillance. It is noted that most (198 [72.53%]) of the laboratories are involved in samples' collection while only 18 (6.59%) declared to be involved in case confirmations during outbreaks. A total of 63 (23.08%) laboratories declared to conduct detection of suspected cases of diseases under surveillance during their routine samples' manipulation.

**Table 1** Distribution of Participating Laboratories in the Study “Capacities in Laboratory-Based Epidemiological Surveillance in Cameroon’s Littoral Region: A Cross-Sectional Study 2024”

	Frequency n	Proportion (%)	95% Confidence Interval (%)
With respect to health districts			
Bonassama	63	23.1	18.2–28.5
Cité des Palmiers	66	24.2	19.2–29.7
Deido	68	24.9	19.9–30.5
Edea	6	2.2	0.8–4.7
Manoka	1	0.4	0.0–2.0
New Bell	40	14.6	10.7–19.4
Njombe-Penja	12	4.4	2.3–7.5
Nkongsamba	17	6.2	3.7–9.8
With respect to health facilities’ category			
District level hospitals	69	25.3	20.2–30.9
Health facilities of intermediate referral level (regional)	1	0.4	0.0–2.0
Health centres’ level	203	74.3	68.7–79.4
With respect to health facility type			
Private confessional	33	12.1	8.5–15.6
Private	218	79.8	74.6–84.4
Public	22	8.1	5.1–11.9
With respect to the type of health district			
Urban	177	64.8	58.9–70.5
Rural	30	11.0	7.6–15.3
Semi-urban	66	24.2	19.2–29.7

**Table 2** Surveillance Activities Conducted by Laboratories per Type of Health Facilities (Capacities in Laboratory-Based Epidemiological Surveillance in Cameroon’s Littoral Region: A Cross-Sectional Study 2024)

Activity	Health Facilities of Intermediate Level (Regional) N=1		District Level Hospitals N=69		Health Centres’ Level N=203		Total N=273	
	n	%	n	%	n	%	n	%
Samples’ collection	1	100.0	45	65.2	152	74.9%	198	72.53
Storage of samples from health facilities	0	0.0	7	10.1	16	7.9%	23	8.42
Screening of suspected cases in epidemic situations	0	0.0	6	8.7	55	27.1%	61	22.34
Confirmation of suspected cases in epidemic situations	1	100.0	2	2.9	15	7.4%	18	6.59

(Continued)

**Table 2** (Continued).

Activity	Health Facilities of Intermediate Level (Regional) N=1		District Level Hospitals N=69		Health Centres' Level N=203		Total N=273	
	n	%	n	%	n	%	n	%
Detection of suspected cases in routine samples	1	100.0	21	30.4	41	20.2%	63	23.08
Notification of suspected cases of diseases under surveillance	1	100.0	29	42.0	63	31.0%	93	34.07
Storage of diagnostic tests	1	100.0	12	17.4	44	21.7%	57	20.88

## Availability of Supplies and Equipment in Laboratories

Out of the 273 laboratories, 263 (96.3%) and 269 (98.5%) health facilities had sterile stool jars and dry tubes respectively but 24 (8.8%) and 9 (3.3%) had shortages in the last 6 months preceding the survey. [Table 3](#) presents details on the availability and shortages of supplies and equipment in laboratories.

## Training of Health Personnel

[Table 4](#) presents the proportions and number of staff trained on sample collection and processing for measles and cholera management. A total of 180 (65.9%) and 163 (59.7%) of laboratories had at least one of their personnel trained on samples' collection as part of measles and cholera surveillance.

## Reporting of Laboratory Results to Surveillance Authorities

[Figures 1 and 2](#) present respectively the reporting route used by laboratories to communicate results' feedback to surveillance units and the reporting timing. It is noted that 202 (74.0%) of laboratories report results via phone calls while 58 (21.2%) accompany the phone call with a report. A total of 26 (9.5%) reported not communicating their results with surveillance units. Out of the 247 laboratories reporting their results, 200 (81.0%) declared to report immediately to surveillance authorities.

**Table 3** Availability of Supplies and Equipment in Laboratories (Capacities in Laboratory-Based Epidemiological Surveillance in Cameroon's Littoral Region: A Cross-Sectional Study 2024)

Supply/Equipment	Current Availability		Shortages in the Last 6 Months		Average Length of Shortage (Days)	Standard Deviation
	n	%	n	%		
Sterile stool jar	263	96.3	24	8.8	37.83	75.88
Swabs	257	94.1	11	4.0	54.27	115.63
Dry tube	269	98.5	9	3.3	8.89	12.37
Syringes	272	99.6	5	1.8	1.6	0.89
Cary Blair medium	43	15.8	35	12.8	172	55.96
Freezer	233	85.3	12	4.4	165.25	51.1
Isothermal carrying case	105	38.5	28	10.3	167.96	83.75
Safety bag	123	45.1	19	7.0	184.89	112.98
Functional fridge	247	90.5	–	–	–	–
Functional freezer	209	76.6	–	–	–	–
Functional centrifuge	221	81.0	–	–	–	–

**Note:** -Not estimated for equipment.

**Table 4** Training of Health Personnel on Sample Collection and Processing for Measles and Cholera Management (Capacities in Laboratory-Based Epidemiological Surveillance in Cameroon’s Littoral Region: A Cross-Sectional Study 2024)

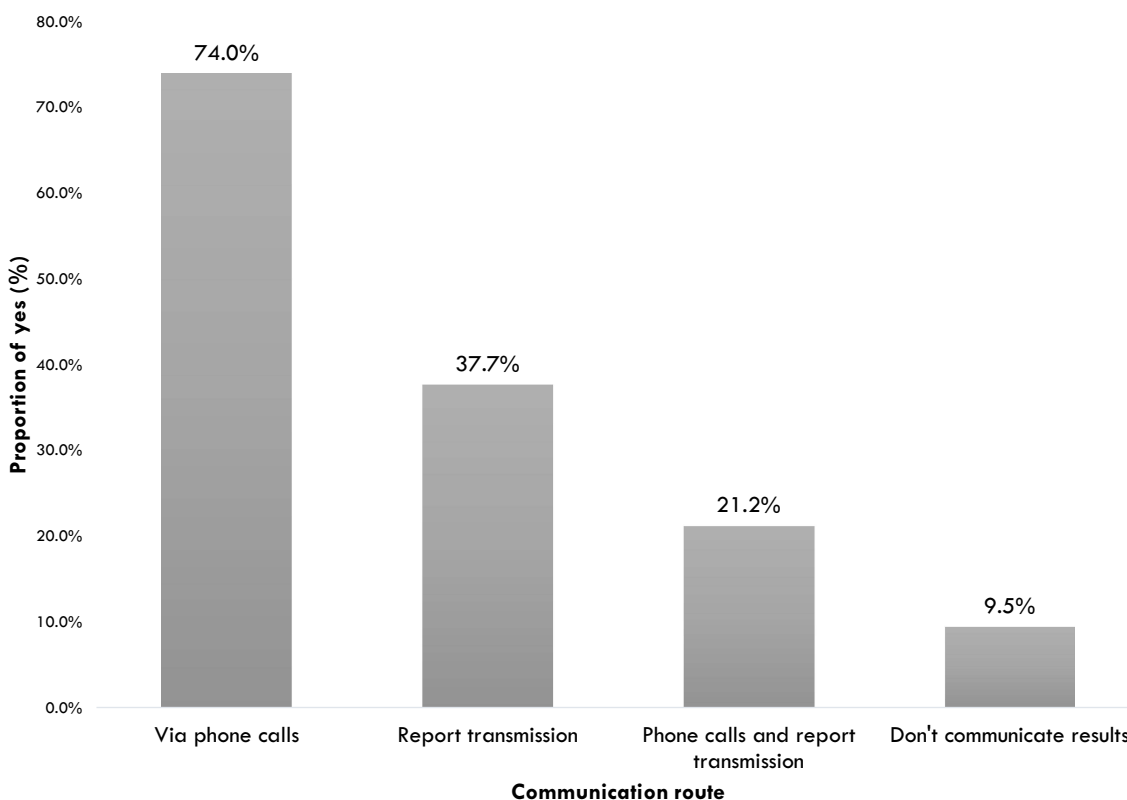
	At Least One Personnel Trained		Mean Number of Trained Staff	Standard Deviation
	Frequency n	Proportion (%)		
Trained in the collection of blood samples as part of measles surveillance	180	65.9	1.23	1.37
Trained in the centrifugation and transport of samples as part of measles surveillance	171	62.6	1.08	1.22
Trained in the collection of stool samples as part of cholera surveillance	163	59.7	1.07	1.28
Trained in the preservation of samples as part of cholera surveillance	158	57.9	1.02	1.26

### Energy Sources for Laboratories

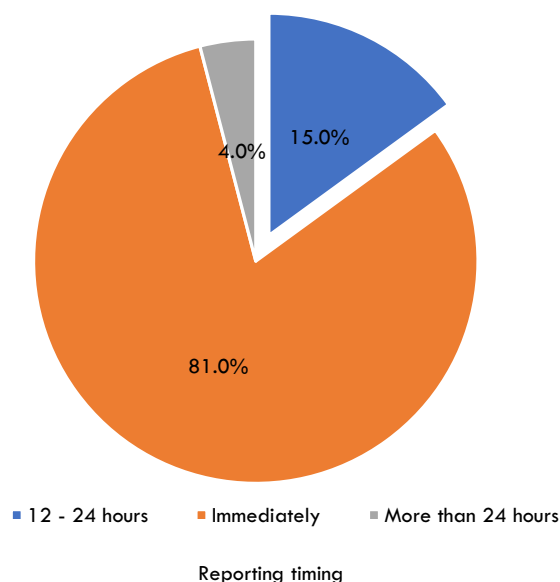
Out of the 273 laboratories, 263 (96.3%) declared to have the national distribution electricity service as their main source of energy followed by generators used by 7 (2.6%) laboratories and solar energy used by 3 (1.1%) laboratories. Out of the 78 laboratories with an alternative energy source, generators were used by 70 (89.7%) laboratories and solar energy used by 8 (10.3%).

### Discussion

The present study was conducted to assess the capacity of health facilities’ laboratories in the Littoral region of Cameroon to confirm epidemic-prone diseases, by evaluating the availability of resources, training of staff and analyzing



**Figure 1** Reporting of laboratory results to surveillance authorities in the Littoral region of Cameroon (Capacities in Laboratory-Based Epidemiological Surveillance in Cameroon’s Littoral Region: A Cross-Sectional Study 2024).



**Figure 2** Reporting timing of laboratory results to surveillance authorities in the Littoral region of Cameroon (Capacities in Laboratory-Based Epidemiological Surveillance in Cameroon's Littoral Region: A Cross-Sectional Study 2024).

communication pathways and energy supply for functioning. It is noted that most (198 [72.53%]) of the laboratories are involved in samples' collection while only 18 (6.59%) and 93 (34.07%) declared to be involved in case confirmations during outbreaks and notification of suspected cases respectively. Out of the 273 laboratories, 263 (96.3%) and 269 (98.5%) health facilities had sterile stool jars and dry tubes respectively. A total of 43 (15.8%), 105 (38.5%) and 123 (45.1%) laboratories had Cary Blair medium, isothermal carrying cases and safety bags respectively for sample transportation. It is noted that 202 (74.0%) of laboratories communicate results for surveillance purpose via phone calls while 58 (21.2%) and 26 (9.5%) reported not communicating their results with surveillance authorities. A total of 263 (96.3%) laboratories declared to have the national distribution electricity service as their main source of energy and 78 (28.6%) had an alternative energy source.

Laboratories play a critical role in various phases of epidemics monitoring, ranging from routine surveillance for suspected cases detection during the absence of outbreaks to continuous surveillance during active outbreaks for case confirmation and investigation.<sup>6,20</sup> Depending on the availability of resources, laboratories are organised at different levels with respect to their ability to carry out complex tests or lengthy test procedures, and their technical platform.<sup>20,21</sup> However, laboratories have basic activities which they are expected to conduct, particularly health facility laboratories which in the Cameroon health system are the operational implementation unit for epidemiological surveillance.<sup>3</sup> The present study revealed that 72.58% of the laboratories conducted samples' collection for epidemiological surveillance but only 6.59% are involved in the confirmation of cases of monitored diseases during outbreaks. This gap is concerning given the central role of laboratories in the conformation of cases leading to confirmation of epidemics. This may imply as it is the case in many Sub-sahara African countries, that confirmation often relies on referral to national or regional laboratories due to limited testing capacity.<sup>20,22</sup> Even though this system of referral may be beneficial in the centralisation of public health data, this would call into question the system's ability to detect all suspected cases of the diseases under surveillance given the fact that surveillance is organised operationally in health facilities. Health facilities' laboratories are at the frontline of the health system, exposing them to the largest number of the normal population seeking health care, enabling rapid diagnosis to be made for the management of patients and thus enabling the identification and isolation of cases of diseases under surveillance.<sup>23</sup> This weakness in the participation of laboratories in the confirmation of cases also raises questions about the lack of trained personnel, inadequate equipment, and absence of protocols in hospital laboratories. Moreover, only 34% of laboratories reported notifying suspected cases to the health authorities, highlighting a missed opportunity to enhance the surveillance system through an alternative route.

Laboratories' operational and technical performance hinges on its capacity in terms consumables, equipment and human resources.<sup>12,20</sup> During outbreaks, the availability of resources is necessary to ensure optimal diagnostic operations to guide the response.<sup>24,25</sup> This study revealed that most laboratories had basic essential consumables such as sterile stool jars, swabs and dry tubes. However, there were notable shortages of transport equipment/consumables including Cary Blair medium, isothermal carrying case and safety bags that were only available in 15.8%, 38.5% and 45.1% of laboratories respectively. The results align with other studies conducted in different settings in Africa which reported limited access to supplies and equipment as a barrier to effective laboratory functioning.<sup>12,26</sup> In routine practice and as noted by the results of this study, health facility laboratories tend not to confirm cases during epidemics or in certain situations are not sufficiently equipped to conduct certain analyses, raising a need to transport and refer their samples to accredited laboratories.<sup>3,20</sup> The noted limitations in terms of availability of transport supplies may compromise the integrity of specimens during transport and reduce the reliability of diagnostic outcomes. This identified limitation concurs with the general observation in Africa where it has been documented that sample referral systems are the most neglected areas where 68.1% and 50.0% of countries are reported to lack a basic or have no existing referral capacity.<sup>22</sup> Moreover, the present study revealed relatively long stock-out periods in laboratories for essential supplies which may suggest procurement and distribution chain challenges. In terms of human resources, the present study revealed, for the case of measles and cholera surveillance, an overall limitation in terms of training of health personnel where about only 60% of laboratories had at least one personnel trained in samples' collection, processing and preservation for surveillance. This aligns with weakness identified previously across African laboratories where around 50–70% of facilities were estimated to have at least one adequately trained staff member for core diagnostic tasks.<sup>27</sup> This identified training gap could lead to compromised sample quality, delayed results, and weakened outbreak responses.

Data in the context of epidemiological surveillance is central to the various decisions and actions that are taken.<sup>28,29</sup> Just like clinical data, timely reporting of laboratory data is essential for outbreak analysis, prompt outbreak investigations and responses.<sup>7</sup> Delays in communication can lead to missed opportunities to contain outbreaks early.<sup>30</sup> The Cameroon surveillance guidelines recommends including all relevant laboratories in the notification network of epidemiological surveillance through the retro-information on laboratory tests conducted.<sup>3</sup> The present study revealed that 9.1% of laboratories do not report their results to surveillance authorities. Even though 81.0% of those reporting their results conduct the reporting immediately, 4.0% reported after 24 hours. Other studies conducted in Ethiopia also reported relatively poor information feedback mechanism from laboratories and poor timely data reporting.<sup>11,31</sup> These results could suggest the absence of clear procedures regarding the communication between the laboratories, the health facility and surveillance authorities. This could also imply weakness of the data management system that could conduct to missed data exploitation to reinforce the surveillance system. The laboratory information system should be improved to ensure standard data management systems and adapted to various epidemic phases.

Access to electricity represents an important aspect of laboratories' operations as they are involved in samples' storage and laboratory analysis.<sup>32,33</sup> Most laboratories reported access to electricity through the national supply chain and reliance on backup generators was common, with nearly 90% of facilities using them as alternative sources. However, only 28.6% of surveyed laboratories reported the availability of alternative energy sources. This is a cause for concern, given the instability of the national supply chain, which is known for its frequent power cuts, some of them prolonged.<sup>34,35</sup> The lack of alternative electricity sources hence indicates a great vulnerability during long power outages and may limit the range of services that can be provided in these facilities during these periods as well the monitoring and storage of samples and media.

The implementation of this study presented some limitations. The data collected was based on self-reported information, which may introduce bias. Also, the data was collected at a certain point in time and did not allow to capture the temporal variation in preparedness in health facilities' laboratories.

## Conclusion

The present study presented limits in terms of laboratory involvement in epidemiological surveillance activities. While the majority of laboratories are involved in sample collection for surveillance, critical gaps remain in case confirmation,

case reporting, equipment/supplies availability energy maintenance and consistent communication with surveillance bodies. These limits could significantly delay outbreak detection and response, undermining the effectiveness and aim of the surveillance system.

There is a need to prioritise improvement in diagnostic capacity, including staff training, and resilient supply chains. In addition, improving communication protocols and feedback mechanisms between laboratories and surveillance authorities is essential to ensure timely reporting and rapid outbreak response.

## Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

## Ethical Approval and Consent to Participate

Only participants who provided informed consent were included and interviewed. The protocol of this study was approved by the Littoral Ethics Committee for Human Health Research of Cameroon (N 2023/0017/CE/CRERSH-LITTORAL).

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare that they have no competing interests.

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