

Perspectives

Sustainable Laboratory Capacity Building in Sierra Leone: From Ebola to COVID-19

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The onset of the Ebola outbreak in 2014 originated in Guinea and proceeded to swiftly reach Sierra Leone and Liberia (1). Unfortunately, these nations were critically deficient in their capacity for pathogenic testing and diagnostics, the availability of healthcare workers, and their supply of epidemic prevention materials, thereby impeding their ability to address the outbreak efficiently (2). This grave scenario underscored the need for support from the worldwide community.

At the time, Sierra Leone lacked the domestic capacity for laboratory testing, including that of biosafety level 3 (BSL-3). Recognizing this constraint, the Chinese government hastily dispatched a mobile BSL-3 laboratory and corresponding technicians to Sierra Leone to facilitate testing within the country. Furthermore, the Chinese government expedited the establishment of the Sierra Leone-China Friendship Biosafety Laboratory (BSL-3) within a span of three months, observed to be operational by March 2015. It is important to note that this laboratory also conducted investigations centered on the detoxification of body fluids in Ebola survivors, fueling advancements in the understanding and management of the Ebola virus (3). The laboratory has played a significant role in the prevention and control measures during the Ebola epidemic.

The Ebola outbreak in West Africa underscored a lack of ability to identify and diagnose emerging and

re-emerging infectious diseases. While the outbreak has since ended, it underscored the necessity of strengthening the health system to better respond to future public health crises. This was underscored to the government and health practitioners. Sierra Leone, in particular, experienced a high mortality rate due to diseases such as malaria, pneumonia, diarrhea, cholera, Lassa fever, and measles. The nation continues to bear the brunt of public health crises, experiencing significant morbidity and mortality. Consistent international efforts are crucial to building the resilience and capacity of the public health system. To this end, China CDC, in collaboration with the Ministry of Health and Sanitation, Sierra Leone, implemented a multi-year capacity building program that incorporated laboratory operational capacity development and personnel capacity building (4). This article evaluates the performance and outcomes of this program (Table 1).

Improved Laboratory Operating Capacity

When the Sierra Leone-China Friendship Biosafety Laboratory was founded in 2015, it initially lacked operational capabilities. This deficiency was addressed through a comprehensive program that furnished the laboratory with skilled staff, necessary facilities, and a relevant management system — an essential

TABLE 1. Framework of the program.

Framework	Laboratory operational capacity building	Personnel capacity building
Inputs	Staff	
	Technical support	Mentors
	Financial resources	Short/long-term training
Process	Facilities	
	Developing a laboratory management system	Developing a training plan
	Extending testing capacity	Mentor instruction
	Developing a sentinel surveillance system	Learning from practice
	Maintaining operation of the lab	Encouraging further education
Outcomes	Sustained operation of the laboratory	
	Increased testing scope of pathogens	Established professional workforce in the lab
	Enhanced surveillance capacity	Improved competency of public health personnel

foundation for maintaining laboratory operations.

The implementation of this program gradually enhanced the laboratory's testing capacity, expanding from initial testing for only the Ebola virus to including several other types of pathogens by the end of 2022 (Figure 1). This laboratory, designated as the National Reference Laboratory for Viral Hemorrhagic Fevers in Sierra Leone, was responsible for testing samples from unexplained severe cases or suspected instances of hemorrhagic fever to determine the responsible pathogens. Concurrently, the program instituted a sentinel surveillance system to manage surveillance of hemorrhagic fever viruses, diarrheal pathogenic bacteria, and mosquito vectors. This bolstered disease diagnosis and early warning capabilities for infectious disease outbreaks (5–7), with all gathered samples tested within the laboratory. Given the persistent risk of severe diseases like Lassa fever and Ebola within the country, in addition to the identification of new pathogens (8–9), this sentinel surveillance system facilitates early detection of outbreaks and enhances the country's preparedness for such situations.

The continued capacity enhancement in the laboratory facilitated the swift establishment of testing for the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus at the pandemic's early stage. As of February 5, 2020, the Sierra Leone-China

Friendship Biosafety Laboratory has fully developed both sequencing and reverse transcription-polymerase chain reaction (RT-PCR) detection capabilities for the SARS-CoV-2 virus, which positioned Sierra Leone among the first African countries with this testing ability. The laboratory, serving as a public health facility, was appointed the national testing site for the SARS-CoV-2 virus. It began testing its first suspected coronavirus disease 2019 (COVID-19) sample on February 14, 2020, signifying the onset of emergency COVID-19 testing in Sierra Leone. The first positive nucleic acid sample was detected in the laboratory at 2:00 a.m. on March 31, 2020. The Sierra Leone government announced the country's first COVID-19 case that same day (10). Up to December 2022, the laboratory had tested 131,708 samples from suspected COVID-19 cases, which constituted 34.4% of the national testing volume in Sierra Leone (Figure 2). Among these, 2,697 were positively confirmed, representing 34.7% of all confirmed cases in the country.

Improving the Competency of Local Public Health Personnel

This multi-year program is focused on providing long-term training in laboratory biosafety, quality

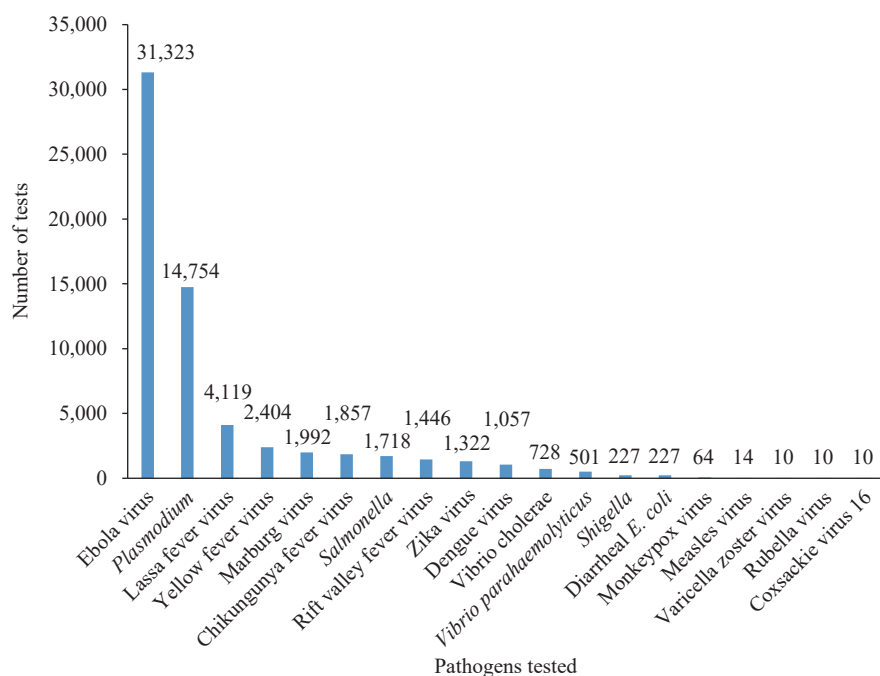


FIGURE 1. Distribution of pathogen types tested and the corresponding number of tests conducted in the laboratory, 2015–2022.

management, and testing techniques related to viruses, bacteria, and parasites. A training plan was developed specifically for personnel working in the laboratory, additionally, long-term mentors were dispatched to Sierra Leone. The comprehensive training curriculum covered areas such as pathogen characteristics, specimen collection, data entry, operational standards, personal protection, correct utilization of equipment, materials management, and biosafety. Training was delivered through a combination of lectures, simulation exercises, and practical sessions under the supervision of skilled Chinese technicians.

When operations began in the lab in 2015, a total of

five local staff members were recruited for training. Following an eight-year period, 19 local lab technicians have undergone training in the laboratory. Among this group, four have successfully secured scholarships for master's or doctoral programs outside Sierra Leone. Ongoing training has been used to bolster the competency of local staff in areas such as biosafety and biosecurity, quality management, disease surveillance, and laboratory diagnostics (Table 2). This trained local workforce played a significant role in laboratory testing and diagnostic processes throughout the COVID-19 pandemic. This team ensured that the laboratory was able to conduct tests on a daily basis and report results

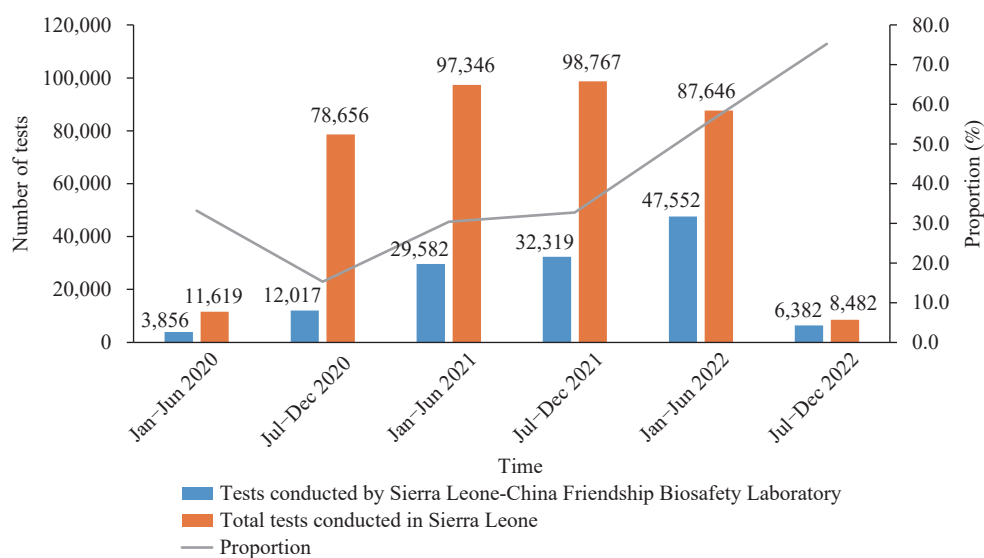


FIGURE 2. Comparison of coronavirus disease 2019 (COVID-19) polymerase chain reaction (PCR) tests conducted by Sierra Leone-China Friendship Biosafety Laboratory with the total tests conducted in Sierra Leone.

TABLE 2. Comparison of laboratory personnel competency in 2015 and 2023.

Category	Ability	March 2015	March 2023
Biosafety	Operating in biosafety level 3	None	Competent
	Using personal protective equipment properly	None	Competent
	Biological waste management & disposal	None	Competent
	Biosafety awareness	None	Acquired
Quality management	Sample collection, transportation and preservation	None	Competent
	Process control	None	Competent
	Documents and records	None	Competent
	Data management	None	Competent
Disease surveillance	Perception of active monitoring	None	Acquired
	Process of surveillance	None	Competent
Lab diagnosis	Nucleic acid testing	None	Competent
	Enzyme-linked immunosorbent assay	None	Competent
	Sequencing	None	In training

to the Sierra Leone Ministry of Health and Sanitation within 24 hours of receiving a sample.

In the past years, the program successfully conducted or sponsored 37 short-term training courses, collectively reaching 1,061 participants from across the country. This initiative significantly strengthened Sierra Leone's capacity for pathogenic testing at the district level. The curriculum spanned diverse topics such as pathogen collection, biosafety, surveillance, quality control, pathogenic diagnosis, and disease control. It encompassed diseases such as Ebola, Lassa fever, plague, anthrax, monkeypox, Marburg, malaria, typhoid fever, and SARS-CoV-2, among others (Figure 3).

DISCUSSIONS

The development of Sierra Leone-China Friendship Biosafety Laboratory during the Ebola outbreak and its subsequent crucial involvement in managing the COVID-19 pandemic have significantly fortified Sierra Leone's laboratory capabilities in both preventing and controlling infectious diseases, as well as responding to health emergencies. The COVID-19 pandemic reiterated the critical necessity to uphold global health security. This is particularly true in terms of enhancing all countries' capacities in observing, detecting, and responding to infectious diseases, which are vital measures in the successful containment of such pandemics.

The program is aligned with the Sierra Leone

National Action Plan for Health Security (2018–2022) (11). Successful execution of this initiative strengthens Sierra Leone's disease surveillance processes, emergency preparedness, and personnel proficiency. Consequently, the capacity of the public health sector to prevent, detect, validate, and report to both local and international bodies, and respond to incidents or outbreaks of emerging or re-emerging infectious diseases of significant public health concern, is substantially improved. This enhancement ultimately benefits the health and well-being of the people of Sierra Leone, as well as the global community.

Given the constraints of limited resources, additional measures must be taken to sustain the operation of this laboratory. This includes nurturing a competent local workforce and maintaining ongoing surveillance. These efforts are crucial for bolstering the country's integral capacities as stipulated under the International Health Regulations (IHR) 2005, thereby augmenting the health security of both the country and the wider sub-region.

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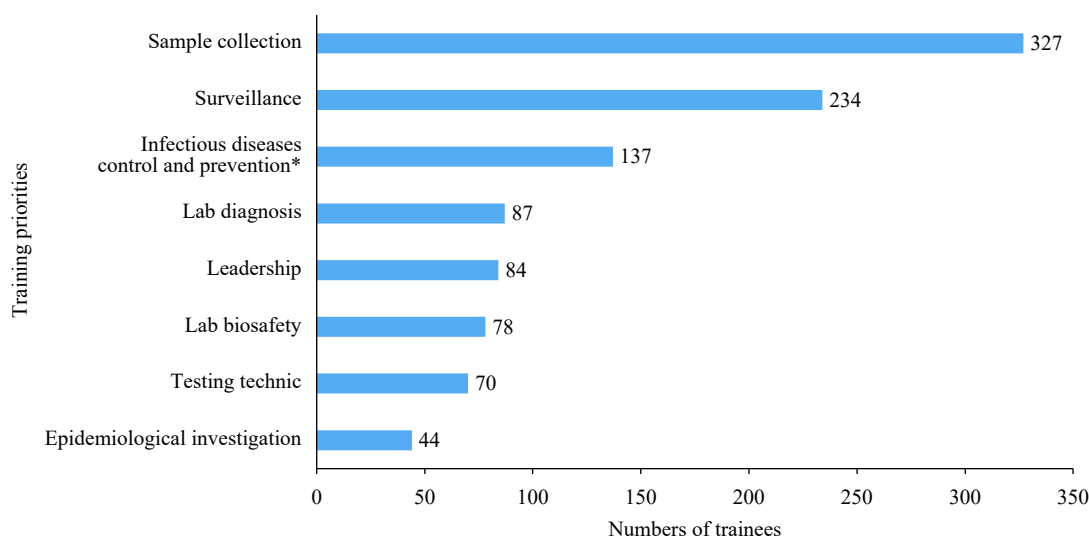


FIGURE 3. Numbers and priorities of brief training workshops conducted from 2015 to 2022.

* Workshops centered on the control and prevention of infectious diseases, such as malaria, cholera, measles, and hepatitis, are being implemented in Sierra Leone.

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