

Evolution of Zoonotic and EVD Responses in Sierra Leone-Laboratory Capacity Strengthening at Njala University

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Abstract

When Ebola first hit Sierra Leone on 24 May 2014, the country struggled to stem the outbreak. There was difficulty running the project through Ministry of Health and Sanitation (MOHS), which led to the establishment of the National Ebola Response Centre (NERC). This initiative developed the principles and operational model for strong regional, district and local collaboration, transforming NERC into Emergency Operations Centre (EOC) with minimum attention to country-led laboratory capacity strengthening. Health laboratory services are essential for the efficient delivery of quality and cost-effective healthcare. Training in laboratory services has long been a neglected part of the health system in Sierra Leone. Perceived by the fact that it is one of the eight core capacities of the International Health Regulations, necessitated the urgency for this project at Njala University. The laboratory system is crucial for rapid detection and safe sample management, timely and accurate sample testing and timely results communication. Less attention is given to building capacity of laboratories in the second and third tier institutions to enable rapid diagnosis for possible emerging diseases in the country. The Royal Netherlands Embassy (RNE) in Ghana has, therefore, provided a 22-month project support otherwise known as the "Post-Ebola Resilience Project." In keeping with the activities for the work package 2 (WP2), training has been accomplished on Bio-safety, Bio-security and Good Laboratory Practices for laboratory staff. Ethical approval for mini projects on Ebola, Lassa fever, Rift Valley fever; Rabies and Influenza have been received from the Njala University Institutional Review Board (NUIRB). Staff involved at Njala University is actively working together, further reinforcing the One Health Concept by focusing on both human and animal health and its interface.

Keywords: Post-Ebola Resilience Project; Serology and Molecular Diagnostic Laboratory; Capacity strengthening; Infectious diseases; Njala University

Introduction

The difficulty in controlling the spread of the virus has caused the 2014 outbreak to be the most severe in terms of number of cases and human fatalities since the discovery of the virus in 1976. Although at least 20 outbreaks of Ebola virus disease (Ebola) have occurred since the virus was first recognized in humans in 1976, the 2014 outbreak was unprecedented in size and severity [1-3]. By the end of December, over 20,000 persons had been infected and close to 8000 had died, with 99% of cases originating in the West African nations of Guinea, Liberia and Sierra Leone [1,2]. Furthermore, the risk of re-emergence or outbreaks of EVD and other emerging infectious diseases such as Lassa fever, dengue, cholera, Marburg fever, and yellow fever remain in the region. This is because as opined by Snyder [3-6] poverty, a weak healthcare system, lack of access to resources, recent civil conflicts and their aftermath and the prevalence of informal settlements, with overcrowded living conditions and weak hygiene infrastructure, are key among the broader social determinants of Ebola. There is a continued need for proactive response to engage with communities in increasing their resilience and preparedness to manage future infectious outbreaks [1,4]. The main question for policymakers, the national and international health community, and civil society is how to ensure that future infection events do not become epidemics and unravel into a complex political, environmental, medical, economical, and public health emergency [4,7].

According to Taylor et al. [8], the virus causing Ebola has been present in fruit bats and marsupials for at least 10 million years. Based on the findings by WHO [9-12], the disease was only first recognized in humans in about 40 years. Looking at it from the Geo-Epidemiology of the disease, Ebola outbreaks, until now, have been small in East and Central Africa, and none

has been as deadly or geographically widespread as the current outbreak in West Africa [7,9].

Against this background, the Royal Netherlands Embassy (RNE) in Ghana 2-year funded project, "Preparedness against Ebola and other Emerging Infectious Diseases in Sierra Leone and Guinea" was initiated in June 2015 [5]. This project involves a consortium of institutions including Njala University (Sierra Leone), Sonfonia University (Guinea), Noguchi Memorial Institute for Medical Research (Ghana), the Wageningen University, University of Amsterdam and the Royal Tropical Institute (the Netherlands). The overall aim of the project is to establish a system for preparedness and resilience of Ebola virus disease (EVD) and prevention of other infectious diseases with epidemic potential in Sierra Leone and Guinea. This is to be achieved under three interrelated components or work packages (WPs): WP1 - Community-based surveillance; WP2 - Laboratory strengthening; and WP3 - Results-based financing.

The laboratory component (WP2) aims to strengthen zoonotic and public health laboratory services of Njala University to ensure rapid and safe sample collection, transportation, and management, as well as rapid and accurate sample testing and rapid results communication in an effective response to selected infectious diseases with epidemic potential.

Purpose

The laboratory activities are focused on five priority infectious zoonotic viral diseases. These were selected based on their documented presence in Sierra Leone and their disease potential to cause pandemics or severe epidemics in humans and/or animals. These are:

1. Ebola viral disease by Ebola virus including the closely related filovirus, Marburg virus.
2. Lassa fever caused by the Lassa virus.
3. Rift Valley fever caused by the RVF phlebovirus.
4. Rabies, caused by Lyssaviruses.
5. Highly pathogenic avian influenza by Avian Influenza virus.

Overall aim and objective

The overall aim of the project was to develop an innovative system for preparedness and resilience of Ebola virus disease (EVD) and prevention of other infectious diseases with epidemic potential in Sierra Leone and Guinea.

Specific objectives

The specific objectives of the project were as follows:

1. Establish a laboratory at Njala University to perform molecular and serological testing on human and animal samples for infectious diseases.

2. Train a pool of laboratory experts that can perform these tests in a safe and reliable way leading to high quality results.
3. Make the newly established laboratory services at Njala University attractive and provide laboratory support to the general public health and veterinary services in Sierra Leone.
4. Train a pool of laboratory experts to design and execute research projects that will provide evidence-based rational interventions in infectious disease control.
5. Create a pool of trainers that can provide training modules in basic laboratory diagnostic techniques on infectious diseases at Njala University.

Problem statement and relevance of laboratory

Health laboratory services are essential for the efficient delivery of quality and cost-effective health care. Even though the results of diagnostic laboratory testing have impact on over 70% of all healthcare treatment decisions, laboratory services have long been a neglected part of the healthcare systems in Sierra Leone and Guinea.

Over the past few years the crucial role of laboratories in diagnosis, treatment, monitoring and public health issues such as disease outbreaks is becoming more and more recognized and the attention for the quality of laboratory services in resource poor countries has increased tremendously. International Health Regulations [11] core capacity eight requires WHO member states to 'establish mechanisms to provide reliable and timely laboratory diagnosis of infectious agents and other hazards potentially causing public health emergencies of national and international concern' and the importance of a laboratory as a support pillar to the health system is increasingly recognized as a need to improve global health and reach the Millennium Development Goals (MDG).

One Health concept seeks to improve health and well-being through the prevention of risks and the mitigation of effects of crises that originate at the interface between humans, animals and their various environments; again, laboratories play a vital role in providing the evidence base for rational interventions.

Well-functioning, sustainable laboratory services, operating according to international standards of quality and safety, are essential for health systems and crucial for improving public health. The analyses they provide offer a reliable foundation for evidence-based control of disease (outbreaks), robust surveillance of adverse events and early treatment of patients.

Laboratory preparedness is an integral and very important part of Ebola virus disease (EVD) and other infectious disease preparedness, as is also witnessed by the fact that it is one of the 8 core capacities of the International Health Regulations [11], which were modified after the SARS outbreak. In EVD response, the laboratory system is crucial for rapid and safe sample management, rapid and accurate sample testing, rapid results communication and subsequent evidence-based patient management and control decisions. Therefore it is crucial to include a laboratory strengthening component in

resilience programmes involving Ebola and other infectious disease emergencies, in particular these were the interface of humans, animals and the environment plays a crucial role [12].

As the laboratory will be part of the university-wide initiatives, it will provide opportunities for students to gain important practical expertise in laboratory science through hands-on training on sample collection and handling or technical sessions on the use and application of laboratory equipment and reagents. Finally, national and international disease control programs will benefit from the knowledge generated by the laboratory activities, as described below.

Methodological Approach

Target group for project intervention

The laboratory is located in the School of Agriculture at the Njala Campus of Njala University in Moyamba district. The laboratory is operated by the Departments of Animal Science and Environmental Health Sciences as a combined resource for the both human and animal health systems under the One Health concept. The initial target populations are the chiefdoms within Moyamba district. Upon completion of the renovation, the laboratory will function as a second line laboratory where samples from patients or animals suspected of viral haemorrhagic fevers (VHF) and other zoonotic infections (when other common diseases such as malaria have been excluded) will be tested. This could be at the request of the health workers, veterinary workers, government or other stakeholders such as NGOs, hospitals or development agencies. The laboratory will thus provide information for evidence-based health care decision and also support response to outbreaks among humans or animals.

During the inception workshop, five priority infectious zoonotic viral diseases were identified as potential serious health problems in Sierra Leone. The selection was based on the documented presence of these viruses in Sierra Leone, the presence of an animal and/or environmental reservoir and their disease potential to cause pandemics or severe epidemics in humans and/or animals.

Avian influenza was specifically chosen to allow for influenza virus surveillance activities in the Moyamba district to be part of the global influenza surveillance network that is coordinated by WHO [9], which may also help to ensure the sustainability of the laboratory.

Geographic area and population under study

The geographical area of the study sites will be determined by the emerging mini projects of the selected five diseases. The location of the mini-projects may also differ per project.

Content and work plan

The WP2 consists of a number of activities and interventions that together cover the objectives of the work package. These activities are presented graphically in the Gantt chart (Figure

1) with a corresponding narrative of the activities as well as the description and the rationale for the approach chosen.

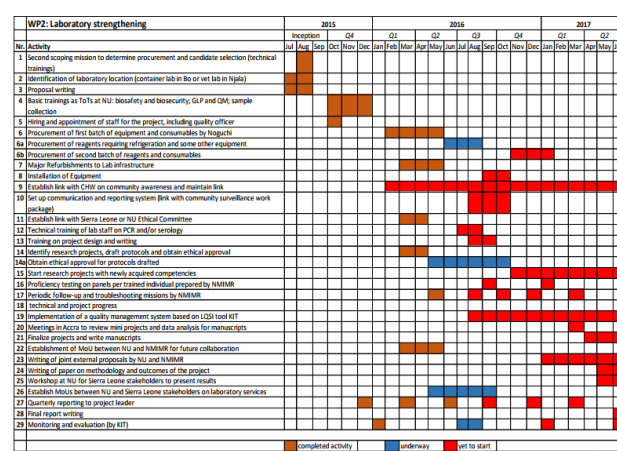


Figure 1 Gantt chart of activity plan for the laboratory strengthening work package.

Work Accomplished in Project Activity

Laboratory training activity

In keeping with the activities for staff capacity strengthening, training has been accomplished by experts from Noguchi Memorial Institute for Medical Research (NMIMR), University of Ghana on Bio-safety, Bio-security and Good Laboratory Practices from 1-12 February 2016. This was followed by initial analytical training by the same experts in Eliza and PCR for Ebola, Lassa fever, Rift Valley Fever, rabies and Influenza A and B from 26 September-6 October 2016 and follow training on 26 February-8 March 2017 (Plates A-C). Simultaneously, Laboratory Quality Management (LQM) training from 10-14 October 2016 and a follow up training for the development of standard operating procedures (SOPs) from 9-13 January 2017. Reports of these training activities are available as part of the laboratory documentations (Figure 2).



Figure 2 Plates A-C (Pictures highlighting training activities).

Laboratory renovations

Refurbishment/renovations to the laboratory building started in March 2016. General renovations of the designated laboratory and its immediate environs progressed quite slowly initially because the work coincided with the preparation for Njala University Congregation in 2016. The pace of the renovation works gathered momentum in April 2016 through May 2016 and eventually completed at the end of May 2016.

Preparation of SOPs for laboratory operation

Based on documented presence of the selected infectious diseases in Sierra Leone and the potential to cause pandemics or severe epidemics the follow up training in serology and diagnostic analysis as well laboratory quality management assigned tasks to laboratory staff for SOPs development as indicated in **Table 1**.

Table 1 Schedule for SOP development by the laboratory staff.

Name	Action	Comments
Nelphson Moinina Kallon	Finalize the: - SOP ELISA for Rift Valley Fever - SOP PCR for Rift Valley Fever and send it to Mr. Datema and Mr. Bonney for review	Accomplished, reviewed and data collection ongoing
Abdulai Conteh	Finalize the: - SOP ELISA for Rabies - SOP PCR for Rabies and send it to Mr. Datema and Mr. Bonney for review	Accomplished, reviewed and data collection ongoing
David Hingola Jojo	Finalize the SOP PCR for Lassa Fever and send it to Mr. Datema and Mr. Bonney for review	Accomplished and data collection ongoing
Abu Macavoray	Finalize the SOP on Dealing with Spills and send to Mr. Datema for review	Accomplished and reviewed
	Finalize the SOP on PCR for Ebola/Marburg and send it to Mr. Datema and Mr. Bonney for review	
Watta Tewo Bundu	Finalize the: - SOP PCR for Influenza - SOP ELISA for Influenza and send it to Mr. Datema and Mr. Bonney for review	Accomplished, reviewed and data collection ongoing
Ishmail Sheriff	Finalize the SOP on PCR for Zika and send it to Mr. Datema and Mr. Bonney for review	Accomplished and reviewed

Procurement of equipment, some reagents and consumables

Orders to procure equipment, reagents and consumables were placed in January 2016. Some quantities have been received at Njala, and the remaining batch of items shipped in a container was also received in November 2016. Other reagents and consumables recently shipped are expected by mid-October 2017.

In effort to enhance the computer capacity of laboratory staff, all the laboratory staff received Intel Core i5 laptops with 6GB memory plus 5 internet mobile devices.

Link was also established with "Njala University Institutional Review Board" (NUIRB) for ethical clearance in May 2016, and the certificated were received in August, 2017.

Staff compliments

As at now the Laboratory staff consists of the following:

- Two (2) Coordinators (one for administrative and management tasks, and the other for laboratory supervision)

- Two (2) Veterinary Doctors (who serve as mentors)
- Six (6) Laboratory Researcher/Technicians

Challenges for Sustained and Efficient Functioning

Solar energy - An alternative for efficient power supply

Power is regularly provided by Njala University Administration from 7:00 AM-5:00 PM (10 hours), and 7:00 PM - 1:00 AM (6 hours) – A total of 16 hours/day. The remaining 8 hours that make up efficient power provision for 24 hours remains unresolved.

We initially thought of the opportunity for standby 25 KVA generator, but the operational and maintenance cost may set in another drawback.

Recently, we visited the Post-Harvest Technology Laboratory at Njala Campus with Eaton 9SX UPS System. The system can power up to 10KVA at 100%. It works best with a super charger

and 12 external battery modules. Two sets of this facility are recommended for the laboratory supplementary energy services at approximately \$10,000 - 12,000/set to overcome the energy challenges.

Staff mobility for sample collection

Sample collection is done in field sites at distance from the Laboratory, and no specified transport is available/assigned for this purpose. Any extended opportunity elsewhere would facilitate the accomplishment field sampling timely without losing the efficacy of the sample for proper storage and use when necessary.

Staff monthly stipends

As at now the management is capable of sustaining the monthly staff stipends up to the end of November 2017. Thereafter, if staff is not absorbed in the Njala University staff employment the tendency of losing them to agencies is envisaged. Alternatively, working for collaborations with other existing institutions and agencies that offer to pay for service rendered could also provide a less pain pathway to maintain the staff in operation. This update therefore, serves as a benchmark through which an expanded project beyond the present capacity can be actualized in partnerships and collaborations.

Procurement of reagents and consumables

Regardless the recent affiliation with FLI and FAO for partnership in sample collection, storage and shipment for their existing project in Sierra Leone up to 2019, there is no other fund source at the end of RNE Post-Ebola Project in November 2017 that put together the establishment of the NU-SMDL. The funds provided for the FLI and FAO collaboration is extremely limited to their own operation with little or no support to other activities of the Laboratory envisaged by Njala University. This is a key driver to the sustainability of the laboratory, and to that extend formal approach to MOHS through the Chief Medical Officer (CMO) has been attempted and awaiting response for inclusion of the laboratory into the sentinel sites for Influenza A and B.

Conclusion and Recommendations

The inspiring vision of Njala University is to chart a way forward for the accomplishment of outcomes in the process of establishment of the Post-Ebola Laboratory for capacity strengthening in Sierra Leone. These are set in deliverables for timely achievement in following stepwise approach:

- Upgrade the level of technical knowledge and expertise of current and new staff via training of trainers, training and exchange visits

- Enhance the 'one-health' concept regarding emerging outbreaks of zoonotic diseases, in particular viral haemorrhagic fevers
- Upgrade lab facilities and equipment to facilitate routine diagnostic testing
- Integrate lab services into the national health machinery
- Develop, implement and sustain a quality assurance system
- Initiate the implementation of a quality management system based on ISO 15189:2012.

Achievement of these deliverables, however, is foreseen to be challenged with the lack of mobility of the staff involved, especially for timely sample collection, rapid detection and safe sample management, timely and accurate sample testing and timely results communication.

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