The Frontline Field Epidemiology Training Program in Liberia, 2015-2018

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ABSTRACT

Introduction: The Liberian Frontline Field Epidemiology Training Program (LFETP-F) was initiated by the Government of Liberia in 2015 in partnership with other organizations. Introduction of the program formed part of measures to improve integrated disease surveillance and response (IDSR) following the Ebola virus disease (EVD) outbreak in West Africa. We describe the establishment and implementation of the program, its outputs, and evaluated to determine whether it is meeting its objectives. **Methods:** We followed the logic model for the program to describe the inputs, activities, outputs, and evaluated the short term impact. We reviewed stakeholder meeting and training reports and interviewed a public health official to describe the establishment, implementation, and outputs of the training. We compared IDSR indicators before and after the inception of LFETP-F and described findings from a post-graduation assessment to determine the impact of the program. **Results:** Stakeholder discussions towards developing human resource capacity to meet Internal Health Regulations after the EVD outbreak led to the establishment of the LFETP-F in Liberia in 2015. From 2015 to 2018, 170 persons were trained in seven cohorts in Liberia. The district, county, and national level surveillance officers were trained in the basics of surveillance, outbreak investigation and scientific communication. Graduates are distributed all over the country, with at least one graduate in each of the 92 districts. Average post-test scores at the trainings showed improvement over pretest scores for each cohort. In 2018, among 20 outbreaks investigated and responded to by LFETP-F graduates, 90% were documented with investigation reports, compared to 53% in 2016; 78% were responded to within 48 hours compared to 37% in 2016. **Conclusion:** LFETP-F is fulfilling its mandate and meeting its objectives. Spread of diseases and deaths have likely been averted by the improved surveillance and response. A sustainability plan for funding and management of the program needs to be carefully developed by stakeholders to ensure that gains achieved over the first three years are not lost.

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Introduction

In 2014/2015, the world witnessed the largest epidemic of the Ebola Virus Disease (EVD), with Guinea, Sierra Leone and Liberia being the worst affected countries [1]. The extent and severity of the epidemic in these West African countries was attributed, in part, to the inadequate capacity for outbreak detection, investigation and response as compared to Nigeria, where the outbreak was quickly controlled, partly due to the availability of skilled personnel [2-3].

In the aftermath of the EVD epidemic, the Liberian Ministry of Health (MoH), with the support of international partners including the World Health Organization (WHO) and the United States Centers for Disease Control and Prevention (USCDC), developed an "Investment Plan for Building a Resilient Health System" [4-5]. Developed to fulfil the International Health Regulations (IHR) of preventing, detecting, and rapidly responding to public health risks, the plan outlined nine action areas [6]. Two of these areas focus on building a fit-for-purpose workforce and developing emergency preparedness and response [4].

In Nigeria, the capacity for outbreak investigation and response was built through the two-year Field Epidemiology (and Laboratory) Training Program (FE(L)TP) [7]. Liberian health authorities embraced the program as a strategy to contribute to the achievement of the strategic plan.

The FETP is designed in three tiers: a three-month FETP-Frontline, nine-month FETP-Intermediate, and two-year FETP-Advanced [8-9]. The FETP´s pyramidal structure, respective cost of training and prerequisite qualification for the three tiers translate into training progressively fewer surveillance officers from the frontline level, to the intermediate level, and at the national level [9].

Each tier has its place in building a strong public health workforce. However, Liberia prioritized FETP-Frontline training in the immediate period following the EVD outbreak because of the urgency to ensure that the newly-recruited county and district surveillance officers, had the capacity to implement the re-introduced Integrated Disease Surveillance and Response (IDSR). The objective of the Liberia FETP (LFETP) was to build capacity for the implementation of the IDSR [9, 2].

The Joint External Evaluation report on Liberia in 2016 noted that one of the best practices for the country was, "The foundation for the Field Epidemiology Training Program (FETP) has been set in collaboration with the US CDC, the University of Emory (sic) and the African Field Epidemiology Network-AFENET" [10-11]. Liberia´s experience and lessons learned in setting the foundation and implementing its FETP-Frontline is worth documenting and sharing for public knowledge and for countries considering a FETP-Frontline.

In this paper, we outline the processes undertaken to establish the FETP-Frontline in Liberia, the implementation and outcomes of the training, and whether the program is achieving the purpose for which it was set up in the country.

Methods

Health care setting for IDSR in Liberia

Liberia is sub-divided into 15 counties which are sub-divided into 92 districts. To decentralize health care beyond the national level, each county and district has a health office [5]. The County Surveillance Officer (CSO) supervises the District Surveillance Officers (DSOs) who supervise disease surveillance and reporting at health facilities and communities within the district. In Montserrado, the capital county, the seven districts are further divided into 22 zones, each managed by a Zonal Surveillance Officer (ZSO). Subsequently, surveillance focal persons, community health volunteers, and port health officers were recruited at the health facilities, communities, and points of entry, respectively.

The FETP-Frontline logic model

The description of the establishment, implementation, and evaluation of the Liberia FETP-Frontline (LFETP-F) was guided by the logic model developed by the US CDC Figure 1.

Establishing the Liberia Field Epidemiology Program

We reviewed and summarized records of meetings to describe processes leading to, and entities involved in the set-up of the LFETP-F.

Implementing the FETP-Frontline in Liberia We reviewed the curriculum and training structure of the Program, and records for the first to seventh cohorts of trainees to describe the processes of participant recruitment, and fieldwork outputs by person, place and time.

Evaluating the FETP-Frontline in Liberia

We used pre and post-test scores to assess knowledge acquired during the training. For each cohort, we compared the average pretest score and posttest score. We assessed skill retention after graduation using a post-graduation assessment tool. The three to six-month post-graduation assessment was done for cohorts 1 to 3 from June to November 2016. Staff of LFETP administered the semi-structured questionnaire to 50 randomly selected graduates and used a checklist for observation. Respondents and their supervisors were pre-informed about the visit of the assessment team. Key outbreaks detected and investigated by LFETP graduates were reported.

We conducted an in-depth interview with the Director of the Infectious Division Epidemiology of the National Public Health Institute of Liberia for his perception of the impact of the LFETP. We analyzed WHO-recommended IDSR indicators related to competencies built through FETP; timeliness of responding to health emergencies and outbreaks, and proportion of outbreaks investigated and responded to with investigation reports. Response to health emergencies and outbreaks is timely if surveillance officers initiate investigation and control within 48 hours of event notification.

We also assessed steps towards sustainability of the Program.

Results

Establishing Frontline FETP in Liberia

In May 2015, the Ministry of Health (MoH) hosted a meeting with health partners in Monrovia to discuss strategies for building capacity in outbreak investigation and response among the public health workforce in Liberia. A presentation by a joint team from US CDC, Emory University and African Field Epidemiology Network (AFENET) on the strategy and merits of the FETP-Frontline led to the adoption of the training program.

The stakeholders agreed that the first training would target the CSOs in the 15 counties and 13 DSOs who had been engaged in the two most populous counties, Montserrado and Nimba Counties. Subsequently, DSOs were to be recruited for each health district and enrolled in the training. Some national level officers were also to be trained, to provide supervision for the CSOs and DSOs.

The 15 CSOs, 13 DSOs and two national officers therefore formed the first cohort of 30 trainees whose training began on August 3, 2015. The Program Coordinator from AFENET secretariat and two consultants who were graduates of advanced-level FETPs in Ghana and Zimbabwe served as temporary faculty until full-time staff were recruited for the Program.

Structurally, the program was placed under the Department of Disease Prevention and Control (DPC) of the Ministry of Health and physically housed in the National Emergency Operations Center (NEOC). When the National Public Health Institute of Liberia (NPHIL) was created in 2016, NPHIL took over the NEOC building and DPC was re-designated the Department of Infectious Disease Epidemiology (DIDE).

Since its inception, the LFETP-F has been funded by the US CDC under its Global Health Security Agenda (GHSA). Emory University was initially contracted by the US CDC to provide technical support for the program. The University collaborated with AFENET to implement the program until February 2017, when AFENET was solely awarded the contract to execute the program.

Implementing the FETP in Liberia

Liberia FETP Staff

In October 2015, a Resident Advisor and two field coordinators were employed by AFENET as full-time staff for the LFETP. An additional full-time

field coordinator was recruited in February 2017 bringing full-time staff strength to four, including two Liberian field epidemiologists. All full-time epidemiologists were graduates of the advanced level field epidemiology training programs in Ghana and Nigeria. Two staff of the NPHIL served as part-time support in the capacity of Program Director and Administrative Officer. The involvement of NPHIL staff allowed NPHIL´s participation in the day-to-day running of the program.

Selection and orientation of participants

The initial target of CSOs and DSOs was expanded to include new cadre of surveillance officers being recruited; assistant CSOs, Zonal Surveillance Officers (ZSOs), and later, health facility surveillance focal persons and port health officers. Selection of participants/trainees for each cohort was done in consultation with the leadership of the MoH (and later NPHIL). Once the selection of trainees for a cohort was made, the Head of Training Unit, NPHIL sent emails to their county and/or national supervisors to release the prospective trainees for the period and to provide their support for the capacity-building process.

The approach was to cover middle level staff (CSOs) in the first cohort, and DSOs by geographic regional groups for the following cohorts. By the graduation of the fifth cohort in February 2018, LFETP-F graduates were distributed across every county in the country **Figure 2**. In subsequent cohorts, we trained officers who had been newly recruited to replace FETP-trained DSOs and CSOs who had left their posts, as well as ZSOs and facility level surveillance officers in Montserrado. For each cohort, some national level participants from NPHIL, MOH were also included **Table 1**.

At the beginning of each cohort´s training, participants were given an orientation during which NPHIL officials stressed the importance of the training and demanded their commitment.

Cohort size

The median cohort size was 24 (range: 21-30).

Gender distribution of participants

The overall male: female ratio among participants was 4:1. The gender distribution was not planned, as selection was solely based on job position.

Curriculum

The curriculum content, training materials and assessment tools used by the LFETP-F were provided by the FETP Curriculum Development Unit of the USCDC Atlanta **Figure 3**. In the process of implementation, the LFETP team made some adaptations to meet the needs of the Liberian surveillance workforce, including introduction of dry runs, modification of field guides, addition of MS Excel training, and the development of case-studies from field experiences and data collected by trainees during their FETP training.

During field intervals, trainees returned to their regular workstations and routine work activities as surveillance officers. Mentors were assigned by the program provided regular remote and in-person technical support to help trainees complete the FETP-F field projects. These projects included data quality audits (DQA), weekly surveillance reporting and data analysis, case or outbreak investigation, problem analysis using the fishbone method, narrative reports, and MS PowerPoint presentations.

Assessment of trainees during workshops was done through various individual and group assignments in class or as homework, daily quizzes on what had been taught the previous day, and pre- and post-tests. In addition, field work by the trainees was assessed by the field mentors under the following criteria: demonstration of understanding of concepts taught in class, attitude to work, and ability to accept correction and new information. Each trainee was required to deliver scientific presentations on their two fieldwork sessions. These presentations were critiqued by colleague trainees and LFETP mentors and scored by external assessors from NPHIL and USCDC on level of understanding of concepts, skills/competencies developed, and application of both in their fieldwork.

Participant outputs

As part of their training, each of the 170 graduates generated an expanded surveillance report covering a 12-week period from their area of jurisdiction and

conducted DQAs in 443 facilities out of 771 facilities in the country. A total of 108 (63.5%) trainees were involved in case and/or outbreak investigations Table 2. The DQA revealed gaps in surveillance data for improvement.

Schedule of training

Between August 2015 and March 2018, a total of seven cohorts of surveillance officers were trained. Each cohort´s training lasted about three months (82-110 days). Vacations, public holidays and conflicting activities largely accounted for the variation in training duration across cohorts. The training comprised three in-class workshops interspersed by two fieldwork sessions. An average of 13 days (14%) of the training period was spent in class, and 80 days (86%) on the field Figure 4.

Mentorship

With a range of three to four full-time mentors at a time, the mentor: mentee ratio was maintained at 1:3-10. The ratio was highest for Cohort 1 when only 3 mentors were available for the largest cohort of 30. Subsequently, two Liberians who had then graduated from the 2-year Ghana FELTP, as well as national and county level graduates of the LFETP, were engaged to provide support mentorship. Full-time mentors visited each mentee in-person at the mentee´s place of work at least once per fieldwork period to provide hands-on support and technical guidance for the mentee´s fieldwork.

Mentors were required to submit weekly reports on the progress of each trainee they mentored and at the end of the training, to submit a comprehensive report on the trainees based on the fieldwork assessment criteria (see curriculum and training schedule) to the Resident Advisor. The biggest challenge to mentorship was conducting site visits beyond Montserrado County during the rainy season, when some roads were unmotorable.

Graduation

The criteria for graduation was completion of all required class, field and scientific presentation outputs as described under the curriculum.

Out of 172 surveillance officers recruited for Cohort 1 to 7, a total of 170 (99%) graduated. Reasons for the two dropouts were ill-health in a female trainee in cohort 3 and conflicting schedule for a male trainee in cohort 6. Two trainees had their graduation deferred until they met the requirements for graduation.

Following each cohort graduation, the Resident Advisor and training team compiled a comprehensive report on each graduate and submitted to NPHIL. This report included the academic performance and attitude of the participant, level of competence attained, and recommendations for future training, continued supervision and/or refresher courses.

Graduates by cadre of staff

Graduates are national, county, district, zonal, facility-level surveillance officers, and port health officers Table 1. DSOs comprised 64% (109) of the graduates Table 1. By the end of Cohort 5, all counties and districts had been covered in the training. The position of assistant CSO was created in Nimba and Montserrado Counties to improve efficiency of surveillance in the relatively highly populated counties. Over the period, we trained 16 DSOs and CSOs who replaced previously trained officers Table 1. This brought the coverage of DSOs and CSOs to more than 100% Table 1. One participant in Cohort 3 was assigned by the Ministry of Agriculture. In Cohort 6, all 22 zonal surveillance officers were trained. Facility level surveillance focal persons training began from Cohort 7.

Evaluating the Frontline FETP in Liberia

Pre and post-test evaluation

Every cohort showed improvement in the average post-test score over the pre-test Table 3.

Post-training evaluation

Forty-eight (95%) of the 50 Liberia FETP-Frontline graduates who were assessed demonstrated retention of skill by maintaining rumor and outbreak logbooks, up-to-date disease trend charts and timely weekly reporting but 15 (30%) respondents admitted

that they still needed assistance in the use of the computer to generate their weekly reports.

LFETP-F graduates played key roles in key outbreaks investigations; EVD outbreaks in Montserrado County, November 2015 and March 2016, and the meningococcal outbreaks in Sinoe County, April 2017 and Lofa County, January 2018 [17]. In all these potentially devastating outbreaks, early detection and reporting, and extensive contact-tracing and monitoring by LFETP-F graduates helped to contain them quickly.

Trend of IDSR Indicators

Review of surveillance data from Liberia weekly disease bulletins showed an improvement in timeliness and completeness of reporting at all levels since FETP trainings began in the country.

According to Director of DIDE of NPHIL, "*before FETP, CSOs and DSOs presented surveillance reports as counts only*". He acknowledged that following FETP, analysis began to take place at the county, district, and zonal levels where officers had been trained and that logbooks of rumors and outbreaks were being maintained at district and county levels.

In the second half of 2017, the NPHIL reported a steady improvement in the timeliness of responding to health emergencies and outbreaks; Among 20 outbreaks investigated and responded to in that period, 78% were responded to within 48 hours compared to 37% in 2016, and 90% were documented with investigation reports, compared to 53% in 2016 [12]. These outbreaks included an unexplained cluster of deaths in Nana Kru Town in January 2017, and the meningococcal outbreak in Sinoe County in April 2017.

Sustaining the Frontline FETP in Liberia

Local capacity for surveillance supervision and mentorship

Officers at the national level have been trained in providing mentorship for frontline trainees. In addition, all CSOs have been trained to provide support mentorship. Liberian epidemiologists are engaged as full-time staff of Liberia FETP.

Funding

Funding alternatives were not clearly defined to ensure sustainability when the current US CDC funding arrangement ends.

Discussion

LFETP-F has accomplished its original objective of building capacity for outbreak detection, investigation, and response.

A total of 170 surveillance officers acquired the knowledge and skills to implement IDSR at various level of the health care system. Increase in post-test over pre-test scores is an indicator that the training resulted in improved knowledge among participants [13]. The effectiveness of the training can also be deduced from skill retention and improved IDSR indicators in Liberia, similar to experiences in Cote d'Ivoire and Benin that implemented FETP-F [14].

As an in-service training program, majority of the graduates returned to their pre-training job positions where they demonstrated improved capacity. Although this indicates achievement of the program objectives, clear career-building pathway with commensurate renumeration needs be considered within the public health system of Liberia to serve as an attraction for graduates to pursue fulfilling careers with surveillance and field epidemiology after the graduation from FETP. A similar recommendation was made from a multi-country analysis of FETP graduates in Africa [15].

According to adult-leaning principles, waning of FETP skills may occur if they are not frequently used [16]. To mitigate this, post-graduation evaluations, refresher trainings and simulation exercises and could be done regularly [17, 18]. A more objective post-training evaluation should be conducted by non-staff of the training program. The fore knowledge of the FETP graduates about the evaluation may also have provided the opportunity to 'clean up' before the arrival of the evaluation team.

Indicators are necessary to establish the impact of the training in the short and long term [19]. The assessment criteria used in this paper can be considered for use in other FETPs.

In the history of building Advanced (the two-year) FETPs across the world, a common challenge has been in finding trained epidemiologists to serve as mentors at the beginning until graduates can become mentors after two years of training [6]. In the frontline training, this challenge was not as acute, because of the availability of graduates of advanced programs from other African countries who can be imported to provide the service. In addition, with a shorter duration of the training, the turn-over of graduates who can serve as support mentors is high.

Starting as an MoH initiative, FETP-F has targeted human health officers for enrollment. However, in the light of the one health concept more attention needs to be placed on veterinary, environmental and laboratory officers to ensure that the mix of trained personnel is adequate for all nature of outbreaks [19, 20].

Since the LFETP has not been the singular effort to improve the IDSR in Liberia, it is a challenge to determine LFETP´s actual contribution. However, the improvement in the indicators shows that the combined effort is yielding positive result.

Drivers for implementation of FETP in Liberia

The implementation of FETP in Liberia may have been driven by several factors. Primarily, the devastating effect of the 2013-2015 EVD outbreak may have given rise to a resolve in Liberian public health authorities and workers to build enough capacity to detect and respond to any future public health emergencies. Secondly, funding for the program has been consistent over the period.

Thirdly, the MoH has owned the program from its beginning. LFETP has therefore enjoyed the support of the Ministry and NPHIL demonstrated in several ways, including having officials attend every cohort graduation ceremony. The fact that the trainees of the program are government staff is seen as an investment into building the health sector. Regular LFETP-F reports and meetings have kept stakeholders informed about the progress of the program.

Conclusion

The Liberia Frontline Field Epidemiology Training Program is meeting its objectives of building capacity for surveillance, outbreak investigation and response in the country. A sustainability plan which clearly outlines needs to be carefully developed by stakeholders to ensure that the gains achieved over the first three years are not lost in the future.

What is known about this topic

- The contribution of the two-year Field Epidemiology Training Program towards building capacity for surveillance is well-known. The relatively newer FETP-Frontline was introduced in many countries after the EVD outbreak of 2014.

What this study adds

- This article describes Liberia´s experience in implementing the FETP-Frontline from the planning stage to implementation up to the 7th cohort of trainees. It outlines how the program is achieving its objectives and provides reference to any country seeking to implement and evaluate its FETP-Frontline.

Competing interests

The authors declare no competing interests.

Authors' contributions

Dr Maame Amo-Addae conceived the idea of writing this article and wrote the initial and final drafts. Dr Peter Adewuyi and Thomas K. Nagbe provided additional information to the draft and conducted a thorough proofreading of the document. All authors accepted the final version.

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References

1. World Health Organization. **Ebola Virus Disease: Situat Rep**. WHO. June 2016. Accessed February 2019. **Google Scholar**

2. Nsubuga P, Johnson K, Tetteh C, Oundo J, Weathers A, Vaughan J, et al. Field epidemiology and laboratory training programs in sub-saharan Africa from 2004 to 2010: Need, the process, and prospects.Pan Afr Med J. 2011;10:1-1 **https://doi.org/10.4314/pamj.v10i0.72235** . **PubMed** | **Google Scholar**

3. Shuaib, Gunnala, Musa, Mahoney, Oguntimehin, Nguku, Nyanti, Knight, Gwarzo, Idigbe, Nasidi F. Morbidity and Mortality Weekly Report Ebola Virus Disease Outbreak — Nigeria. MMWR. 2014;63(39):867-72. **PubMed** | **Google Scholar**

4. Ministry of Health Liberia. **Republic of Liberia Investment Plan for Building a Resilient Health System in Liberia.** MOH Liberia. 2015. Accessed May 2019.

5. World Health Organization. **High Level Meeting on Building Resilient Systems for Health in Ebola-Affected Countries: Report of a Meeting.** WHO. 2014. Accessed May 2019.

6. World Health Organisation. **International Health Regulations (2005) - Third Edition.** WHO. 2016. Accessed February 2019. **PubMed** | **Google Scholar**

7. Nguku P, Oyemakinde A, Sabitu K, Olayinka A, Ajayi I, Fawole O, et al. Training and service in public health, Nigeria Field Epidemiology and Laboratory Training, 2008 - 2014. Pan Afr Med J. 2014; 18(Supp 1):2. **https://doi.org/10.11694/pamj.supp.2014.18.1.4930** **PubMed** | **Google Scholar**

8. López A, Cáceres VM. Central America Field Epidemiology Training Program (CA FETP): a pathway to sustainable public health capacity development. Human Resources for Health. 2008; 6:1-6. **https://doi.org/10.1186/1478-4491-6-27** **PubMed** | **Google Scholar**

9. Jones DS, Dicker RC, Fontaine RE, Boore AL, Omolo JO, Ashgar RJ, et al. Building global epidemiology and response capacity with field epidemiology training programs. Emerg Infect Dis. 2017; 23(Suppl 1): S158-S165.https://doi.org/10.3201/eid2313.170509 . PubMed | Google Scholar

10. Bell E, Tappero JW, Ijaz K, Bartee M, Fernandez J, Burris H, et al. Joint external evaluation — development and scale-up of global multisectoral health capacity evaluation process. Emerg Infect Dis. 2017; 23(Suppl 1):S33-S39.https://doi.org/10.3201/eid2313.170949. PubMed | Google Scholar

11. World Health Organization. Joint External Evaluation of IHR Core Capacities of the Republic of Liberia: mission report 2016. Geneva: World Health Organization. 2017. Accessed February 2019.

12. NPHIL, WHO. Liberia IDSR Epidemiology Bulletin 2019. NPHIL, WHO. 2019. Accessed February 2019.

13. Haniffa R, Lubell Y, Cooper BS, Mohanty S, Alam S, Karki A, et al. Impact of a structured ICU training programme in resource-limited settings in Asia. PLoS One. 2017; 12(3): e0173483.https://doi.org/10.1371/journal.pone.0173483. PubMed | Google Scholar

14. André AMK, Lopez A, Perkins S, Lambert S, Chace L, Noudeke N, et al. Frontline field epidemiology training programs as a strategy to improve disease surveillance and response. Emerg Infect Dis. 2017; 23(Suppl 1): S166-S173.https://doi.org/10.3201/eid2313.170803 PubMed | Google Scholar

15. Mukanga D, Namusisi O, Gitta SN, Pariyo G, Tshimanga M, Weaver A, et al. Field Epidemiology Training Programmes in Africa - Where are the Graduates? Hum Resour Health. 2010; 8:1-7.https://doi.org/10.1186/1478-4491-8-18 PubMed | Google Scholar

16. Voelcker-Rehage C. Motor-skill learning in older adults-a review of studies on age-related differences. Eur Rev Aging Phys Act. 2008; 5(1):5- https://doi.org/10.1007/s11556-008-0030-9. Google Scholar

17. Deveney MR, Scott KJ. Simulated aquatic animal disease outbreaks: a tool for improving responses to emergencies. Rev Sci Tech. 2008; 27(1):147-59. http://dx.doi.org/10.20506/rst.27.1.1795 PubMed | Google Scholar

18. Mellor N, Horton H, Luke D, Meadows J, Chatterjee A, Gale T. Experience of Using Simulation Technology and Analytics During the Ebola Crisis to Empower Frontline Health Workers and Improve the Integrity of Public Health Systems. Procedia Eng. 2016; 159: 44-52.https://doi.org/10.1016/j.proeng.2016.08.062 PubMed | Google Scholar

19. Bond KC, Macfarlane SB, Burke C, Ungchusak K, Wibulpolprasert S. The evolution and expansion of regional disease surveillance networks and their role in mitigating the threat of infectious disease outbreaks. Emerg Health Threats J. 2013; 6(1).https://doi.org/10.3402/ehtj.v6i0.19913. PubMed | Google Scholar

20. Monday B, Gitta SN, Wasswa P, Namusisi O, Bingi A, Musenero M, et al. Paradigm shift: contribution of field epidemiology training in advancing the "One Health" approach to strengthen disease surveillance and outbreak investigations in Africa. Pan Afr Med J. 2011; 10(Suppl 1):13. PubMed | Google Scholar

Table 1: Distribution of Liberia FETP-Frontline graduates by cohort and cadre of staff

Cohort #	1	2	3	4	5	6	7	Total trained	Number of personnel	Proportion trained by March 2018
District Surveillance Officers (DSOs)	13	21	17	19	22	0	17	109	92	>100%
Zonal surveillance officers (ZSOs)	0	0	0	0	0	22	0	22	22	100%
County Surveillance Officers	15	0	0	0	1	0	2	18	17	>100%
National Surveillance officers	2	2	4 *	4	2	2	0	16	N/A	N/A
Facility surveillance focal person	0	0	0	0	0	0	2	2	771	<1%
Port health officers	0	0	0	0	0	0	1	1	15	7%

** included 1 animal health officer*
> 100% coverage implies replacement staff have been trained

Table 2: Fieldwork output by Liberia FETP-Frontline graduates Cohorts 1 to 7 during training

	1	**2**	**3**	**4**	**5**	**6**	**7**	**total**
Number graduated	30	23	21	23	25	24	24	170
Number submitted expanded surveillance report	30	23	21	23	25	24	24	170
Number conducted a data quality audit	30	23	21	23	25	24	24	170
Number conducted a surveillance problem analysis	6	14	12	13	8	14	24	91
Number participated in an outbreak investigation	8	7	3	4	5	15	15	57
Number conducted a case investigation	7	2	7	4	13	8	10	51

Table 3: Average pre-post test scores, Cohort 2 -7, LFETP, 2015 - 2018			
Cohort	*Average pretest*	*Average posttest*	*Difference*
2	41.8	81.0	+39.2
3	65.9	81.4	+15.5
4	53.2	76.7	+23.5
5	59.2	77.6	+18.4
6	48.3	72.8	+24.5
7	55.4	75.4	+20.0

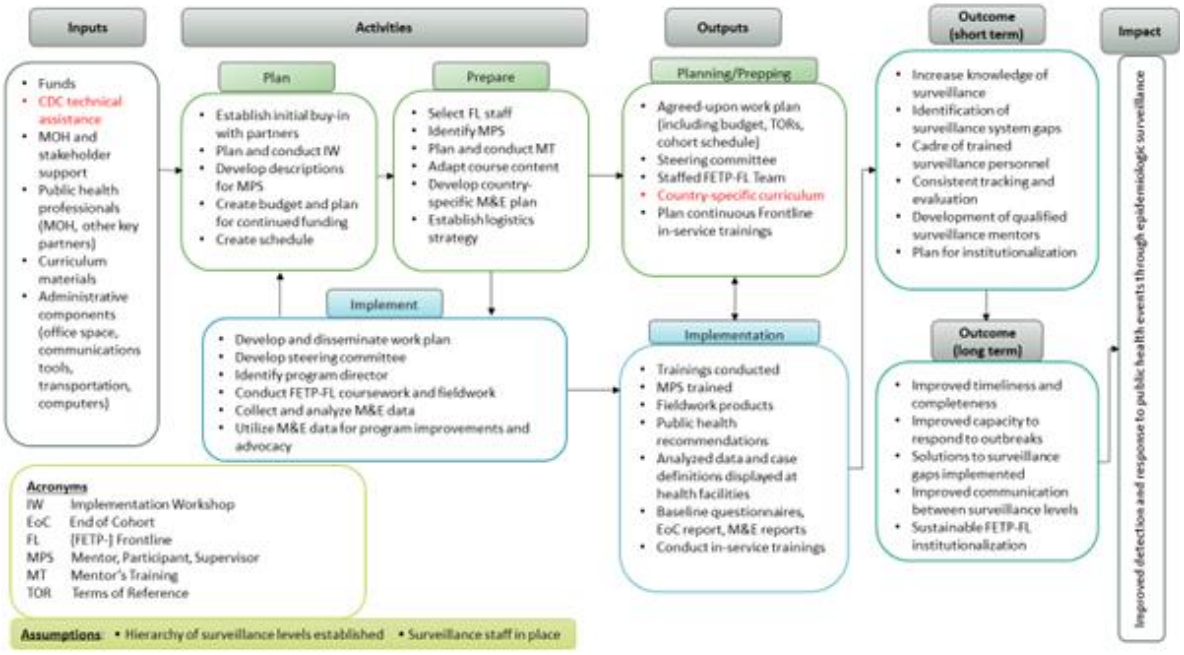

Figure 1: FETP-Frontline logic model

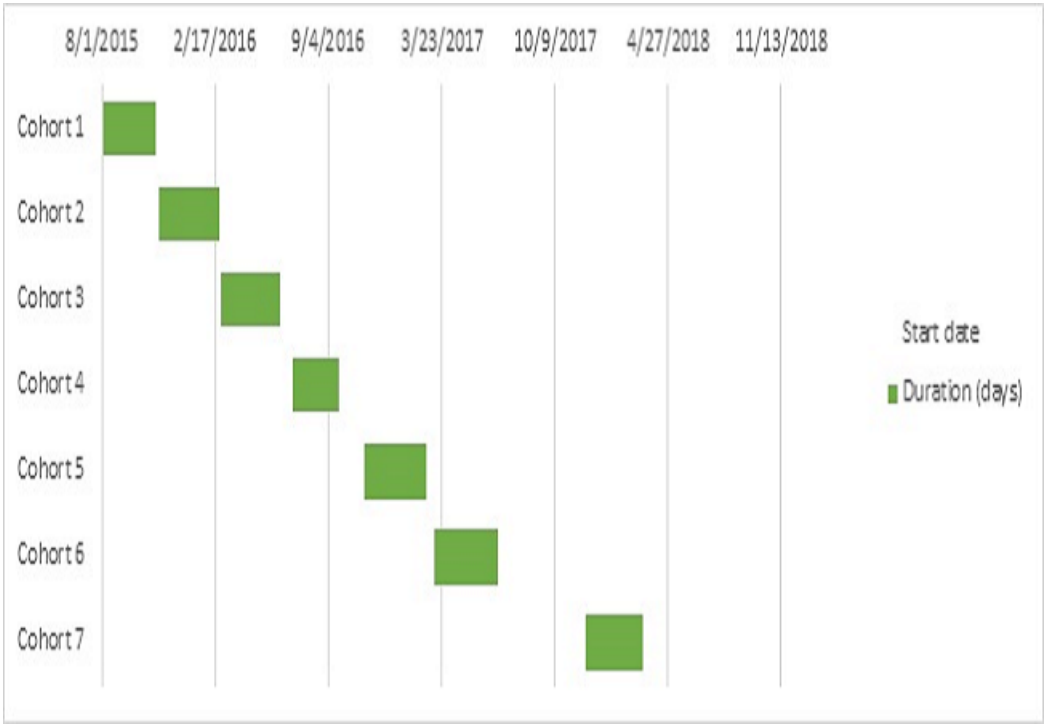

Figure 2: Geographical distribution of DSOs in FETP-Frontline Cohorts 1 – 5, Liberia, 2015-2017

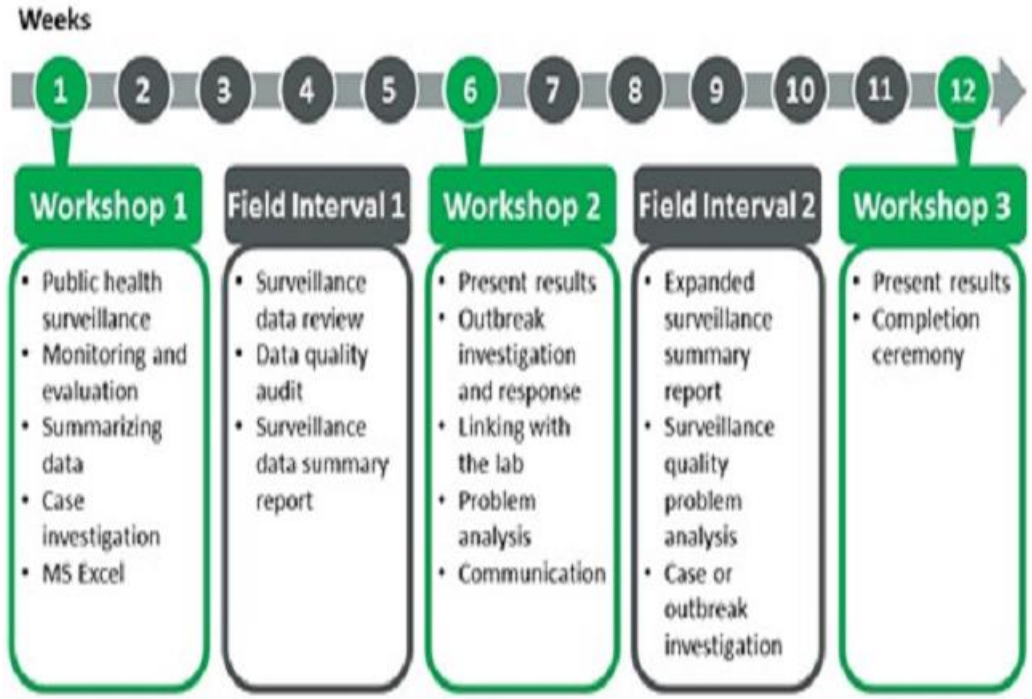

Figure 3: In-class and fieldwork time allocation and content for Liberia FETP-Frontline, August 2015 - 2018

Figure 4: Training dates and duration for cohorts 1 – 7