Field Epidemiology
In Action

Evaluating the Impact of Field Epidemiology Training Programs

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Summary

Since 1951, graduates of Field Epidemiology Training Programs (FETPs) have responded to disease threats all around the world. Graduates of these programs have the skills to collect, analyze, and interpret disease information, using evidence to take quick action and save lives. With over 14,000 graduates worldwide, FETPs have become an important part of building a global workforce of disease detectives. FETP program fellows learn by doing, spending 20-25 percent of their time in the classroom and 75-80 percent in the field. Programs are tailored to meet the needs of each country, recognizing differences in disease burdens, cultures, priorities, partners, capacities, and public health systems. As the world emerges from the current COVID-19 pandemic, the status of FETPs will likely increase as national governments re-examine their preparedness for public health emergencies and re-invest in strengthening their response workforces.

Despite the strong global growth of FETPs, there have been few attempts to systematically evaluate their impact. Evaluations, if done at all, rarely progress beyond a review of training processes and outputs. As countries seek to strengthen their response capacities, a more complete understanding of the impact of FETPs will be critical.

There have been enormous developments in evaluation theory and practice over the last few decades, with an increasing emphasis on impact evaluation. Kirkpatrick's four levels of evaluation set the standard for assessing training programs. Numerous evaluators have devised their own evaluation frameworks, with many building on the work of Kirkpatrick. Others, finding deficiencies in Kirkpatrick's four-levels, have proposed alternate evaluation models. Impact evaluation has become increasing important in the development sector with both donors and recipients insisting that program managers demonstrate impact. Many programs have avoided impact evaluations given their perceived complexity and high resource requirements. However, evaluators are increasingly using non-experimental theory-based approaches that are simpler and more cost effective than more traditional counter-factual approaches. Theory of change is a popular theory-based process for documenting the underlying pathways, assumptions and hypothesis underpinning a program or development

initiative. Once the theory has been established, the program can be evaluated using mixed methods to understanding why change does or does not occur. Evaluators often drawn on case-based approaches that focus on understand if, how and why a program contributed to its intended impact.

Background

Field epidemiology training programs (FETPs) are supervised, on-the-job, competency-based training programs for public health professionals. (1) They train field epidemiologists to collect, analyse, and interpret public health information, using evidence to take action and save lives. The FETP model was developed by the United States Centres for Disease Control and Prevention (CDC) in 1951 and has grown into a global multi-partner program. Today, there are FETPs in 86 countries and over 14,000 graduates worldwide. (1, 2) FETPs are designed to strengthen public health systems in four ways. First, they strengthen the workforce by increasing the number and quality of field epidemiologists. Second, they improve outbreak response capacity. Third, they enhance disease surveillance, data analysis and interpretation of the data. Finally, they promote the use of evidence based recommendations in decision making and policy development. (3)

FETPs should be closely aligned with the needs of the country and, as such, vary in scope and approach. Despite inter-program variations, FETPs are unified by shared core principles and connected through the global coordinating body, 'Training Programs in Epidemiology and Public Health Interventions Networks' (TEPHINET). A global strategic management group assesses emerging challenges and provides recommendations to the global FETP community. (1) In 2016, TEPHINET introduced a formal accreditation process and published a program evaluation guide promoting program consistency and quality. (2, 4)

As health security concerns have grown globally, FETPs have become increasingly recognised in national, regional, and global preparedness and response mechanisms. The International Health Regulations (IHR), revised in 2005 following the severe acute respiratory syndrome (SARS) outbreak of 2003, includes explicit targets for training field epidemiologists. (5, 6) The Global Health Security Agenda, launched in 2014 to support IHR implementation, also identifies training as a key element in strengthening health security. (7) At the regional level, the Asia Pacific Strategy for Emerging Diseases (APSED) identifies FETPs as an essential part of progressing IHR 2005. (8) An evaluation of the first ten years of APSED implementation concluded that significant progress had been made in the implementation of IHR. In particular, improvements were noted in the Member States' capacity to develop human resources through FETP. However, the evaluation concluded that all Member States in the Asia Pacific region remained vulnerable to emerging diseases and public health emergencies, and that national and regional readiness to respond to large-scale and complex events in an effective and coordinated way was still lacking. (9) In 2017, the WHO updated and renamed ASPED to the Asia Pacific Strategy for Emerging Diseases and Public Health Emergencies III (APSED III). In this revised strategy, field epidemiology training is mentioned under two of the eight focus area. The strategy mentions the development of "an adaptable, skilled workforce, incorporating FETP trainees and alumni and other technical experts, to carry out surveillance, risk assessment, and response" and the need to "develop and maintain a register of experts, including FETP fellows and alumni, available for rapid regional and global deployment in response to disease outbreaks and public health emergencies". (8)

FIELD EPIDEMIOLOGY TRAINING

Introduction

Field epidemiology training has developed and diversified over time. There are numerous approaches, models, and curricula in use. The length of training varies from a few months to two years. Some are housed in departments of health, and others are university-based, offering certificates or degrees. Some programs have incorporated laboratory or other specialty tracks or adopted an One Health focus. (16) The field epidemiology training model is also used beyond human health with some programs focused on animal health. While these variations are necessary to deliver training programs of relevance in the varied settings in which they are offered, there are strong commonalities between them. Field epidemiology training programs share the following characteristics:

1. **Programs are field-based**. As "learning by doing" is a fundamental feature of FETPs, fellows spend the majority of their time in the field. Typically more than 70% of program time is field-based, (7), although this ranges from 60% - 90%, with more classroom time required for degree-granting programs. (17) FETPs require host institutions to place trainees. These placements may be the substantive position of the fellow or a different public health institution that has volunteered to serve as a FETP placement site.
2. **Programs are competency-based**. As an applied discipline, field epidemiology training focuses on developing technical competencies rather than achieving academic milestones. Competencies are defined as a cluster of related knowledge, attitudes, and skills that affect the major part of one's job. Competencies can be measured against well-accepted standards and improved through training. (18)
3. **Fellows learn through service.** While placed in public health departments and agencies, trainees contribute to core epidemiology functions. With guided mentoring and supervision, fellows analyse surveillance data, detect and respond to outbreaks and other health emergencies, conduct planned epidemiological studies of interest to hosting agencies, communicate scientific findings and translate those findings into public health actions. (7) Fellows are often given focused projects to own. (12)

The goal of FETPs is to "develop skilled and experienced epidemiologists who can detect and respond to disease outbreaks, conduct and evaluate surveillance, carry out applied epidemiological studies, evaluate programs and develop technical policies, all to turn public health data into action". (1) In the long term, FETPs aim to provide a critical mass of competent health workers to respond to acute public health issues and strengthen the health system. (15)

In 2019, most FETPs with TEPHINET membership were hosted by Ministries of Health (69%, n=46), with the remainder hosted by National Institutes of Public Health (27%, n=18), universities (27%, n=18), or other agencies (6%, n=4). (19) In 2019, 39% (n=26) of these FETPs offered Masters Degrees in epidemiology (82%), public health (14%), or other disciplines (4%). (19) The professional backgrounds of the 1632 fellows from all 67 programs were: physicians (25%), epidemiologists (25%), nurses (20%), allied health workers (12%), veterinarians or para-veterinarians (9%), laboratory technicians (5%), biologists (4%) and entomologists (1%).

Over the years, several programs have moved to offering degree-granting FETPs as a means of career enhancement. Some of these programs have, however, lost their "learning by doing" focus and become more attuned to a traditional academic MPH program. (16) This has led, in some cases, to a loss of ownership and interest in the program by the relevant Ministry of Health. The Indonesian FETP, for example, started in 1982 as a non-degree program and moved to a Master's degree-granting program in 1990. The training became increasingly university-based, with decreased engagement with government agencies and reduced funding for field projects. (20)

FETP History

The first FETP commenced in Atlanta, Georgia, in 1951. (21) In response to the threat of biologic terrorism during the Korean war, Alexander Langmuir, the chief epidemiologist of the Communicable Disease Center of the United States (now known as the US CDC), established the Epidemic Intelligence Service (EIS). (7) This 2-year program trained field epidemiologists who were capable of rapidly responding to public health threats. The training model focused on "learning while doing", combining the hands-on experience of the medical residency with the case study methodology used by the John Hopkins School of Hygiene and Public Health in Baltimore, Maryland. After brief classroom instruction, the EIS officers were placed in health departments at the national, state and local levels and in universities. While on-assignment officers applied epidemiological skills for surveillance, conducting specialized studies, and responding to disease threats. (21) On-site mentors provided ongoing supervision. "Training through service" became the cornerstone and distinguishing feature of the EIS program. It has never become an academic degree-awarding program. (22)

The EIS program flourished on Langmuir's assumption that good things would happen if bright, motivated, and ambitious young officers were challenged with real-world health problems. (21) During its first 63 years, EIS trained 3641 health professionals. (22) The majority (~85%) of graduates entered the public health workforce with a number going on to hold important positions in public health, including Acting Surgeon Generals, CDC Directors, and State epidemiologists. (23, 24) EIS fellows demonstrated the value of the program as they lead investigations of local, state, of national and global importance, including Polio (1955), Smallpox (1966), Legionnaires disease (1976), Ebola (1976, 2014), HIV/AIDs (1981), Anthrax (2001), SARS (2003), Ebola (2014), Zika (2016) and COVID-19 (2020). (25)

In the 1970s, the EIS training model was replicated in other countries. In 1975, the first FETP outside of the United States was established in Canada. In 1980 the first FETP outside North America was established in Thailand. (7, 26, 27) Subsequently, programs were established in Asia, the Americas, Australia, Europe, and Africa. (27) Today, there are 86 FETPs serving more than 160 countries throughout the world. (1) Positioning within Ministries of Health allows FETP fellows to address priority issues identified by their Ministry of Health. (16)

With time FETPs adapted as they responded to country needs and demands. Curriculums were tailored, with some programs partnered with degree-granting academic institutions. (16). Some programs incorporated a laboratory component and became known as Field Epidemiology and Laboratory Training Programs (FELTP). (28-32) Others adopted a regional training approach supporting training needs for several countries. Examples include Central

America FETP, French-speaking East African FETP and Central Asia FETP. (2, 7, 29, 33) These regional programs support countries who are not positioned to host their own programs and often provide fellows with exposure to a broader set of health challenges, a more diverse range of supervision and a richer experience. (15) There are also an increasing number of One Health and veterinary based FETPs being developed around the world. Other specializations offered by FETPs include management, monitoring and evaluation, social and public health sciences, health inspection, health education and public health leadership. (34, 35)

To train field epidemiologists at all levels within a country, a three-tiered training approach has been adopted by several countries (36). These tiers are often referred to as Frontline (or Basic), Intermediate, and Advanced FETP, with Frontline programs targeting health workers at the local/district level, Intermediate the regional level, and the Advanced at the national level. (37, 38) The curriculum of this 3-tiered training program is based on fundamental competencies needed at each level of the surveillance system. (27, 37)

In 1992, the Public Health Schools Without Walls program was started in response to the public health capacity needs in low-income countries. Similar to EIS, this program emphasized the combination of rigorous academic and extensively supervised practical experience. (39) Some countries in Africa commenced FETP under the umbrella of the Public Health Schools Without Walls, including Zimbabwe in 1993, Uganda in 1994, and Ghana in 1995. (40) These programs differ from those modelled after EIS in that fellows spend more time in the classroom (~40%) and a Master of Public Health is awarded to graduating fellows.

As the number of programs increased, concerns arose over training inconsistencies and varying quality. This led to two responses. Firstly, the CDC developed a standardized curriculum in 2005. (27) The instructional design staff used a model known as ADDIE (analysis, design, development, implementation, and evaluation) to guide the development of a curriculum around 16 core competencies and 47 instructional goals. (27) The core competencies were:

1. Use epidemiologic practices to conduct studies that improve public health program delivery
2. Respond to outbreaks
3. Analyse epidemiologic data using appropriate statistical methods
4. Manage a public health surveillance system
5. Use laboratory resources to support epidemiologic activities
6. Develop written public health communications
7. Develop and deliver oral public health communications
8. Use computers for specific applications relevant to public health practices
9. Manage a field project
10. Manage staff and resources
11. Be an effective team leader and member
12. Manage personal responsibilities
13. Apply simple tools for economic analysis
14. Train public health professionals
15. Mentor public health professionals
16. Evaluate and prioritize the importance of diseases or conditions of national public health concern

The second response was the development of a continuous quality improvement handbook for FETPs. (4) This handbook, developed by TEPHINET, provided an evaluation framework for FETPs.

Since 1951, FETPs have grown in number and importance as countries around the world have sought to strengthen their defence to known and emerging diseases. The COVID-19 pandemic has uncovered critical vulnerabilities in national, regional, and global health security and has highlighted the speed and ease at which infectious disease can spread. While FETPs are not a panacea, their importance will likely increase as countries look to bolster workforce capacity at all levels to adequately prepare for, detect and respond to such threats. Dr. Thomas Frieden, Director of CDC from 2009-2017, identified FETP as one of CDC's key activities in improving global health, stating "The Field Epidemiology Training Program… may be the single most important thing CDC does in global health". (3)

Field Epidemiology Networks

In the late 1980s, faculty and fellows of FETPs started participating in international conferences. These meetings provided an opportunity for program directors to meet and share learnings. It was soon realised that a better mechanism was needed to enhance the coordination of FETPs. In 1997, a series of meetings coordinated by the World Health Organization and the CDC lead to the creation of the Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET). (27) The mission of TEPHINET is to "empower and mobilize a competent field epidemiology workforce to serve all people through standardised training, experiential learning, training program quality improvement, mentoring, and knowledge exchanges in order to connect epidemiologists better, faster, and with quality across the globe". (2) Today TEPHINET is a professional network of 71 field epidemiology training programs (FETPs), including those with laboratory and veterinary components. The network fosters collaboration and peer-to-peer assistance, promotes program quality, supports continuous learning, and facilitates the mobilisation of trained field epidemiologists in response to global disease threats. (1) On a global scale, TEPHINET covers more than 14,000 trainees and graduates. (2)

In 2000, TEPHINET held its first independent global conference in Ottawa, Canada. Since then, TEPHINET has held nine global conferences and nineteen regional conferences in the Americas, Southeast Asia, and the Western Pacific regions. (2) Several regional FETP support networks have been established to foster regional collaboration and cooperation. These including the African Field Epidemiology Training Network (AFENET), the Eastern Mediterranean Public Health Network (EMPHINET), the South Asia Field Epidemiology Network (SAFETYNET), the European Programme for Interventional Epidemiology Training (EPIET), and the network of Central and South American FETPs (REDSUR).(1, 7, 41, 42)

In October 2008, TEPHINET merged with The Task Force for Global Health, a non-profit organisation based in Atlanta. The organisational structure of the Task Force provides TEPHINET with administrative and management support and allows TEPHINET to achieve better economies of scale for supplies and services. (2)

Field Epidemiology Training Accreditation

In response to the growing number of FETPs around the world and the variation in their administration, TEPHINET has developed and implemented an FETP accreditation process. The main goal is to maintain and improve program quality. (3, 7, 43). Accreditation provides an opportunity for programs to align with common training standards. Accreditation commenced in 2016 with EIS, the Canadian FETP, and the UK FETP. To date, 17 programs have been accredited. The accreditation standards include:

1. Management, Infrastructure, and Operations
2. Integration with Public Health Service
3. Staffing and Supervision
4. Selection and Training of Residents
5. Continuous Quality Improvement (2)

The accreditation process can take up to a year and includes an in-country visit from an accreditation review team. Any program can use the accreditation indicators and standards to identify areas of improvement regardless of its intent to apply for accreditation.

FETP Outputs, Outcomes, and Impact

One of the goals of FETPs is to provide a cadre of health professionals who are capable of responding to acute public health threats, develop policies based on scientific evidence and strengthen health systems. (43) Many fellows directly respond to outbreaks and produce evidence to strengthen health systems during their candidature. After a program has been in existence for several years, it is not uncommon to find graduates occupying the highest levels in the public health system. (15) Retention of graduates within the country's public health system is a crucial priority for FETPs. Although several programs have published retention rates, it is difficult to compare across countries given the different time frames used. Some countries have struggled to keep their graduates within the national public health structure. Yemen, for example, retained only 28% of FETP graduates in the government public health system seven years after the program commenced. Many (43%) obtained employment with international organisations, including WHO. (44) On the other hand, Papua New Guinea reported 98.7% of graduates from 2013-2018, who were working in the public service when enrolled, continued to work in the public service in 2019, after graduation. (45) Other programs report retention rates from 56-88%. (7, 12, 36, 46) Developing a career pathway for graduates is seen as an important measure to retain graduates. This requires demonstrating the impact of a network of field epidemiologists collaborating at various levels within government structures. (36)

The number of outputs from 21 Intermediate FETPs (320 graduates) and 51 Advanced FETPs (2778 graduates) in 2018 is summarised in Table 1. (19) The focus on applying skills in outbreak response is a central tenet of FETPs; almost 40% of all graduates reported being involved in an outbreak investigation. From 2005-2007, FETP fellows responded to ~3300 outbreaks (7), and from 2009 – 2012, 4663 outbreaks were investigated. (17) Surveillance system strengthening is another core competency taught during FETPs. From 2009 – 2012, 1255 surveillance systems were evaluated by FETP fellows. (17)

Table 1. Number of outputs from 21 Intermediate and 51 Advanced FETPs in 2018

Output	Number (Intermediate)	Number (Advanced)	Total
Outbreak investigations	151	1014	1165
Public health analysis	130	442	572
Oral presentation at a conference	91	659	750
Surveillance system evaluation	53	534	587
Develop/implement surveillance system	50	189	239
Epidemiological study planned	28	550	578
Scientific protocol prepared	28	521	549
Poster presentation at conference	24	492	516
Peer-review publication	14	479	493

A review of the literature shows the diversity and importance of the public health issues tackled by fellows. Below is a summary of key FETP outputs published in peer-reviewed literature:

- Outbreak investigations
    - Ebola in West Africa (~70 graduates from 9 countries) (7, 47-50)
    - Widespread typhoid outbreak in Kampala, Uganda (51)
    - Encephalopathy outbreak in India linked to litchi consumption (52)
    - Severe Acute Respiratory Syndrome (SARS) (17, 27)
    - West Nile Virus (17)
    - Avian (H5N1) and swine (H1N1) influenza (17)
    - Yellow Fever (17)
    - Cholera (15, 17, 53, 54)
    - Typhoid (15)
    - Measles (17, 44)
    - Rabies (17)
    - Hepatitis A (15, 55)
    - Polio (54, 55)
    - MERS-CoV (56)
    - Marburg (57)
    - Foodborne diseases (15, 57)

- Surveillance System Support
    - Transition to integrated disease surveillance in the US (12)
    - Mass gathering surveillance for sporting events (e.g., World Cup in South Africa (12, 58)), political conventions and global religious meetings (e.g., a religious mass gathering in Saudi Arabia, Pakistan, Morocco, Iraq, and Jordan (59-62))
    - Surveillance following natural disasters (15, 63)
    - Development of new surveillance systems for infectious diseases, behavioural risks, injuries (15)
    - Early warning systems, including emergency department surveillance (12)
    - Strengthening surveillance during 2014 MERS outbreak in Saudi Arabia (7)
    - Establishing surveillance in Jordan during the Syrian refugee crisis in 2014 (56)

- Post-Disaster Response Activities
    - 2004 Indian Ocean tsunami (17, 20)
    - 2010 earthquake in Haiti (17)
    - 2011 Bomb blast in Dar-es-salaam, Tanzania (53)
    - Hurricane in Guatemala (2007) and Honduras (2007) (36)

- Prevention and Control Activities
    - Supporting global initiatives such as the Global Polio Eradication Initiative, HIV/AIDS, malaria (15, 64-66)
    - Conducting national cluster surveys on nutrition in the Philippines (15)
    - Country assessment of the International Health Regulations core capabilities in Tanzania (53)

- Communication Products
    - Oral or poster presentations at conferences (2534 from 2009-2012 (17))
    - Peer-reviewed publications (1001 from 2009-2012 (17))

While the list of outputs from training programs is impressive, there are few papers that focus on outcomes or impacts of FETPs. Papers that do make mention of outcomes or impacts are generally sharing success stories rather than reporting on the results of a systematic evaluation process. A selection of outcomes and impacts are presented below:

- Dramatic fall in fireworks-related injuries after Philippines FETP established an injury surveillance system and a fireworks injury intervention program (15)
- Improvements in vaccine coverage, changes in the age of vaccinating susceptible children, and reassuring the public about vaccine safety following FETP led surveys and outbreak investigations in the Philippines (15)
- FETP led investigations into cholera in the Philippines led to repairs and reconstruction of water systems (15)
- FETP fellows and staff investigated the Reston strain of Ebola in the Philippines leading to evidence for National policies (15)
- FETP Thailand conducted studies that led to the implementation of national control programs for measles, Hep B and HIV (15)
- A rubella investigation by Thai FETP led to a change in the national vaccination schedule (67)
- A botulism outbreak in Taiwan was investigated by FETP fellows who identified a commercially prepared peanut product, which subsequently led to the countries first ever food recall (67)
- An investigation of meningococcal meningitis during Hajj resulted in enhanced surveillance and treatment; follow-up studies confirmed that that single dose of ceftriaxone sodium could eliminate the carrier state (67)
- HIV/TB HIV screening among TB cases in a district in Papua New Guinea increased from 24% to 62%; 50 new coinfections were detected, and patients referred for antiretroviral therapy (Enga Province).

- Anti-retroviral therapy uptake in TB/HIV coinfected patients increased from 50% to 90% in integrated HIV/TB sites and from 20% to 70% in non-integrated HIV/TB sites in Papua New Guinea (National Capital District) (45)
- FETP Fellows from Papua New Guinea recorded an increased number of vaccination clinic sites in East New Britain Province from 16 to 38 and increased cumulative pentavalent vaccine coverage from 40% to 60% in 1 year (45)
- FETP fellow from Papua New Guinea increased adherence to post-exposure prophylaxis (PEP) for survivors of sexual violence from 21% to 75% through the introduction of four cost-effective interventions: provision of anti-emetics, cash for transport to the clinic, implementation of a PEP clinic log-book, and follow-up reminder calls (45)
- Starting new vaccine initiatives for rubella and Japanese Encephalitis in Lao (68)

FETP Evaluation

Training programs are often evaluated to demonstrate value to donors and decision-makers, and to improve the implementation and outcome of the training. However, evaluations of training programs is often limited to variables that are easy to measure, such as process indicators (e.g., reaction of trainees to the training) or simple output indicators (e.g. number of students graduating). (69-71) Few programs attempt to address the outcomes and impacts of the training, such as how the trainees apply their new knowledge, skills, and attitudes or how the training makes an impact beyond the workplace. The evaluations of FETPs are no exception. Within the literature, there are numerous papers describing experiences and lessons learned from FETPs, (16, 45, 72, 73) with a number reporting on process indicators. (17, 36, 37, 54, 57, 74-80) There is minimal information regarding outcomes and impacts of FETPs. Although several papers describe stories of impact, these 'highlights' were not captured in the context of a structured evaluation, are not quantifiable, and there is no indication as to whether these impacts were sustained, replicated, or translated in any meaningful way. Several studies have focused on retention and career progression as an indicator of program impact on individuals and organizations. (74, 81, 82) Lopez et al. provided examples of how FETP initiatives contributed to policy; however, the impacts were not quantified. (36) Det et al. suggested that quantifying the impact of changes in practice attributed to FETPs, through regularly and systematically collecting examples from services and stakeholders, may provide more robust evidence of FETP impact. (83)

The growth of FETPs and their outputs point towards a training program that is highly successful. However, further rigour examining FETP impact is required to validate stories of impact and identify opportunities to improve training further and maximise results. Patel et al. suggested that many FETPs have in fact, failed to bring about transformational change. (84) One of the reasons for this failure, Patel postulates, is the poor integration of FETPs into a country's broader capacity development strategy. He states that "to focus on a training program as a public health capacity development measure in itself is to bury a good idea under the weight of expectation". Patel suggests that FETP curricula need to focus on softer management skills to facilitate the translation of investigation and research finding into tangible and lasting impacts. He highlights the need for FETPs to go beyond the production of reports, papers, and presentations of results, and to rather focus on impact. To do this, a broader skillset may be required as the translation of outputs into impacts will likely require

engagement with policymakers, multiple government departments, non-governmental organizations, and donors. Investigation of outbreaks, evaluation of surveillance systems, conducting field projects, publishing papers and presenting at conferences, while useful output indicators, all fail to advance health in any significant way unless they are translated into practical outcomes. The quantity, and even quality, of outputs, does not necessarily equate to service, organizational, or public health impact. (83) As fellows are only in the program for a limited time (1-2 years), there is little opportunity for fellows to directly impact policy during their candidature. Strong ties between the FETP and key governmental decision and policy makers is critical to facilitate knowledge translation.

Within the FETP sphere, two global guidance documents address FETP evaluation. The first is the CDC Field Epidemiology Training Program Development Handbook. (85) The final chapter in this manual provides an overview of FETP monitoring and evaluation. Using a logic model as its basis, this evaluation framework consists of the following six steps: (1) engaging stakeholders, (2) describing the program, (3) focusing the evaluation design, (4) gathering credible evidence, (5) justifying conclusion, and (6) using and sharing lessons learned. No details are provided on specific evaluation methods or models, and no tools or templates are provided. TEPHINET's Continuous Quality Improvement Handbook provides a more detailed evaluation framework and includes data collection forms. (4) The handbook outlines 16 core competencies and 21 core learning activities for FETP fellows. Using a logic model, a series of input, process, output, outcome, and impact indicators are suggested. In total, there are 173 indicators recommended for evaluation; most are input, process, and output indicators. The following indicators are presented under outcomes:

- Graduates working in-country (number and %)
- Graduates working in government public health service (number and %)
- Sub-national administrative areas with graduates (number and proportion)
- Directory of trainees and graduates
- New epidemiology/surveillance units created or improved (y/n)
- Surveillance systems set up/improved by FETP staff/trainees (number)
- Programs/projects created in response to recommendations of FETP (number)
- Laws/ordinances/regulations in response to recommendations made by FETP (number)
- Policy recommendations implemented in the short and long term (number)
- Participation in international investigation & response teams by fellows and graduates (number/year)
- Membership/participation of program in international networks (y/n)
- Membership/participation of Ministry of Health surveillance unit in regional or global surveillance systems (y/n)

The one impact indicator is the change in the health status of a target population resulting from the implementation of a recommendation from the training program.

Published FETP Evaluations

The following published FETP evaluations were identified in the literature:

United Stated EIS (FETP), 1991-1996

Moolenaar et al. evaluated EIS classes of 1991-1996 using two specific outcomes measures; publications and job choices. The number of peer-review publications by EIS graduates and the number of times each publication was cited in the literature were used to create an impact factor. The mean number of articles published was 1.7 (median 1, range 0 – 8), with each paper being cited an average of 16.7 times (median 6, range 0-526). Just over one-quarter of EIS graduates chose to serve in the state or local health departments and contribute to the public health infrastructure at the local level. EIS officers who were placed outside of the CDC Headquarters for their training were more likely to work at the state and local levels. The authors noted the limitations associated with the use of publications as indicators of impact. The publication is only one outcome measure and does not reflect the contributions made through service to the departments hosting the fellows. Fellows placed in the field, compared to those at CDC headquarters, were more likely to prioritize disease control activities over epidemiological investigations that lent themselves to publication. The authors concluded by raising questions about what outcomes should be used to measure the success of a program. They acknowledged that the choice of the outcome measure is likely to drive, as well as reflect the priorities of the program. Other outcome measures proposed include the number of investigations completed, scientific presentations given, contributions to public health practice, or subjective evaluations provided by fellow and supervisors.

Multisite FETP evaluation, 1996

This multisite FETP evaluation was commissioned by the CDC in 1996. (15) It involved programs in Mexico, Thailand, Philippines, Spain, and Uganda. Researchers conducted interviews with trainees, staff, health program managers, political decision-makers and donors. The managers and decision-makers reported numerous examples of how information produced by fellows and graduates was valuable to them in designing and implementing health programs. Fellows and graduates formed functional networks in the countries' health systems, and nearly all graduates remained in public health. (15) The team conducting the evaluation found that despite not awarding degrees, the FETPs provided a viable career ladder for national staff. (15)

India FETP, 2012

Bhatnagar et al. evaluated the Indian FETP by a review of program documents, reports prepared by fellows, abstracts and papers, and an online survey of graduates. The survey included: self-perceived competencies before and after FETP, learning activities, field assignments, supervision, curriculum, relevance to career goals, strengths, and weaknesses. Using a logic model, the evaluation focused on five key program elements: (1) students, (2) curriculum, (3) faculty teams, (4) fieldwork, and (5) laboratory support. Output measures included: the number of graduates, dissemination of field reports and investigations conducted. Program success was defined as a workforce qualified in applied epidemiology, a network of graduates, institutional training capacity, evidence-based public health decisions, and sustainability of the program.

Multisite FETP evaluation, 2012-2013

The CDC and TEPHINET conducted a multi-site evaluation of seven FETPs using a balanced scorecard approach, as described by Jones et al. (43) This was the first systematic study in more than ten years that looked at a standardised and structured way to evaluate FETPs. An external team met with FETP program staff in several countries to undertake a program evaluation focused on quality and sustainability. The indicators were based on key elements for success, as outlined by TEPHINET in their Continuous Quality Improvement Handbook. (4, 20) The five domains evaluated included training, fieldwork, leadership development, management, and sustainability. Under each domain, a series of key evaluation questions were used to assess each FETP. The evaluation questions were primarily process focused (e.g., what is the operational status of the curriculum? Is it competency-based? What is the status of policies and procedures for the program? What is the status of an advisory board for the program, etc.), with some touching outcomes measures (e.g., what is the status of public health studies done by the trainees? What is the MOH retention of graduates?). This scorecard evaluation was conducted in four countries in Latin America, two in Africa and one in the Middle East. Evaluations took ~5 days of in-country consultations and cost between USD 10,000-20,000 per country.

To assess the quality of fellows' work, the evaluation team also developed and implemented a blinded, systematic, consensus expert review of abstracts submitted to the 10th Global TEPHINET conference. (71) Abstracts were used because they provided a common activity that could be assessed across FETPs as all fellows were required to submit a TEPHINET abstract. The evaluation team considered the abstract as a marker of the achievement of core FETP competencies. The review of abstracts allowed the team to move beyond assessing what fellows had learned to assessing changes in their behaviours as a result of what they had learned. A random selection of abstracts from 10 FETPs was reviewed and scored by an expert panel. Seven review criteria were evaluated: (1) rationale for the study and study objectives, (2) methods, (3) results, (4) conclusion, (5) public health significance, (6) usefulness and the potential effect of recommendations, and (7) overall clarity of abstract. Each of the criteria was evaluated using three questions: did the authors do the right thing, did the authors do it the right way, and is the writing clear and logical. The inability to know how much the FETP mentors/advisors helped in the preparation of the abstract was highlighted as a limitation of this approach. The assessment team was able to quickly identify program areas of strength and weakness and assist programs in developing plans focused on priority areas for improvement. No program scored uniformly high or low across all indicators. This demonstrates that the programs had a variety of strengths and weaknesses that could be individually identified with this process.

Multisite FETP evaluation, 2014

In 2014, the findings of a multisite evaluation of ten FETPs was published. (3) Several different FETP models were included in the evaluation, including national and regional programs, university-affiliated and non-affiliated, part-time and full-time, and those with and without a laboratory track. The evaluation focused on process indicators and did not attempt to examine the impact of the programs, although examples of short-term outcomes were included. Based on these indicators, the more successful programs were identified as those with a strong ministry of health ownership. University-affiliated programs had added complexity, cost, and sometimes competing priorities.

United Kingdom FETP, 2018

The only study specifically evaluating the impact of an FETP was published by Dey et al. Using mainly qualitative methods, Day et al examined the impact of the United Kingdom FETP in 2018. (83) The framework used for the evaluation was Kirkpatrick's model for training evaluation. (86, 87) The team specifically focused on levels 3 and 4 of this model. Level 3 focuses on the degree to which participants apply what they learn during training when they are back on the job and level 4 on the degree to which the targeted outcomes occur as a result of the training. The evaluation was conducted through focus groups with supervisors and staff, individual interviews with stakeholders (policymakers, managers, experts), and an online survey of graduates and current fellows. The evaluation focused on assessing progress towards meeting the program's three objectives of (i) strengthening capacity and provision of national epidemiology services, (ii) developing a network of highly skilled field epidemiologists with a shared sense of purpose working to common standards and (iii) raising the profile of field epidemiology by embedding it into everyday health protection practice. The following tree cross-cutting themes and twelve subthemes emerged from the analysis:

- Confidence
    - Practice preparedness
    - Capacity to deliver field service provision
    - Skilled workforce
    - External reputation
- Application
    - Understanding broader context
    - Developing partnerships
    - Networking
    - Application to other fields
- Rigour
    - Research and evidence
    - Constructive challenge to working practices
    - Innovation
    - Sharing good practice

The study was able to assess progress against these objectives as well as provide a deep understanding of the reasons and enabling factors permitting this progress. Several opportunities for further strengthening the program were identified, such as extending the remit of the program to non-communicable diseases. Through the interviews, the evaluators were able to gain insights into how and why participants felt that FETP had contributed to change in public health practice.

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