



training program, was initiated and developed as a collaboration between the South African National Department of Health (NDOH), the National Institute of Communicable Diseases (NICD) of the National Health Laboratory Service (NHLS), and the U.S. Centers for Disease Control and Prevention (CDC), to increase field epidemiology capacity for the country. SAFETP uses an established applied epidemiology curriculum, providing an accredited Masters in Public Health (MPH) degree from the University of Pretoria (UP), with mentored competency-based practical field experience. To date, the program has trained 87 health professionals in applied epidemiology. This paper describes the first 10 years of the SAFETP, including the origin and rationale for the program, the training model, accomplishments, challenges encountered, and observations regarding possible future directions of the program.

Origin, genesis, and evolution of SAFETP

Training in applied field epidemiology at a national level has its origins in the 1950's with the creation of the Epidemic Intelligence Service (EIS) at CDC. [5, 6] The creators of EIS envisioned a competency-based training program in applied epidemiology modeled after a medical residency, in which participants learn by doing, under the close guidance and supervision of an experienced mentor. EIS has never been an academic degree awarding program, but rather a post-doctoral training program designed to develop the next generation of trained field epidemiologists to serve the U.S. public health system. During the first 63 years of the program, EIS has trained 3641 health professionals in applied epidemiology (personal communication, EIS program office).

Beginning in , a97.

the strategic plan of the program. The sustainability of the program, together with increasing its visibility and impact, were listed as key strategic objectives. Moreover, demand for the laboratory component of the program

participation at national and international scientific conferences to present accepted work; and supplemental workshops on relevant topics.

For completion of the CLAs and UP thesis requirements, residents are supported by a SAFETP assigned mentor and a field supervisor. In addition, GDD provided technical assistance has included a scientific writer, a biostatistician, and a CDC FETP resident adviser, who have provided training and support to all residents in scientific communication, statistical analysis, and epidemiologic field investigation methods. The scientific writer conducts workshops on scientific communication which address the specific requirements of each of the written CLAs. The writer-editor reviews draft written materials and provides one-on-one consultation during the scientific writing process. The biostatistician provides individual consultation regarding survey design, sample size calculation, and statistical analysis.

SAFETP has also been an active member of the relevant professional networks for training in field epidemiology. This includes at the global level, the Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET), [15] and regionally in Africa, the African

Over 45 scientific manuscripts have been published in peer-reviewed scientific journals by SAFETP residents, based on their activities during the training program. [17] SAFETP trainees have made significant contributions in investigating and responding to numerous disease outbreaks and priority health conditions and control activities throughout the country that have been key inputs for local, provincial, and national public health decision making (Table 3). Selected examples of the outbreaks include outbreaks of Rift Valley fever during 2008–2011 that led to greater collaborations with the veterinary and animal health sector; [18, 19] an outbreak of multi-drug resistant *Pseudomonas aeruginosa* in a hospital in Cape Town in 2010; [20] a diarrheal

disease outbreak investigation in Free State that led to major improvements in the water treatment system; and, identifying the emergence of multi-drug resistant *Candida auris* fungal infections, leading to the development of clinical and diagnostic guidelines for detection and investigation of future outbreaks. [21, 22] SAFETP residents have also responded to outbreaks in other African countries in the region. Selected examples of these include an outbreak of typhoid in Zimbabwe in 2011–12, [23] which highlighted the role of contaminated boreholes in continued transmission; an outbreak of diarrheal illness in Swaziland in 2014; and an investigation of a cluster of hydrocephalus cases in Lesotho in 2017. Finally, residents have completed analytic research studies on the determinants of loss to follow-up among HIV patients in South Africa on anti-retroviral treatment enrolled in a pharmacovigilance cohort study from 2004 to 2012. [24] The results bolstered the strategy of community-based adherence support programs and integrated patient care, implemented by the South African HIV/AIDS treatment program. Residents also conducted analyses identifying risk factors for tuberculosis smear non-conversion in Western Cape Province from 2007 to 2013, [25] helping health providers better target at-risk patients.

SAFETP trainees and graduates have also helped strengthen public health surveillance programs within

the country. The trainees have contributed to the design, implementation, and evaluation of various surveillance systems at all levels of the health system. During 2015, a team of SAFETP residents (n = 6) and alumni (n = 7) conducted an evaluation of the National Notifiable Medical Conditions (NMC) surveillance system in the country. The findings from the evaluation have informed the recent re-engineering of the NMC surveillance system for South Africa.

Challenges

SAFETP has experienced several challenges over its first decade. The external program review in 2012 confirmed that at least 30% of residents had completed all requirements except the UP thesis, and thus, were not graduating with their MPH on time. UP had always offered a peer-reviewed manuscript as an option instead of a traditional academic thesis. However, the majority of residents had been submitting the traditional academic thesis. The SAFETP adopted the external reviewers' recommendation and made a first authored, peer-reviewed manuscript compulsory and encouraged residents to use this manuscript as the basis for fulfilling the UP thesis requirement for graduation. SAFETP staff then followed up with individual residents who had previously completed the two year training, but had not achieved the MPH. This involved one-on-one meetings to review their progress in manuscript writing, statistical analysis, and interpretation of their data. As a result, the overall MPH graduation rate went up from 55%, as measured in 2013, to 87% measured in 2018, following the completion of the 2016 cohort.

The external evaluation also pointed out that the program was not attracting medical or veterinary graduates for enrollment. Less than 20% of the program participants to date have been medical doctors or veterinarians. Ongoing efforts are underway, working with the leadership of NDOH and DAFF, to facilitate and support more medical and veterinary staff from those agencies to join SAFETP. DAFF is supporting two veterinarians currently in the program. The demand for curative care in South Africa places undue pressure on medical doctors to go into providing clinical services. However, supervisory staff at facility and provincial DOH levels have shown willingness to support nurses and medical scientists to join the program. Fully addressing this issue is an ongoing challenge, however, SAFETP has recently undertaken a series of focus group discussions on field epidemiology for fourth-year medical and veterinary students to increase awareness of the opportunities that the discipline presents.

An ongoing program challenge is increasing the quantity and quality of outbreak investigations conducted by the residents. Residents are required to participate in at

least three outbreak investigations. Their individual responsibilities in each investigation gradually increase, as their competency in outbreak investigation progresses, so that by the third outbreak, they are expected to lead the investigation. Residents may partially complete their outbreak investigation competency through the ORU. The number of requests, the type of investigations requested, along with ORU staff availability and standardization of the outbreak investigation approach, have been identified as factors leading to variable resident experiences in learning to do outbreak investigations. In general, residents assigned to provinces and districts have an increased likelihood of being involved in outbreak investigations within their jurisdiction. Ongoing efforts are underway to improve the coordination, supervision, and standardization of outbreak reporting and investigation, to better prepare SAFETP residents to acquire this critical competency.

Future directions

Sustainability and transition to NICD funding support
SAFETP started with being almost completely funded by the US CDC. Since inception, the NICD has provided

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