Summary of work activities
Anita Ashni Shah
Intervention Epidemiology path (EPIET), 2019 cohort

Background

The ECDC Fellowship Programme is a two-year competency-based training with two paths: the field epidemiology path (EPIET) and the public health microbiology path (EUPHEM). After the two-year training, EPIET and EUPHEM graduates are considered experts in applying epidemiological or microbiological methods to provide evidence to guide public health interventions for communicable disease prevention and control.

Both curriculum paths provide training and practical experience using the 'learning by doing' approach in acknowledged training sites across European Union (EU) and European Economic Area (EEA) Member States.

According to Articles 5 and 9 of ECDC's founding regulation (EC No 851/2004) 'the Centre shall, encourage cooperation between expert and reference laboratories, foster the development of sufficient capacity within the community for the diagnosis, detection, identification and characterisation of infectious agents which may threaten public health' and 'as appropriate, support and coordinate training programmes in order to assist Member States and the Commission to have sufficient numbers of trained specialists, in particular in epidemiological surveillance and field investigations, and to have a capability to define health measures to control disease outbreaks'.

Moreover, Article 47 of the Lisbon Treaty states that 'Member States shall, within the framework of a joint programme, encourage the exchange of young workers. 'Therefore, ECDC initiated the two-year EUPHEM training programme in 2008. EUPHEM is closely linked to the European Programme for Intervention Epidemiology Training (EPIET). Both EUPHEM and EPIET are considered 'specialist pathways' of the two-year ECDC fellowship programme for applied disease prevention and control.

This report summarises the work activities undertaken by Anita Ashni Shah, cohort 2019 of the Intervention Epidemiology path (EPIET) at Rijksinstituut voor Volksgezondheid en Milieu (RIVM), Bilthoven, the Netherlands.

Pre-fellowship short biography

Anita Ashni Shah holds a Master of Public Health with a specialisation in Epidemiology and Biostatistics from the University of Melbourne, Australia. Upon completion of her studies, Anita worked as part of the Health Emergencies Programme at the World Health Organization (WHO) in Geneva, Switzerland for five and a half years, first supporting the West Africa Ebola virus disease outbreak from 2014 to 2016. Thereafter, she worked on several public health emergencies and outbreaks including Zika virus, Yellow fever, cholera, measles, and diphtheria outbreaks. She was also the focal point for publishing WHO Disease Outbreak News Reports from 2016 to 2019. Additionally, during her time at WHO, she gained field experience during several international deployments to Liberia, Republic of the Congo, and the Democratic Republic of the Congo to support outbreaks of Ebola virus disease and Yellow fever.

Methods

This report accompanies a portfolio that demonstrates the competencies acquired during the EPIET fellowship by working on various projects, activities, theoretical fellowship training modules, other modules or trainings and from international assignments or exchanges.

Projects included epidemiological contributions to public health event detection and investigation (surveillance and outbreaks); applied epidemiology field research; teaching epidemiology; summarising and communicating scientific evidence and activities with a specific epidemiology focus.

The outcomes include publications, presentations, posters, reports and teaching materials prepared by the fellow. The portfolio presents a summary of all work activities conducted by the fellow, unless prohibited due to confidentiality regulations.

Results

The objectives of these core competency domains were achieved partly through project or activity work and partly through participation in the training modules. Results are presented in accordance with the EPIET core competencies, as set out in the ECDC Fellowship Manual[1].

1. Epidemiological investigations

1.1 Outbreak investigations

Norovirus outbreak among primary school teachers attending a 'study day', the Netherlands, January 2020

Supervisors: Erik de Jonge, Ewout Fanoy

An outbreak of gastrointestinal illness occurred following a 'study day' that was held at a conference centre and included lunch on a ship in Rotterdam on 6 January 2020. Attendees included 155 teachers from four primary schools, 7 school board members and 11 catering staff. More than 40 attendees reported having diarrhoea and/or vomiting the following day. A retrospective cohort study was conducted. Questionnaires were distributed to investigate demographics, symptoms, food and drink consumption, and toilet use during the event. Faecal specimens were collected from two to three cases per school and evaluated for viral pathogens causing gastrointestinal disease. Specimens positive for norovirus were sequenced. Of the 150 respondents, 63 (42%) met the case definition (diarrhoea and/or vomiting within 48 hours of attending the event). None of the staff respondents reported symptoms. All 10 specimens that were received tested positive for norovirus type II. Six of the 10 specimens could be sequenced and were identical. The tomato and cucumber salad served during lunch and consumed by 77% of the cases was identified as a potential vehicle for transmission (relative risk (RR): 1.8; 95% confidence interval (CI): 1.1-2.8). The inspection revealed no breach of hygiene protocol at the conference centre or ship. Environmental investigations were not possible and leftover food was not available for testing. Introduction of norovirus by either staff or an attendee who touched food items during the buffet lunch is most plausible. We reiterate standard recommendations for preventing future outbreaks, which include proper disinfection during food handling and strict personal hygiene practices.

Anita was a co-investigator. She developed an outbreak investigation protocol, an online questionnaire and data entry mask; analysed data; co-authored an update for the weekly early warning committee meeting; and co-authored an outbreak investigation report. An abstract was prepared and submitted for Transmissiedag at RIVM, which was postponed due to the COVID-19 pandemic.

High SARS-CoV-2 attack rates following exposure during five singing events in the Netherlands, September–October 2020

Supervisor: Mirjam Knol

Previous reports suggest SARS-CoV-2 transmission risk increases during singing events. From September to October 2020, several clusters of COVID-19 cases among singing events were reported across the Netherlands. Our aim was to investigate whether singing increased SARS-CoV-2 transmission risk during these events. Data from six events were retrospectively collected from spokespersons and singing group members via questionnaires. Information was consolidated with the National Notifiable Diseases Surveillance System. Specimens were requested for sequencing for point source and cluster assessment. We described outbreaks in terms of person, place and

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[1] European Centre for Disease Prevention and Control. European public health training programme. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/ecdc-fellowship-programme-manual-cohort-2021

time and depicted potential SARS-CoV-2 transmission routes. A previously published model (AirCoV2) was used to estimate mean illness risk of one person through airborne transmission under various scenarios. Events included 9-21 persons (mean: 16), aged 20-79 years (median: 62). Response rates ranged from 58% to 100%. Fifty-two confirmed and two probable cases were identified among 94 members. Attack rates ranged from 25% to 74%. Limited sequencing data was obtained from three events. Events lasted 60 to 150 minutes (singing time:20-120 minutes). Rooms ranged from 320 to 3 000 m^3. SARS-CoV-2 transmission likely occurred during five events; with a possible index case identified in four. AirCoV2 showed 86% (range: 54-100%) mean illness risk for 120 minutes of singing in a smaller room (300m^3) with one air exchange/hour (ACH) and supershedder presence. Halving time, increasing ACH by 6-fold, and increasing room size by 10-fold, reduced risk to 58, 54, and 24%, respectively. Indirect contact and droplet transmission probably caused some cases, but unlikely explain the high attack rates. AirCoV2 indicated that airborne transmission due to singing is possible in case of supershedder presence. Airflow expelling respiratory droplets >1.5m possibly influenced transmission. It is possible that singing itself increased SARS-CoV-2 transmission risk through airborne transmission. Specific recommendations regarding singing groups may be needed.

Anita was a principal investigator. She developed an outbreak investigation protocol and developed seven online questionnaires and data entry masks. She prepared and analysed data and presented findings at an internal RIVM meeting. She submitted an abstract for ESCAIDE 2021 (not accepted), a manuscript to MedRxiv and to an international peer-reviewed journal.

Training modules related to assignments/projects

EPIET/EUPHEM Introductory Course
This course provided insights into the principles of outbreak investigation including the ten steps of an outbreak investigation. Training was provided on developing case definitions, interpreting measures of association, designing questionnaires and data entry masks, and formulating recommendations. Knowledge gained through the lectures was applied in case studies and group exercises.

Outbreak Investigation Module
During the module, all ten steps of the outbreak investigation were performed and training was given on the practical aspects of data management and analysis during outbreak investigations, as well as the interpretation and communication of findings. Knowledge gained on how to perform analytical studies, including descriptive, cohort, and case-control studies was practically applied through case studies using statistical software tools such as R. Insights were given into mapping, phylogeny and epidemic intelligence.

Multivariable Analysis Module
During the module, practical training was given on multivariable statistical analysis using R to investigate outbreaks. Models taught included linear regression, simple and multivariable logistic regression, conditional logistic regression, Poisson and Cox regressions. Training was given on choosing the optimal regression model, controlling for confounding and effect modification, and interpreting the results of the model.

Rapid Assessment and Survey methods (RAS) module
During the module, training was given on risk communication during an outbreak investigation and crises.

Educational outcome

Anita consolidated her knowledge of the ten steps of an outbreak investigation during her involvement in two investigations as a co-investigator and principal investigator. Through participation in a multidisciplinary team, Anita was able to gain hands-on experience establishing protocols and questionnaires, constructing case definitions, developing data entry masks, performing descriptive and multivariable analyses, and compiling outbreak investigation reports. Additionally, she supported preparation of material for the Early Warning Committee, as well as communication to individuals affected by the outbreaks. Anita developed a deeper understanding of the elements involved, particularly the importance of liaising with local municipal health services and integrated epidemiological and microbiological knowledge during an outbreak.

1.2 Surveillance

Routine national surveillance activities for measles, mumps and rubella, 2019–2020

Supervisor: Irene Veldhuijzen

Measles, mumps and rubella (MMR) are notifiable diseases in the Netherlands. The National Institute for Public Health and the Environment uses two sources for MMR surveillance purposes: the registration system Osiris, in which municipal health services provide demographic, laboratory and epidemiological information about cases, and the virological weekly reports, in which a selection of medical laboratories report the numbers of positive virological tests per week. The RIVM conducts surveillance for notified MMR cases on a weekly basis and shares results with

the weekly infectious diseases Early Warning Committee. Samples for genotyping are collected for all measles and rubella cases and a selection of mumps cases.

In 2019, 2 measles cases, 1 rubella case, and 131 mumps cases were reported. Among the mumps cases, males (n = 85) accounted for almost double compared to females (n = 46), with a mean age of 27 years (range: 2-63 years). Forty-four students were reported with mumps. Ninety-seven cases (79%) were vaccinated: 19 (20%) with one dose, 68 (70%) with two doses, 5 (5%) with three or more doses of vaccine, and 5 (5%) were vaccinated with an unknown number of doses. The vaccination status was not known for the eight remaining cases. On average, the 26 unvaccinated cases were 36 years old (range: 4-60 years). Six patients were hospitalised and aged between 19 and 34 years; two of these reported orchitis and one pancreatitis. In addition, nine adults reported complications: eight reported orchitis and one reported orchitis or encephalitis. Among men, orchitis was less prevalent in vaccinated men (5%) compared to unvaccinated men (38%) (P<0.001). 17% of the cases (n = 22) acquired the infection abroad and country of infection is unknown for four people. In 2020, until 1 May, 61 mumps cases have been reported, which is higher than for the same period in 2019 (42 cases). In early March 2020, control measures were put in place nationwide in response to the COVID-19 pandemic and from 1 April, a decrease in the number of mumps notifications was seen. As the average incubation period for mumps is between 16 and 18 days, this shows that the decrease coincided with control measures that were put in place. There were more male (57%) patients than female and the mean age was 27 years (range: 2-70 years). Seventeen students were reported and six acquired the infection abroad. In addition, nine people acquired the infection abroad and country of infection is unknown for four people. Most cases (n = 38, 62%) did not have an epidemiological link, except for eight clusters identified in 2020.

Anita routinely analysed and reported surveillance data and reported clusters/outbreaks to the early warning committee weekly meeting, including detailed reports. She contributed to the WHO Measles and Rubella elimination report, and wrote the mumps chapter of the RIVM Annual National Immunisation Programme in the Netherlands report.

Combining genomics and epidemiology of several mumps clusters to strengthen mumps virus surveillance in the Netherlands, October 2019–March 2020

Supervisor: Irene Veldhuijzen

From October 2019 to March 2020, several clusters of mumps cases were identified in the Netherlands. Our objective was to describe cluster-associated mumps virus transmission using epidemiological and molecular information in order to help future mumps prevention efforts. An epidemiological cluster includes ≥2 mumps cases with an epidemiological link to a laboratory-confirmed mumps case. A molecular cluster includes ≥2 mumps cases with identical mumps virus sequences. Cases with a symptom onset date between 1 October 2019 and 31 March 2020 reported through the National Notifiable Diseases Surveillance System were included. We described epidemiological and clinical characteristics of mumps cases. Sequence data was obtained from selected regions of mumps virus genomes (2 270 nucleotides). Correlations between epidemiological and molecular information were investigated. In total, 102 mumps cases were notified (90% laboratory-confirmed, 10% epidemiologically linked). Fourteen epidemiological clusters were identified containing 2 to 12 cases. Sequence data was obtained from 50 mumps genotype G viruses. Twelve molecular clusters were identified containing 2 to 13 cases, dispersed geographically and timewise. Twenty-one (30%) of 71 cluster-associated cases were identified using epidemiological information, 25 (35%) using molecular surveillance, and 25 (35%) using both. Combined information redefined six epidemiological clusters into two distinct molecular clusters. The first lasting for 14 weeks, the other for six. Additionally, one molecular cluster was detected, linked by geography and time but without an epidemiological link. Both epidemiological and molecular information indicated ongoing mumps virus transmission for extended time periods. Sequence analysis provided valuable insights into epidemiological clustering. Our findings illustrated the importance of combined information in cluster identification.

Anita prepared and analysed data. She submitted an abstract (accepted as a poster presentation) for ESCAIDE 2020 and submitted a manuscript to an international peer-reviewed journal.

Analysis of International Health Regulations State Party Self-Assessment Reporting questionnaires for WHO Regional Office for Europe (WHO/Europe)

Supervisor: Corien Swaan

Public health measures to prevent, protect against, control and respond to events are fundamental to restrict public health risks as highlighted in the International Health Regulations (IHR 2005). Our aim was to perform descriptive analysis and identify common themes using keywords of the IHR Self-Party Assessment Annual Reporting (SPAR) questionnaire responses from 49 European Member States. We used SPAR 2018 questionnaire data (48 questions on 19 topics) and investigated 13 IHR capacity areas from the SPAR tool. Capacity areas and subgroups were categorised into five levels across the indices, in which level one indicated the lowest level of national capacity and level five the highest, and then given a score out of 100. We determined the mean score per capacity area and identified common keywords in the next attainable level for each European Member State. Of 49

countries, the two capacity areas with the highest overall mean score were the 'Laboratory and the National IHR Coordination' and 'National IHR Focal Point Functions' with 79 and 78, respectively. Capacity areas, 'Points of Entry' and 'Chemical Events' scored the lowest on average with 57 and 64, respectively. Keyword analysis identified three common themes in the next attainable level, including implementing activities at 'intermediate and local levels', ensuring the activity includes 'relevant sectors' and/or 'partners', and that the activity is carried out 'systematically', 'routinely' or 'regularly'. Overall, countries varied widely in terms of their capacity to prevent, protect against, control, and respond to events. Additional local risk assessments could be used to better understand national preparedness capacities. Collaboration and capacity building between countries are needed to strengthen preparedness, particularly with regards to points of entry and chemical events.

Anita prepared data and performed descriptive analysis. She liaised with WHO/Europe regularly through teleconferences and produced a descriptive preliminary draft report. Project was put on hold due to the COVID-19 pandemic.

Training modules related to assignments/projects

EPIET/EUPHEM introductory course
During this course, an introduction was given to components of surveillance systems, types of surveillance, ways of setting up surveillance systems, how to analyse and interpret surveillance data, and the use of whole genome sequencing in surveillance. Additionally, evaluation of surveillance systems using different attributes were discussed and practically applied during module activities.

Rapid Assessment and Survey Methods module
During the module, training was given on setting up a surveillance system, planning and conducting a survey to address public health questions, analysing results of surveys and using results to drive public health decisions, particularly in complex emergency situations (CES). Practical sessions were given using mapping software, QGIS and Google Earth. Practical exercises on performing a rapid risk assessment at the European level and in a pandemic situation, as well as on risk communication during an outbreak investigation and crises, were conducted.

Educational outcome

Through performance of routine national surveillance for measles, mumps, and rubella, Anita gained experience in conducting surveillance on a national level and learned about surveillance systems in place in the Netherlands, as well as the stakeholders and structures involved. Anita consolidated information from medical molecular laboratory reports and the national surveillance system for notifiable diseases. This required following up with laboratories and municipal health services to ask for additional information about reported cases. Additionally, information was communicated weekly to the Early Warning Committee. The project on combining genomic and epidemiological mumps virus information helped Anita to understand the importance and benefits of being able to use both during cluster identification. The project related to IHR SPAR questionnaire analysis for WHO/Europe fostered a deeper understanding of preparedness activities and monitoring processes in place for EU Member States.

2. Applied public health research

Pre-exposure prophylaxis (PrEP) pilot in the Netherlands, August–December 2019

Supervisor: Fleur van Aar

A five-year national HIV pre-exposure prophylaxis (PrEP) pilot started in Dutch Sexual Health Centres (SHC) in August 2019 offering PrEP and associated care to a maximum of 6 500 individuals at an increased risk of contracting HIV. Our aim is to describe characteristics among enrolled clients in the pilot during the initial five months. Our study population included eligible PrEP clients (men who have sex with men (MSM) and other vulnerable groups) from SHCs in the Netherlands from 1 August to 31 December 2019. Information collected during PrEP consultations included sociodemographics, sexual behaviour, PrEP regimen (daily or event-driven) and previous use. We analysed characteristics of PrEP clients. Overall, 2 797 eligible PrEP clients were enrolled, of whom, 1 677 (59.9%) used PrEP in the past year, 2 733 (97.7%) were MSM, 1 707 (61%) were of Dutch nationality and 2 705 (96.7%) were previously tested for HIV. The median age was 37 years (interquartile range (IQR): 28-48 years). Among MSM, 45.9% (n = 1 255) reported ≥10 partners in the past six months, 41.5% (n = 1 133) reported drug use in relation to sex, 73.4% (n = 2 006) reported inconsistent condom use with receptive anal sex and 28.1% (n = 768) reported group sex at first PrEP consultation. Proportions of these behaviours were lower among MSM not using PrEP, but similar among HIV-positive MSM. Among 1 837 consultations during the three monthly follow-up visits, clients reported daily PrEP use in 1 046 (56.9%) consultations, event-driven use in 708 (38.5%) consultations, and both in 57 (3.1%) consultations. Preliminary data indicates reaching 43% of the pilot capacity. Enrolling MSM most at-risk remains important for optimal program effectiveness. Both daily and event-driven PrEP were used frequently, showing importance of choice to clients.

Anita developed a study protocol, reviewed literature, and performed descriptive analysis. Anita submitted an abstract for ESCAIDE 2020 (not accepted). Project was put on hold due to the COVID-19 pandemic.

Investigating the association between Legionnaire's disease and wastewater treatment plants, 2013-2018

Supervisor: Petra Brandsema

The source of infection for many sporadic cases of Legionnaires' disease (LD) remains unknown. We aimed to assess the relationship between the risk of Legionnaires' disease in people living in close proximity to wastewater treatment plants (WWTPs) and several characteristics in the Netherlands. We analysed 1 604 cases of LD in the Netherlands with onset between 2013 and 2018 and 16 040 controls randomly sampled and frequency matched on age and sex. Characteristics on 776 WWTP including 327 municipal sewage treatment plants and 449 industrial plants were available. Of 1 604 patients, 71.9% were male and 92.8% were aged ≥45 years. The relationship between risk of LD and WWTP was assessed using univariable, multivariable, and multilevel analyses. Recommendations for further analysis include using cumulative number of cases and cumulative number of inhabitants for each 1x1km cell across the Netherlands in a Poisson model.

Anita developed a study protocol. She reviewed literature, conducted data cleaning and performed descriptive and statistical analysis. She produced a summary report.

Risk factors for acquiring COVID-19 in the general population: a case-control study (CONTEST)

Supervisor: Mirjam Knol

Risk factors for transmission among the general population during the COVID-19 pandemic are still unclear. We aimed to investigate risk factors for testing SARS-CoV-2 positive among the Dutch population attending Municipal Health COVID-19 testing locations. We conducted a test-negative study among adults attending Dutch COVID-19 testing locations from 8 February 2021. Participants were invited via appointment confirmation email. Eligibility included questionnaire completion prior to test result and not residing at a care facility. The association between demographic and chronic conditions with COVID-19 was assessed using univariable and multivariable logistic regression. Analysis was restricted to tested adults who experienced symptoms, had no close contact with a COVID-19 case, and had not previously tested SARS-CoV-2 positive since January 2020. From 8 February to 2 April 2021, 5 912 adults met the inclusion criteria, of whom 245 tested positive (4%), 1 902 (32%) were male, 5 111 (86%) were Dutch, and the median age was 43 years old (range: 18-85 years). Of the 280 (5%) who were vaccinated against COVID-19, 180 (3%) received two doses, 92 (2%) received one dose, and information was missing for 8 (0.1%). Risk factors for acquiring COVID-19 included being aged 45 to 59 years (odds ratio (OR):1.62; range: 1.11-2.39) and having a middle educational level (intermediate, lower vocational) (OR:1.43; range: 1.10-1.86). Adjusting for age, sex and education level, adults living with adolescents (13-18 years) (adjusted OR (aOR):1.67; range: 1.04-2.72) had higher risk than those living alone. Chronic conditions, contact professions, onsite occupations, and household size were not significantly associated with testing positive (p-values>0.5). Our study characterised symptomatic patients during the third wave in the Netherlands. Preliminary data indicated higher risk for acquiring COVID-19 for adults living with adolescents.

Anita developed a study protocol, an online questionnaire and a data entry mask. She performed data management, cleaned and analysed data, and communicated results during internal presentations at RIVM. She submitted an abstract for ESCAIDE 2021 (accepted as a poster presentation) and prepared a manuscript for an international peer-reviewed journal.

Training modules related to assignments/projects

EPIET/EUPHEM Introductory Course
This course provided training from designing, preparing and conducting applied research projects to interpreting and communicating findings. Practical sessions through case studies and group work were provided to apply knowledge gained including how to formulate research questions, produce a research study protocol, ethical and governance considerations, and formulating recommendations for public health action.

Outbreak Investigation Module
During the module, training was provided on performing analytical studies, interpretation, communication of findings, as well as formulating recommendations for public health action. Knowledge gained on how to perform analytical studies, including descriptive, cohort, and case-control studies was practically applied through case studies using statistical software tools such as R.

Multivariable Analysis Module
During the module, practical training was given on multivariable statistical analysis using R. Models taught included linear regression, simple and multivariable logistic regression, conditional logistic regression, Poisson and Cox

regressions. Training was given on choosing the optimal regression model, controlling for confounding and effect modification, and interpreting the results of the model.

Rapid Assessment and Survey methods (RAS) module
During the module, training was given on setting up a surveillance system, planning and conducting a survey to address public health questions, analysing results of surveys and using results to drive public health decisions, particularly in CES. Practical sessions were given using mapping software, QGIS and Google Earth. Practical exercises on performing a rapid risk assessment at the European level and in a pandemic situation and on risk communication during an outbreak investigation and crises were conducted.

Vaccinology module
During this module, information was given on vaccine types, vaccination programmes and their impact, evaluation of vaccination interventions, and how to investigate and respond to outbreaks of vaccine-preventable disease using appropriate methods. Knowledge gained through training was applied in case studies and group work.

Educational outcome

Through all research projects, Anita enhanced her skills in managing large datasets and performing statistical methods including multivariable analysis. In particular, it was through these projects that Anita was able to really develop her skills in the statistical programme R and become a proficient user. Through the PrEP project, Anita was able to develop an understanding of how data is collected from Dutch Sexual Health Clinics and how to conduct a descriptive analysis on a large dataset. Through the project on *Legionella* and wastewater treatment plants, Anita gained experience in new statistical methods and working with spatial data. During the project on risk factors for acquiring COVID-19 in the general population, she gained experience implementing a large national research study and learned about the steps involved in vaccine effectiveness analysis.

3. Teaching and pedagogy

Facilitation of a case study on Salmonella in the Caribbean at the Radboud University Medical Center, University of Nijmegen, 22 November 2019

As part of the Research Minor Control of Infectious Diseases module for medical and biomedical students at the Radboud University Medical Center, Anita facilitated an EPIET case study on '*Salmonella* in the Caribbean' to a group of eight students. Verbal feedback was obtained from participants following the case study, and students noted that while the case study was informative and delivered well, they would have benefitted from additional information on the laboratory aspects.

Guest lecture: Insights from the field – Ebola outbreak in the Democratic Republic of the Congo at the Radboud University Medical Center, University of Nijmegen, 22 November 2019

Anita presented a guest lecture to a group of ~30 medical and biomedical sciences students on the topic of 'Insights from the field – Ebola outbreak in the Democratic Republic of the Congo' at the Radboud University Medical Center. The lecture included background on Ebola virus disease and described coordination mechanisms in a large-scale outbreak response, the use of data for decision-making and the challenges faced, followed by an interactive quiz. The quiz measured knowledge gained from students during the lecture and was answered by all students. Overall scores showed a good grasp of knowledge (average: 79% of questions correctly answered).

Facilitation of a case study on 'Giardiasis in Bergen, Norway' at the Radboud University Medical Center, University of Nijmegen, 17 November 2020

As part of the Research Minor Control of Infectious Diseases module for third year medical and biomedical students, Anita facilitated an EPIET case study on '*Giardiasis* in Bergen, Norway' to 15 students, online. Additional supplementary material was developed to assist with the online aspect of the teaching. Prior to the case study, a 10-minute presentation was given on Anita's background and career path thus far. The training was evaluated with an online questionnaire; 5/15 students answered the questionnaire and average scores for each component were: stimulation of interest (4.4/5), organisation of facilitator (5/5), time management and pace (5/5) and encouragement of discussions (5/5).

Facilitation of a case study on 'Giardiasis in Bergen, Norway' at the Radboud University Medical Center, University of Nijmegen, 11 December 2020

As part of the Research Minor Control of Infectious Diseases module for third year medical and biomedical students, Anita – together with EPIET fellow Nika Lazić – facilitated an EPIET case study on '*Giardiasis* in Bergen, Norway' to seven students, online. Prior to the case study, a brief introduction to Anita's career path thus far was presented, followed by questions from the students. The training was evaluated with an online questionnaire; 3/6

students answered the questionnaire and average scores for each component were: stimulation of interest (4.3/5), organisation of facilitator (4.6/5), time management and pace (4.3/5) and encouragement of discussions (4.3/5).

Facilitation of an Outbreak Investigation Module at the Netherlands School of Public Health and Occupational Health, 19 January 2021

Anita facilitated the Outbreak Investigation Module at the Netherlands School of Public Health, which is part of the curriculum for all medical doctors who are completing a residency in infectious disease control. Anita presented a lecture online to nine students on 'Study design in outbreaks', followed by facilitation of an EPIET case study on 'An outbreak of trichinosis in France'. She developed supplementary slides to assist with the online aspect of the case study. The training was evaluated with an online questionnaire; 7/9 students answered the questionnaire and average scores for each component were: clarity of the lecture (4.1/5), knowledge improved following lecture (4.4/5), stimulation of interest (4.3/5), organisation of facilitator (4.7/5), time management and pace (4.6/5), and encouragement of discussions (4.1/5).

Training modules related to assignments/projects

EPIET/EUPHEM Introductory Course
During the course, insights were given into the principles of adult education including the practical aspects on preparing a training plan and selecting training material for different target audiences. Training was also provided on how to integrate instructional design concepts in developing a training activity. Additionally, the technique of problem-based learning was practically demonstrated.

Project Review Module
During this module, Anita gained experience in chairing presentations, as well as providing and receiving constructive criticism.

Educational outcome

Anita found the teaching activities instrumental and was able to develop her competencies through outlining course objectives, delivering lectures and facilitating case studies to different audiences. As the majority of teaching was online from March 2020, due to the COVID-19 pandemic, Anita enhanced her teaching delivery by focusing on how to effectively engage with students and ensure active participation through trainings via online platforms. Overall, Anita found it a very rewarding experience.

4. Communication

Publications related to the EPIET fellowship

1. **Shah A.A.**, Bodewes R., Reijnen L., Boelsums T., Weller C.M., Fanoy E.B., Veldhuijzen I.K. Outbreaks of mumps genotype G viruses: clusters associated with multiple exposures in the Netherlands, October 2019 to March 2020. (accepted)

2. **Shah A.A.**, Dusseldorp F., Veldhuijzen I.K., te Wierik M.J.M., Bartels A., Schijven J., Vermeulen L.C., Knol M.J. High SARS-CoV-2 attack rates following exposure during singing events in the Netherlands, September-October 2020. (submitted)

3. **Shah A.A.**, Middeldorp M., de Gier B., Raven S., Fanoy E., Melker H., Hahné S., Knol M.J. Risk factors for acquiring COVID-19 in the general population in the Netherlands: a case-control study. (in preparation)

Reports

4. **Shah A.A.**, Tulen A.D., Fanoy E.B, Weller C.M., Molenaar M., Stougje D., Schoss S., de Graaf M., van der Eijk A.A., de Jonge E. Norovirus outbreak among primary school teachers attending a 'study day', Outbreak Investigation Report. The Netherlands. January 2020. (internal report)

5. **Shah A.A.**, Bodewes R., Kaaijk P., Rots N., van Els C.A.C.M., Ruijs W.L.M., van Binnendijk R., Veldhuijzen I.K. Mumps. In: RIVM Report. National Immunisation Programme in the Netherlands Surveillance and developments in 2019-2020. Bilthoven, the Netherlands. 2020.

6. Preliminary draft report: Analysis of International Health Regulations State Party Self-Assessment Reporting questionnaires for WHO/Europe, December 2019.

7. Summary report: Investigating the association between Legionnaire's disease and wastewater treatment plants in the Netherlands, 2013-2018.

8. Section of Early Warning Meeting Report: 'Norovirus-uitbraak na een studiedag voor docenten van 4 basisscholen'. National Institute for Public Health and the Environment (RIVM), Bilthoven, the Netherlands; 16/01/2020.

9. Section of Early Warning Meeting Report: 'Hoge attack rate van SARS-CoV-2 bij drie zangkoren'. National Institute for Public Health and the Environment (RIVM), Bilthoven, the Netherlands; 22/10/2020.

10. Section of Early Warning Meeting Report: 'Verhoogd aantal meldingen in 2020 van bof'. National Institute for Public Health and the Environment (RIVM), Bilthoven, the Netherlands; 19/03/2020.

11. WHO Measles and Rubella elimination report: Netherlands section, 2020.

Protocols

12. Outbreak investigation protocol: Norovirus outbreak among primary school teachers attending a 'study day', the Netherlands.

13. Outbreak investigation protocol: High SARS-CoV-2 attack rates following exposure during singing events in the Netherlands, September-October 2020.

14. Study protocol: Pre-exposure prophylaxis (PrEP) pilot in the Netherlands.

15. Study protocol: Investigating the association between Legionnaire's disease and wastewater treatment plants in the Netherlands.

16. Study protocol: Risk factors for acquiring COVID-19 in the general population in the Netherlands: a case-control study (CONTEST).

Conference presentations

17. **Shah A.A.**, Bodewes R., Reijnen L., Boelsums T., Weller C.M., Fanoy E.B., Veldhuijzen I.K. Poster presentation at ESCAIDE 2020. Outbreaks of mumps genotype G viruses: clusters associated with multiple exposures in the Netherlands, October 2019 to March 2020. 27-29 November 2020. Online.

18. **Shah A.A.**, Middeldorp M., Abbas Zadeh S., Dijkstra F., Raven S., Fanoy E., van Dam S., Hahné S., Knol M.J. Poster presentation at ESCAIDE 2021. SARS-CoV-2 risk factors among adults attending Municipal Health testing locations in the Netherlands, February to April 2021. 16-19 November 2021. Online.

Other presentations

19. Oral presentation at the internal COVID-19 Research Group Meeting at RIVM. 'Risk factors for acquiring COVID-19 in the general population: a case-control study (CONTEST)'. 2 June 2020. Online.

20. Oral presentation at the Internal Seminars of EPI – RIVM (Refereer). 'Risk factors for acquiring COVID-19 in the general population: a case-control study (CONTEST)'. 17 September 2020. Online.

    Oral presentation at the Internal Seminars of EPI – RIVM (Refereer). 'High SARS-CoV-2 attack rates following exposure during singing events in the Netherlands, September–October 2020'. 25 February 2021. Online.

5. Other activities

Anita routinely attended the weekly scientific seminars organised by the RIVM Centre of Infectious Diseases Department. She followed the weekly RIVM signals and alerts meeting, which provided training on event evaluation and communication. She participated in the RIVM COVID-19 biweekly journal club, which gave insights into recent literature and findings related to COVID-19. Anita was involved with organising and participating in EPIET/ EUPHEM seminars at RIVM. Additionally, she participated in the monthly ECDC COVID-19 Think Tank with other EPIET fellows around the European Region.

6. EPIET/EUPHEM modules attended

1. Introductory Course, 21/09/2019 to 12/10/2019, Spetses, Greece

2. Outbreak Investigation Module, 9/12/2019 to 13/12/2019, Nicosia, Cyprus

3. Multivariable Analysis Module, 20/04/2020 to 24/04/2020, online

4. Project Review Module, 24/08/2020 to 28/08/2020, online

5. Time Series Analysis Module, 25/01/2021 to 29/01/2021, online

6. Rapid Assessment and Survey Methods Module, 27/04/2021, 4/05/2021 to 06/05/2021, online

7. Vaccinology Module, 14/06/2021 to 18/06/2021, online

7. Other training

1. EAN mini module: Advanced Course. Outbreak investigation analysis with R, 25/11/2019 to 26/11/2019, Stockholm, Sweden

2. ESCAIDE 2019, 27/11/2019 to 29/11/2019, Stockholm, Sweden

3. EUPHEM Management, Leadership and Communication in Public Health module, 10/02/2020 to 14/02/2020, online

4. ECDC Essentials of Writing and Reviewing Scientific Abstracts: a field epidemiology focus, 17/03/2020, online

5. ESCAIDE 2020, 24/11/2020 to 27/11/2020, online

6. EpitweetR workshop, 24/11/2020, online

7. Begin R. Course on basic training in using R software, 16/04/2021, RIVM, Netherlands

8. Tidy-R. Course on data wrangling using R, 25/05/2021, RIVM, Netherlands

9. Vis-R. Course on elaborating graphs and maps using R, 28/05/2021, RIVM, Netherlands

10. ESCAIDE 2021, 16/11/2021 to 19/11/2021, online

Discussion

Coordinator's conclusions

Although Anita was already a skilled fellow with strong international public health background at the start of the fellowship, able to work independently and effectively, she was still eager to learn and improve both her existing skills and in areas that she had less experience. During the two fellowship years, she was involved in five field assignments in the surveillance and research area, along with two outbreak investigations, including one project related to the COVID-19 pandemic and investigation of COVID-19 outbreaks during singing events. Through her knowledge and experience, technical skills and a high commitment, she has completed all of these, achieving the EPIET objectives.

Even if I have only been Anita's frontline coordinator during the second year of her fellowship, by which time she had already achieved most that was required for graduation, I can say that Anita is highly skilled, able to work independently but also in groups, with strong interpersonal skills. She has improved her public health competencies working with several public health topics. Furthermore, she has acquired/improved practical skills such as programming in R and performing new biostatistical methods and modelling. As well as her technical excellence, she has shown herself to be a superb team colleague and EPIET fellow. Lastly, during this time, she has also improved her understanding of public health agencies and institutions in Europe, and particularly in the Netherlands. In summary, she has succeeded in performing all her tasks to a high standard and with an excellent professional attitude.

I believe that Anita has all professional, technical, and soft skills needed for epidemiological and public health-related work. I wish her every success in the future and have no doubt she will contribute immensely to field epidemiology in her career.

Supervisor's conclusions

From her previous job at WHO, Anita brought in a good understanding of surveillance reporting on a global level and field experience from several missions abroad. She wanted to improve her surveillance and outbreak investigation skills on a national level and get more experience in applied research and multivariable analysis.

During her fellowship Anita did two outbreak investigations, one on norovirus and one on SARS-CoV-2 among singing groups. In both outbreak investigations she was involved from beginning to end including writing a protocol, development of the questionnaire, collecting and analysing the data and writing the report. While the norovirus outbreak was rather straightforward, the SARS-CoV-2 outbreak was not – with different stakeholders involved and interest from the public. Anita accommodated the feedback of all stakeholders and managed to submit the resulting manuscript to MedRXiv and a peer-reviewed journal. Anita was involved in routine MMR surveillance during the first year of her fellowship and this resulted in a description of several mumps clusters consolidating epidemiological data and molecular data, which serves as a very nice example to strengthen surveillance by combining lab and epi data. A paper of this work is currently under revision at an international journal. Anita also performed a descriptive analysis of IHR self-assessment data in collaboration with WHO.

Anita worked on three research projects. The first one was a descriptive analysis of a pilot on HIV pre-exposure prophylaxis (PrEP). This was valuable input for further analyses on PrEP use and evaluation of the PrEP program in the Netherlands. In a second research project, Anita investigated the association between wastewater treatment plants and Legionnaire's disease following up on earlier signals of such an association. Anita had to work with spatial data and find out the appropriate statistical analyses to be used to disentangle the associations with different kinds of wastewater treatment plants. Lastly, Anita worked on a case-control study assessing risk factors for SARS-CoV-2 infection in the general population. She was involved in all steps of the study, including writing the protocol, developing and testing the questionnaire, managing the data flows, data cleaning and analysis, and reporting. Anita fulfilled the teaching requirements by facilitating several case studies and sharing her previous experience at WHO and abroad to (bio)medical students. During her fellowship, Anita gained experience in different study designs (case-control and cohort), different infectious diseases (respiratory diseases, STI, VPD, GI infections) and different analyses (descriptive, spatial, genomic, multivariable, multilevel analyses). Furthermore, Anita very much advanced herself in working with R. What also stood out was her ability to create questionnaires in Dutch, with help of a good translation program. With all these different projects she achieved all EPIET learning objectives.

Anita was a very committed and motivated fellow. She was very responsive to comments on her work. Her work is very organised and structured, and she was always well prepared for meetings. Overall, it was a pleasure to supervise Anita during her fellowship and to see her developing her skills in field epidemiology. I am confident that she will continue to work in public health, where she will use and further expand her skills gained during her fellowship.

Personal conclusions of fellow

Overall, the EPIET fellowship has provided me with an enriching and unique experience. In the past two years, I have broadened my knowledge and skills in applied field epidemiology at regional, national, and EU levels, particularly during a complex time with the ongoing COVID-19 pandemic. I have had the opportunity to work on a diverse range of projects and diseases, including foodborne infections, vaccine-preventable disease, and respiratory diseases. Through my projects and taught modules, I was able to practice the technical aspects and harness my knowledge and skills, specifically during outbreak investigations, in routine surveillance, and in the implementation of a national research study. This experience deepened my understanding of the complexities of infectious disease epidemiology, surveillance and operational research. By pushing me outside of my personal and professional comfort zone, the fellowship enabled me to grow into a well-rounded epidemiologist. I am very excited to be able to use the gained knowledge and skills in future endeavours.

Acknowledgements of fellow

A special thank you to my supervisor, Mirjam Knol, and frontline coordinators, Zaida Herrador Ortiz and Sooria Balasegaram, for your excellent support and technical guidance throughout the past two years. Your mentorship and critical feedback allowed me to develop a wide range of competencies. I appreciate that you were approachable and provided encouragement throughout my fellowship.

Thank you to all my project supervisors and those with whom I collaborated at RIVM, for great teamwork and constructive feedback. I thoroughly enjoyed working on our projects and learning from such dedicated and experienced individuals. I would also like to express my gratitude to the Epidemiology department of RIVM; it was great to be part of such a supportive team. I am grateful for the feedback on projects and fruitful discussions, as well as statistical and R software support.

A big thank you to all past and present EPIET and EUPHEM fellows at RIVM. I am grateful for your advice and support throughout the fellowship. I enjoyed our motivational coffee breaks and informative seminars together. Lastly, a special thanks to all the fellows from Cohort 2019. It was a pleasure to have shared this journey with you. During the COVID-19 pandemic, we faced new challenges together and experienced a new way of connecting with each other. I am excited to be part of a network of highly trained field epidemiologists and microbiologists and hope our paths will cross in the near future.