

The section header "Summary of work activities" in a white, sans-serif font on a blue background.The author's name "Amy Mikhail" in a white, sans-serif font on a blue background.The main title "European Public Health Microbiology Training Programme (EUPHEM) 2012 cohort" in a white, sans-serif font on a blue background.The section header "Background" in a bold, blue, sans-serif font.

According to the European Centre for Disease Prevention and Control (ECDC) Advisory Group on Public Health Microbiology ('national microbiology focal points'), public health microbiology is a cross-cutting area that spans the fields of human, animal, food, water, and environmental microbiology, with a focus on human population health and disease. Its primary function is to use microbiology to improve health in collaboration with other public health disciplines, in particular epidemiology. Public health microbiology laboratories play a central role in detection, monitoring, outbreak response and the provision of scientific evidence to prevent and control infectious diseases.

European preparedness for responding to new infectious disease threats requires a sustainable infrastructure capable of detecting, diagnosing and controlling infectious disease problems, including the design of control strategies for the prevention and treatment of infections. A broad range of expertise, particularly in the fields of epidemiology and public health microbiology, is necessary to fulfil these requirements. Public health microbiology is required to provide access to experts in all relevant communicable diseases at the regional, national and international level in order to mount rapid responses to emerging health threats; plan appropriate prevention strategies; assess existing prevention disciplines, develop microbiological guidelines; evaluate/develop new diagnostic tools; arbitrate on risks from microbes or their products and provide pertinent information to policy makers from a microbiological perspective.

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.

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This report summarises the work activities undertaken by Amy Mikhail of the 2012 cohort of the European Public Health Microbiology Training Programme (EUPHEM) at Public Health England (PHE), London, UK.

All EUPHEM activities aim to address different aspects of public health microbiology and underline the various roles of public health laboratory scientists within public health systems.

Material and methods

This report accompanies a portfolio summarising the outcome of different activities conducted during the EUPHEM fellowship. The activities comprised specific projects, activities and theoretical training modules.

Specific projects included epidemiological investigations (outbreaks and surveillance); applied public health research; applied public health microbiology and laboratory investigations; biorisk management; quality management; teaching and public health microbiology management; summarising and communicating scientific evidence, and activities with a specific microbiological focus.

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

Results

Objectives of these core competency domains were achieved partly by project/activity work and partly by participation in training modules. Results are presented according to the EUPHEM core competencies defined in the EUPHEM scientific guide¹.

1. Epidemiological investigations

1.1. Outbreak investigations

A. Infection control assessment for a nosocomial outbreak of *Mycobacterium abscessus* in cystic fibrosis patients, Cambridgeshire, UK 2012

A retrospective whole genome study of *Mycobacterium abscessus* isolates from cystic fibrosis patients attending a specialised hospital unit in the south east of England between 2008 and 2012 revealed that 10 patients had been infected with a near-identical strain. Further investigations determined that this cluster of patients had overlapping hospital stays and resulted in the postulation that patient-to-patient transmission was occurring. Consequently, a situation assessment was undertaken at the hospital in order to determine infection control measures that could prevent further transmission. The fellow participated in the assessment, attended subsequent outbreak control team meetings and contributed to recommendations for further action. The findings led to changes in the configuration of sinks and taps to prevent transmission via water droplets, replacement of soft furnishings with items that could be disinfected, increased disinfection procedures, cohort segregation of infected patients when visiting the hospital and the use of negative pressure rooms for infected in-patients, where possible. In addition, a routine sputum screening programme for *M. abscessus* was implemented for all cystic fibrosis patients attending the unit. No new cases related to the outbreak strain were detected after the implementation of these measures.

B. Investigation of an enteric virus outbreak in a London restaurant, UK 2014

In January 2014, an outbreak of gastrointestinal illness occurred at a London restaurant, affecting both diners and staff. The fellow designed and conducted an epidemiological investigation in order to identify the vehicle of transmission and prevent further cases. Diners with gastrointestinal symptoms (cases) and unaffected members of their party (controls) were surveyed using a questionnaire and the odds of becoming ill were calculated for each item on the menu, revealing that there was a strong association between illness and consumption of shellfish (cockles and mussels). Primary identification and subsequent genotypic analysis of stool specimens collected from 20% of cases determined that this was a multi-pathogen outbreak, involving both norovirus (multiple genotypes) and sapovirus. Both viruses were also found in a batch of cockles (*Cerastoderma edule*) and mussels (*Mytilus edulis*) that had been served by the restaurant, leading to the immediate removal of these items from the menu. Sporadic cases continued to occur until the restaurant was closed for 10 days and chemically fumigated, which effectively halted the outbreak.

¹ <http://ecdc.europa.eu/en/publications/Publications/microbiology-public-health-training-programme.pdf>

C. Training modules

The EPIET/EUPHEM introductory course familiarised participants with the logistical and analytical approach to outbreak investigations. The module 'Computer tools in outbreak investigations' taught essential data management skills (data entry, validation and cleaning) and key epidemiological techniques (how to perform cohort and case-control studies, including descriptive and stratified analyses) using appropriate software packages. A module organised by the EPIET alumni network entitled 'Molecular outbreak epidemiology' presented new tools and methods for phylogenetic investigation of outbreaks involving person-to-person transmission where partial or whole genome sequences of the aetiological agent of infection are available. The fellow also participated in a workshop on strategies for investigating outbreaks in healthcare settings in Warsaw, Poland.

Educational outcome: Participation in outbreak control meetings and teleconferences, risk assessments, infection control assessments, involvement in outbreak investigations (case definitions, active case finding, data collection, data analysis, on-site visits), writing of reports and scientific articles, implementation of prevention measures.

1.2. Surveillance

A. Diphtheria seroprevalence and carriage survey, East Java, Indonesia 2013

Indonesia has experienced a 30-fold increase in the incidence of diphtheria since 2008 and by 2012 had the second highest incidence of diphtheria globally. This survey was conducted jointly by the EUPHEM fellow (focussing on serology and carriage surveys) and a Field Epidemiology Training Programme (FETP) fellow (focussing on vaccine coverage and seroepidemiological analysis) in collaboration with Indonesian public health personnel. The survey investigated possible causes for the increase in cases and piloted methods for estimating vaccination coverage and immunity in the local context. The pilot was undertaken in one high- and one low-incidence district. Three hundred children aged 1–15 years were randomly selected from midwife child health records and school lists (150 per district, 10 per single year of age). Carriage (1.7%) was only detected in the high-incidence district, which also had lower DTP3 vaccination coverage (56%) and higher median diphtheria serum antitoxin levels (2.048 IU/mL) than the low-incidence district (97% and 0.256 IU/mL). This led to the conclusion that low vaccination coverage was the primary driver of the outbreak and that an immunisation campaign targeting populations with low vaccination coverage was needed to prevent further cases. Diphtheria incidence in Indonesia remains elevated and efforts are currently underway to expand the seroprevalence survey to regional and national levels using methodology piloted in this study.

B. Detecting outbreaks of resistance to antimicrobial compounds in England

In the context of increasing antimicrobial resistance, the need for comprehensive surveillance of this issue has recently been recognised as a major priority by the UK Department of Health and the World Health Organization. The purpose of this study was to develop and test an early warning system for detecting increases in resistance to specific antimicrobial therapies by applying an automated algorithm to data from England's national antimicrobial resistance database (AMSURV). The role of the fellow was to modify an algorithm already in use for detection of pathogen-specific outbreaks, test the algorithm on an extract of AMSURV data from 2010 to 2013 and look back through a selection of the generated alerts to verify their accuracy. The modified algorithm will be incorporated into Public Health England's weekly detection and reporting system for outbreaks.

C. Training modules

The EPIET/EUPHEM introductory course familiarised participants with the basic approach to developing, evaluating and analysing surveillance systems. As a component of this course and in response to a request from a Member State, the fellow also participated in the development of a rubella seroprevalence survey protocol for implementation in Poland. Building on this foundation, the core module in 'Vaccinology' taught specific approaches to the surveillance of vaccine-preventable disease, including determination of vaccine coverage and vaccine effectiveness. The module 'Rapid health assessment in complex emergencies and mass gatherings' covered strategies for surveillance in complex emergencies, including nutritional, morbidity and mortality surveys.

Educational outcome: Participation in disease-specific networks at the national and European level; analysis of national laboratory-based surveillance systems; development and execution of seroprevalence surveys in response to national, European and international needs; scientific articles; formulation of specific public health recommendations and contribution to national surveillance strategies and policy.

2. Applied public health microbiology research

*A. Identification of routes and risk factors for aerosol transmission of *Mycobacterium abscessus* between cystic fibrosis patients in a hospital setting*

The detection of a nosocomial outbreak of *Mycobacterium abscessus* in late 2012 involving transmission between in-patients raised questions about how such transmission had occurred. The objective of this study was to determine if cystic fibrosis patients infected with *Mycobacterium abscessus* disseminated viable colonies into the air or onto surfaces and whether aerosol-generating procedures increased the risk of dissemination. The fellow designed a protocol and participated in a pilot study to assess this, where aerosol samples and surface swabs collected from the rooms of ten infected patients during physiotherapy or lung function tests were screened for the presence of mycobacteria. Although no patient strains of *M. abscessus* (*sensu stricto*) were detected, two aerosol samples and a surface swab were found to contain a closely-related species, *Mycobacterium chelonae*, thus demonstrating proof of principle for the methods used. The study will be expanded to other cystic fibrosis units in England where patient-to-patient outbreaks of *M. abscessus* have occurred.

*B. Risk of verocytotoxigenic *Escherichia coli* (VTEC) transmission between children in childcare settings*

Current legislation in England requires that children under the age of five who have been infected with VTEC be excluded from childcare settings until asymptomatic with two VTEC negative stool specimens, which can result in exclusion periods of 40 days or more and poses a significant challenge for working parents. The aim of this project was to develop and pilot methods to determine whether children who had become asymptomatic or were still shedding bacteria but at a low level continued to pose a risk for further transmission or could safely be allowed to return to a childcare setting at this stage. The fellow co-authored a study protocol (focusing on the use of quantitative real-time PCR to assess changes in bacterial load over time) jointly with a European Intervention Epidemiology Training (EPIET) fellow (focusing on the detection of secondary transmission and risk factors for this). The protocol aimed to determine the rate of secondary VTEC transmission in childcare settings and identify conditions under which no further secondary transmission occurred. The protocol is being piloted with VTEC outbreaks occurring during the current season and the study will continue until sufficient data has been collected to provide an evidence base to guide national policy.

C. Training modules

While the EPIET/EUPHEM introductory course focused on the development and presentation of study protocols, the module 'Initial management in public health microbiology' focussed on laboratory aspects, time management and team collaboration during the execution of studies and projects.

Educational outcome: Preparation of study protocols; design of data collection forms; organisation of a multicentre study; collaboration with external actors; ethical considerations in public health research; methods for collection of environmental specimens; culture methods for non-tuberculosis mycobacteria; use of appropriate protective equipment to prevent transmission of respiratory pathogens when working with vulnerable patients in a hospital setting; sensitivity of molecular diagnostic methods relative to culture at different stages of VTEC infection; data analysis; presentations and report writing.

3. Applied public health microbiology and laboratory investigations

A. Seroepidemiology of pertussis and sub-clinical infection during an outbreak at a residential school, UK 2012

The purpose of this study was a) to investigate the risk of developing clinical symptoms or a serological response to *Bordetella pertussis* infection in adolescents during a school outbreak in relation to estimated vaccination status and b) to determine whether sub-clinical infection contributed to transmission in this age group. The fellow analysed oral fluid specimens with a sandwich capture ELISA, designed and conducted a seroepidemiological analysis using survey data and specimens collected from a representative sample of students attending the affected school. The results indicated that receipt of an acellular component preschool booster was associated with increased risk of developing clinical symptoms of pertussis and increased transmission, while primary immunisation with a whole cell anti-pertussis vaccination was associated with better protection (higher anti-pertussis toxin IgG titres but fewer symptomatic cases). Seropositivity rates increased with age, indicating that waning immunity may have played a role in this outbreak and highlighting the need for further investigation to identify appropriate vaccination booster strategies for pre-school children and adolescents.

B. Phylogenetic analysis of norovirus during a foodborne outbreak caused by consumption of contaminated shellfish, UK 2014

Initial analysis of typing results from an outbreak of gastroenteritis caused by consumption of contaminated shellfish revealed a high level of diversity in norovirus strains, both within specimens from individual cases and in the implicated shellfish. The fellow undertook further comparative analysis of norovirus strains associated with this outbreak using bioinformatic techniques to assess the level of similarity and distance between isolates. Norovirus genogroups I and II were both represented and a total of nine subtypes were identified. Although norovirus genogroup II, genotype 4 predominated, neither cases nor shellfish shared an identical sequence and the majority of cases (62%) were infected with more than one genotype. These results illustrate the complexity of strain competition dynamics within human hosts, who propagated diverse strains of norovirus in spite of being epidemiologically linked by exposure to a common source of infection. Shellfish may become contaminated with a diverse range of pathogens and propagate multi-pathogen outbreaks if exposed to sewage, due to the practice of deliberate sewage release into the ocean during periods of high rainfall. Timely warning of such activities and removal of exposed shellfish from the market during these periods is therefore recommended.

C. Secondment to the Rare and Imported Pathogens Laboratory

Public Health England's Imported Fever Service receives specimens from UK patients with a febrile illness of unusual aetiology associated with recent travel abroad. The specimens are rapidly screened for possible causative organisms with molecular and serological test panels appropriate for the patient's travel history and clinical condition. The fellow was seconded to the service and its associated laboratory for one week in June 2014 during which training was given on the test panels and selection process, technical and medical validation of laboratory results. The majority of queries received at the unit during this time were for Lyme disease and viral haemorrhagic fevers; specifically dengue virus (associated with travel to South East Asia) and Ebola virus (associated with travel to West Africa and the current outbreak). The unit did not detect any cases of travel-associated Ebola virus in British residents during this period, but laboratory confirmation of dengue virus in patients who had travelled to endemic areas was common.

D. Training modules

The fellow participated in a European Diphtheria Surveillance Network (DipNet) wet lab workshop hosted by Public Health England in which laboratory techniques for the detection and characterisation of *Corynebacterium sp.* were taught. Methods covered included culture and isolation on specialised media, confirmation and typing of species via biochemical tests, determination of toxigenicity status via the ELEK test and detection of toxin genes with PCR. The fellow also attended a workshop and conference on 'Rapid next generation sequencing (NGS) for public health microbiology' hosted by the Medical Microbial Genomics Centre at the University of Münster, which included wet lab sessions where *Escherichia coli* was sequenced in parallel with two different NGS technologies; in silico sessions demonstrating use of analytical software for whole genome data and a mini conference during which experiences with the use of NGS for public health microbiology and new innovations in this area were presented. An annual series of diagnostic workshops hosted by Public Health England provided the fellow with a comprehensive overview of novel diagnostic strategies currently being implemented in laboratories throughout the organisation.

Educational outcome: Application of laboratory methods to detect immunological and molecular evidence of recent infection; understanding limitations of laboratory methods and the appropriate use of diagnostic algorithms; seroepidemiological analysis; bioinformatics and phylogenetic techniques; scientific presentation at a conference; writing of a scientific article.

4. Biorisk management

A. Implementation of serological tests for diphtheria at the regional public health laboratory in East Java, Indonesia

The fellow provided logistic support to the Balai Besar Laboratorium Kesehatan (BBLK) regional public health laboratory in East Java to facilitate the development of local capacity for monitoring immunity to *Corynebacterium diphtheriae* with the Vero cell in-vitro toxin neutralisation assay. Key support included the sourcing, purchase and shipping of complex assay reagents to Indonesia, including the arrangement of permits and specialised shipping conditions for hazardous and biological substances in compliance with international transport regulations.

B. Training modules

The EUPHEM module 'Biorisk management' provided training on techniques for biorisk/biosafety assessment and mitigation, including WHO recommendations on biosafety management in laboratories. Formal assessment and certification was also provided for international regulations on the transport of dangerous goods as prescribed by the International Civil Aviation Organization (ICAO). In addition, the fellow received training and a formal assessment at her host site for safe working in containment level 3 laboratories. The four-day course included a comprehensive overview of local and international health and safety regulations as applied to laboratory work with infectious organisms, theoretical and practical training in biosafety engineering, safety checks, audits and

techniques for working with hazard group 3 organisms. An overview of containment level 4 facilities was also provided and later complemented with a visit to two such facilities at the Smittskyddsinstitutet, Stockholm and at Public Health England's Rare and Imported Pathogens laboratory.

Educational outcome: Practice of appropriate measures for the safe transport of hazardous substances and pathogenic specimens; understanding and experience of the principles and practice of biorisk management; knowledge of biosafety when working with infectious organisms; understanding of processes associated with BSL3 and BSL4 laboratories; biorisk assessments and biorisk mitigation.

5. Quality management

A. External Quality Assessment for the molecular detection and characterisation of currently circulating influenza viruses in UK laboratories, 2013

An external quality assessment (EQA) exercise is organised annually for the UK influenza molecular testing network, during which participating laboratories are sent a panel of temporally representative influenza specimens to identify and sub-type using methods of their own choice. A key objective of this project was to identify mechanisms to automate and improve the presentation of results for participants and other stakeholders. The fellow developed and tested a novel quality scoring method which assessed both the qualitative and quantitative accuracy of participating laboratories in a single score. The new method made it possible to compare performance between laboratories and evaluate year-on-year changes in performance within laboratories. The quantitative results for each laboratory were also plotted against consensus reference values which facilitated rapid visual identification of laboratories with global deficiencies in sensitivity or specificity.

B. Training modules

The EUPHEM two-day 'Quality Management' module provided an overview of quality management concepts in diagnostic laboratories, according to the ISO 15189 standard. Topics covered included factors influencing quality in laboratories, internal and external quality control, norms and accreditation, assessments and audits, documentation and record keeping, sample management, stock purchase and inventory management, management of equipment and temperature-controlled devices, process improvement, customer service and international health regulations.

Educational outcome: understand the principles and practice of quality assurance; prepare and analyse the results from an external quality assessment exercise; contribute to an external accreditation audit; understand local and European accreditation procedures.

6. Teaching and pedagogy

A. Mini project review, UK 2013

The fellow organised and participated in this meeting, which is held annually in the UK to facilitate detailed presentation and discussion of current projects among EPIET and EUPHEM-associated fellows and invited subject experts based in the UK or the Republic of Ireland.

B. The role of laboratories in complex emergencies and mass gatherings

Lecture presented to EPIET and EUPHEM fellows as a component of the module 'Rapid health assessment in complex emergencies and mass gatherings' in Athens, Greece, June 2013.

C. Lab4Epi module, Public Health England, UK 2014

The fellow contributed materials to this two-day module in 2013 and co-organised the programme in 2014. The module is presented to trainee field epidemiologists to provide them with a functional overview of the public health laboratory's role in outbreak investigations and surveillance of infectious disease. A new virology case study, based on the series of laboratory investigations that led to the identification of Middle East Respiratory Syndrome (MERS) coronavirus in imported cases to the UK was presented. This illustrated key strategies used in the identification of unknown or novel pathogens. Lectures and discussions during the day included hot topics in antimicrobial resistance, molecular epidemiology in outbreak investigations and the challenges of applying whole genome sequencing to public health microbiology.

D. Management of a national outbreak – Salmonella exercise

The fellow acted as a facilitator for a case study presented as a component of the Public Health Master of Science course at King's College London, February 2014.

Educational outcome: Plan and organise lectures; define learning objectives; teach laboratory and microbiology topics to epidemiologists; organise meetings and workshops; develop learning materials.

7. Public health microbiology management

A. Public health microbiology management during execution of project work

Public health microbiology management was an integral component of all projects and activities during the fellowship. This included laboratory management; work flow management; consideration of ethical issues; team building and coordination; time management; management of cultural differences in international contexts; working with external collaborators and working in a multidisciplinary team comprising microbiologists, physicians, laboratory technicians, clinical scientists, epidemiologists, statisticians, government officials and public health officers.

B. European Diphtheria Surveillance Network coordination group meeting, 2013

A meeting of the EDSN coordination group was held at Public Health England in January 2013 to discuss the status of the diphtheria surveillance network, identify current needs in terms of laboratory diagnosis, external quality assurance, training and surveillance and to identify mechanisms of support for the supply of specialised laboratory reagents (such as diphtheria antitoxin) to European laboratories. The fellow participated in the meeting and co-authored the minutes. The meeting concluded with proposals to continue support for training and external quality assurance schemes, undertake serosurveillance studies at national level in coordination with serosurveillance for other vaccine-preventable diseases, conduct seroprevalence and carriage studies in high-risk population groups and produce a document for EU Member States describing minimal laboratory requirements for diphtheria diagnosis.

C. UK risk assessment for influenza A(H7N9) and MERS coronavirus, 2013

By June 2013, the UK had experienced three cases of Middle East Respiratory Syndrome (MERS) coronavirus, including the first documented family cluster. A series of risk assessment meetings were held in order to ascertain the risk to the UK and for travellers to the Middle East, particularly in light of the approaching Haj season, and also to assess the risk of influenza A(H7N9) being introduced as the case incidence in China was increasing. The fellow participated in the risk assessment meetings and was responsible for consolidation of the resultant documentation and minutes.

D. The role of EU disease-specific networks and reference laboratories in combatting emerging infectious disease and anti-microbial resistance

A workshop was held at Public Health England in October 2013 to discuss the role of EU disease networks and a potential future role for EU reference laboratories, in light of recent changes in the structure, management and delivery of these networks. The fellow participated in the meeting as a rapporteur and co-authored a position paper describing the organisational perspective on this topic. The paper also summarised ways in which PHE could further engage with and contribute to EU disease-specific networks in the future.

E. Training modules

A one-week module entitled 'Initial management in public health microbiology' focussed on the understanding of roles and responsibilities in public health management. Topics included the identification of different management styles, team roles and team evolution, the delegation of tasks and the provision of structured feedback.

Educational outcome: Gain experience of working in a multidisciplinary public health team; understand team management; understand roles and formal responsibilities in public health microbiology; plan, schedule and organise research projects.

8. Communication

A. Publications

1. Mikhail AFW, Ribeiro S, Litt D, Andrews N, Amirthalingam G, Campbell H, et al. Sub-clinical infection and pertussis transmission dynamics in adolescents; seroepidemiology of a school outbreak, UK 2012. (Submitted).
2. Mikhail AFW, Blake A, Hunter A, Pomeroy L, Simone B, Mook P, et al. Multi-pathogen enteric virus outbreak of gastroenteritis at a London restaurant, January 2014. (In preparation)
3. Hughes GJ[†], Mikhail AFW[†], Husada D, Irawan E, Bracebridge S, Efstratiou A. Seroprevalence and determinants of immunity to diphtheria for children living in two districts of contrasting incidence in East Java, Indonesia, March 2013. (In preparation)
4. Mikhail AFW, Ellis J, Zambon M. Application of novel methods to assess laboratory capacity to detect and characterise influenza in the UK, 2010–2013. (In preparation)

[†] Contributed equally

B. Reports

1. Mikhail AFW. Nosocomial outbreak of *Mycobacterium abscessus* in cystic fibrosis patients: hospital infection control site visit report, Cambridgeshire, November 2012.
2. Mikhail AFW. Nosocomial outbreak of *Mycobacterium abscessus* in cystic fibrosis patients: review of facilities and diagnostic procedures for non-tuberculosis mycobacteria at the Cambridgeshire Regional Public Health Laboratory, November 2012.
3. Mikhail AFW, Hughes GJ. Public Health England's response to the diphtheria outbreak in Indonesia: project report for the Global Health Fund, May 2013.
4. Mikhail AFW, Williams CJ. Nosocomial outbreak of *Mycobacterium abscessus* in a cystic fibrosis unit: situation update report, November 2013.
5. Ellis J, Lackenby A, Mikhail AFW, Zambon M. Public Health England influenza proficiency testing programme: summary report panel 8, December 2013.
6. Mikhail AFW, Blake A, Hunter A, Pomeroy L, Simone B, Mook P, et al. Outbreak of gastroenteritis due to enteric viruses at a Westminster restaurant, January 2014: outbreak report.
7. Fifer H, Mikhail AFW, Efstratiou AE. Public Health England position paper: The role of EU Disease-Specific Networks and EU reference laboratories to combat emerging infectious diseases and antimicrobial resistance.

C. Protocols

1. Mikhail AFW, Grogono DG, Hoffman P, Walker J, Bennet A, Thompson KA, et al. Investigation of environmental mechanisms for indirect patient-to-patient transmission of *Mycobacterium abscessus* in a cystic fibrosis unit: study protocol.
2. Simone B[†], Mikhail AFW[†], Balasegaram S, Boxall N, Jenkins C, Adak G, et al. Risk of secondary transmission of verocytotoxigenic *Escherichia coli* (VTEC) among children in childcare settings: [Protocol for] a prospective cohort study.

† Contributed equally

D. Teaching materials

1. Carvalho C, Ruggles R, Jain A, Mikhail AFW. Gastroenteritis during the Olympic Games: a case study (contributed materials to the Second UK Field Epidemiology Training Programme Lab4Epi course, Public Health England, London, UK – February 2013).
2. Jasir A, Mikhail AFW. Role of laboratories in complex emergency situations and mass gatherings (modified lecture material presented at the EPIET/EUPHEM module 'Rapid health assessment in complex emergencies and mass gatherings', National School of Public Health, Athens, Greece - June 2013).
3. Mikhail AFW, Birmingham A, Pebody R. Emergence of a severe acute respiratory infection [MERS coronavirus] in the UK: case study of a novel infectious agent (developed for and delivered at the Third UK Field Epidemiology Training Programme Lab4Epi course, Public Health England, London, UK - March 2014).

E. Conference presentations

1. Mikhail AFW, Hughes GJ, Irawan E, Husada D, Kafatos G, de Zoysa A, et al. Diphtheria in Indonesia: a survey of vaccine coverage and carriage in response to the current outbreak. Poster presentation at the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), Stockholm, Sweden, November 2013.
2. Mikhail AFW, Ribeiro S, Litt D, Andrews N, Amirthalingam G, Monk P, et al. Are notified cases just the tip of the iceberg? Seroepidemiology of a pertussis outbreak in a school setting, UK 2012. Oral presentation at the European Society for Paediatric Infectious Disease (ESPID) annual congress, Dublin, Republic of Ireland, May 2014.

F. Abstracts accepted for presentation at ESCAIDE 2014

1. Mikhail AFW, Ribeiro S, Litt D, Andrews N, Amirthalingam G, Monk P, et al. Sub-clinical pertussis infection in teenage children as a vehicle for transmission; seroepidemiology of recent infection during a school outbreak, UK 2012 (oral presentation).
2. Mikhail AFW, Blake A, Hunter A, Pomeroy L, Simone B, Mook P, et al. The perils of gourmet eating: outbreak of gastroenteritis due to enteric viruses at a high-end London restaurant, January 2014 (oral presentation).
3. Mikhail AFW, Ellis J, Zambon M. Application of novel methods to assess the response capacity of frontline laboratories to influenza in the UK, 2013 (oral presentation).

G. Selection of other presentations

1. Mikhail AFW, Hughes GJ. Diphtheria in Indonesia: a pre-survey investigative mission. Oral presentation delivered as a component of the 'Initial Management in Public Health' module, European Centre for Disease Prevention and Control, Stockholm, Sweden, February 2013.
2. Mikhail AFW, Hughes GJ. Diphtheria in Indonesia: response to the current outbreak. Oral presentation at the scientific teleconference for European epidemiology and public health microbiology fellows (TEAM) monthly meeting, April 2013.
3. Mikhail AFW, Grogono DG. *Mycobacterium abscessus*: assessing the risk in real time of aerosol dissemination in a hospital setting. Oral presentation at the workshop 'Outbreaks in Healthcare Settings', Narodowym Instytucie Zdrowia Publicznego – Państwowym Zakładzie Higieny (NIZP-PZH), Warsaw, Poland, November 2013.
4. Mikhail AFW, Blake A, Anderson SR. Outbreak of food poisoning at a London restaurant: lessons learnt. Oral presentation for the North West London Health Protection Unit quarterly training day, London, UK, March 2014.
5. Mikhail AFW, Hewitt K. Outbreak of food poisoning at a gourmet London restaurant: a case study. Oral presentation for the Field Epidemiology Services Victoria "cake studies" quarterly meeting, London, UK, April 2014.
6. Mikhail AFW, Charlett A. Excedence alerts: developing mechanisms to detect outbreaks of antimicrobial resistance in England. Oral presentation for the scientific teleconference for European epidemiology and public health microbiology fellows (TEAM) monthly meeting, May 2014.

9. International missions

Diphtheria outbreak investigative missions, Indonesia, January and March 2013

In response to the significant rise in the incidence of diphtheria in East Java, the Indonesian Ministry of Health implemented a diphtheria vaccination booster campaign in the province for children and adolescents under the age of 18 years in November 2012. Cases continued to rise after this intervention, including cases in children that had received a booster during the recent campaign, which was of particular concern. In January 2013, the fellow participated in an investigative mission to assist local partners in an assessment of the current situation and determine what studies could be done to improve the targeting and strategy of future vaccination campaigns. A review of cases in 2012 revealed that the majority (79%) of cases were over five years of age and that incidence varied by district, with the most affected districts located in the eastern part of the province. Although access to primary immunisation was adequate, a lack of vaccination records for children over five years precluded the use of this source to identify under-vaccinated groups. Consequently a serological survey was recommended and a protocol developed. The fellow returned to Indonesia for a second four-day mission in March 2013 to assist with pilot implementation of the serological survey in one high- and one low-incidence district. The main objectives were to evaluate the feasibility of identifying immunity gaps in the population with a serological survey and to identify local risk factors for contracting diphtheria by comparing vaccination history, medical history, living conditions and cultural precepts affecting the choice to vaccinate in the high- and low-incidence districts.

Educational outcome: Rapid public health assessment during an outbreak of a vaccine-preventable disease; design and coordination of a seroprevalence survey; collaboration with international partners at regional, national and international levels (Ministry of Health, WHO); analysis of surveillance databases; writing of reports and scientific articles; scientific presentations.

10. EPIET/EUPHEM modules attended

- EPIET/EUPHEM introductory course, Menorca, Spain (three weeks)
- Computer tools in outbreak investigations, Robert Koch Institute, Berlin, Germany (one week)
- Initial management in public health microbiology, ECDC, Stockholm, Sweden (one week)
- Biorisk and quality management, ECDC, Stockholm, Sweden (one week)
- Vaccinology, Public Health England, London, UK (one week)
- Rapid assessment in complex emergencies, National Institute of Public Health, Athens, Greece (one week)
- Project review module, ECDC, Stockholm, Sweden (two weeks)

11. Other courses

- Host site orientation and induction, Public Health England, London, UK (three weeks)
- Diagnostic technologies annual workshop, Public Health England, London, UK (two days)
- European Diphtheria Surveillance Network laboratory workshop, Public Health England, London, UK (two days)
- Rapid next-generation sequencing for public health microbiology, University of Münster, Germany (one week)
- Leadership training, Public Health England, London, UK (one day)
- Practices and principles of working at containment level 3, Public Health England, London, UK (four days)
- Molecular outbreak epidemiology, Smittskyddsinstitutet, Stockholm, Sweden (half-day)
- Workshop on outbreaks in healthcare settings, NIZP-PZH, Warsaw, Poland (two days)
- UK annual mini project review, Public Health England, London, UK (four days)

Discussion

A. Coordinator's conclusions

One of the main goals of the EUPHEM programme is to expose the fellows to different public health experiences and activities, thus enabling them to work across various disciplines.

This report summarises all activities and projects conducted by Amy Mikhail during her two-year EUPHEM fellowship (cohort 2012) at the Centre for Infectious Disease Surveillance and Control (CIDSC), Public Health England, London, UK.

The projects described here show the breadth of public health microbiology. Outbreak and surveillance activities ranged from small local community and restaurant outbreaks to the analysis of national databases and international investigations. Outside of Europe, international missions to Indonesia contributed to the understanding of important international public health issues. Laboratory and epidemiological projects covered bacterial and viral pathogens across a variety of disease programmes, including food and waterborne diseases, respiratory tract infections, vaccine-preventable disease, healthcare-associated infections and antimicrobial resistance. Projects involved different professional groups, for example physicians, laboratory technicians, epidemiologists, statisticians, government officials and public health officers, strengthening the fellow's ability to work in a multidisciplinary team.

Activities were in line with the 'learning by doing' and 'on-the-job' training approach of the EUPHEM programme and followed the core competency domains described for professionals in mid-career and above. Activities were complemented by nine training modules providing theoretical knowledge. Projects had a clear educational outcome, with results communicated in scientific journals and at conferences.

The EUPHEM coordination team concludes that the fellow has succeeded in performing all her tasks to a very high standard and with a professional attitude.

B. Supervisor's conclusions

The EUPHEM programme has provided Amy Mikhail with a great opportunity to find her niche in the field of public health microbiology and epidemiology whilst working with colleagues from diverse disciplines, both nationally and internationally. It has been a pleasure to mentor Amy for the past two years and it has been interesting to see her develop within the programme and acquire many new skills. Her projects covered all domains within the programme and showed that she was able to work on these projects independently, only occasionally consulting colleagues and peers for advice. One of her greatest strengths is her desire to work internationally in areas of public health requiring considerable reinforcement and she was given the opportunity to do this via her missions to Indonesia (East Java). Another key area in which Amy developed and excelled was that of epidemiological outbreak investigations. I wish her every success for the future and shall follow her career with interest.

C. Personal conclusions of the fellow

The EUPHEM programme provides an unprecedented and unique opportunity to receive professional training and experience in public health microbiology across a broad range of pathogens and disciplines. A major focus of the programme is to prepare and engage fellows in reactive work, including disease surveillance and outbreak investigations – I have particularly enjoyed this aspect of the fellowship and working to respond to defined public health needs. The cross-disciplinary approach of the programme has broadened my knowledge in many areas but is also timely, given that modern microbiological methods and techniques are increasingly converging and no longer pathogen-specific. A key objective of the EPIET family of programmes is also to improve working relationships between disciplines, especially epidemiology and public health microbiology. Throughout the fellowship, my projects and activities have incorporated both of these elements and I have also worked jointly with epidemiology training fellows on three projects. These experiences have also served to further strengthen interdepartmental relationships in the host institution. Through these mechanisms, fellows are effectively embedded into the infectious disease public health response network within Europe and beyond.

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