EUPHEM

EUPHEM REPORT

Summary of work activities

Elizabeth Dickson
European Public Health Microbiology Training Programme (EUPHEM), 2017 cohort

Background

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 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/produce 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.

Stockholm, September 2019

This report summarises the work activities undertaken by Elizabeth Dickson, cohort 2017 of the European Public Health Microbiology Training Programme (EUPHEM) at the Scottish Microbiology Reference Laboratories, Glasgow and Health Protection Scotland.

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.

Pre-fellowship short biography

Dr Elizabeth Dickson completed her undergraduate degree in Microbiology in 1998 and went on to do a PhD in molecular microbiology at the Glasgow Dental School and Hospital. This was funded by the Borrow Milk Foundation and looked at the effect of fluoridated milk on the cariogenic microorganisms in the mouth. Following successful completion, Elizabeth took up a postdoctoral research position at Brown University in Rhode Island, USA. Here she worked on a variety of projects involving mouse models and included vaccine development work for *Francisella tularensis* and immunological-based liver research. On returning to the UK, Elizabeth secured a funded position for clinical scientist training which took her to the north of Scotland and exposed her to the clinical aspects of microbiology that had previously been missing. This training also gave Elizabeth the opportunity to undertake an MSc in clinical microbiology at Nottingham University. The training concluded when she obtained the official registration from the Federation of Clinical Scientists. The training theme then continued with higher specialist training at Edinburgh Royal Infirmary however prior to completion of this training course, Elizabeth was given the opportunity to take up a permanent post as Principal Clinical Scientist within the Scottish Microbiology Reference Laboratories, Glasgow in 2013. During her EUPHEM fellowship, Elizabeth has gained experience in all disciplines of microbiology (bacteriology, virology, parasitology), epidemiology, bioinformatics and statistical analysis through a number of research projects based at the Scottish Microbiology Reference Laboratories, Glasgow and Health Protection Scotland.

Methods

This report accompanies a portfolio that demonstrates the competencies acquired during the EUPHEM fellowship by working on various projects, activities and theoretical training modules.

Projects included epidemiological investigations (outbreaks and surveillance); applied public health research; applied public health microbiology and laboratory investigation; 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 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 projects or activities (on-job services) and partly through participation in the training modules. Results are presented in accordance with the EUPHEM core competencies, as set out in the EUPHEM scientific guide[1].

1. Epidemiological investigations

1.1. Outbreak investigations

Supervisor: Jim McMenamin

A. Investigation of an outbreak of M. abscessus *complex in Cystic Fibrosis patients in Scotland, 2000-2017*

Mycobacterium abscessus complex infection in Cystic Fibrosis patients leads to chronic infection with limited treatment options. An investigation was undertaken to determine the genomic profile of Scottish *M.abscessus* isolates from 2000 to 2017 utilising whole genome sequencing (WGS) to support epidemiological data in understanding mode of transmission and evaluate control measures. Clinical *M. abscessus* isolates (79) referred to the Scottish Mycobacteria Reference Laboratory were sent to University of St Andrews where WGS using the

[1] European Centre for Disease Prevention and Control. European public health training programme. Stockholm: ECDC; 2017. Available from: http://ecdc.europa.eu/en/publications/Publications/microbiology-public-health-training-programme.pdf

Illumina MiSeq platform was performed. WGS analysis showed that the isolates could be split up into the three known subspecies: *M. abscessus* supbsp *bolletti* (4), *M.abscessus* subsp *massillense* (18) and *M. abscessus* subsp *abscessus*(57). The latter group comprised three main clusters: sequence type (ST) 5, ST9 and clonal complex (CC)24. Epidemiological investigations were performed on ST5 and ST9 as WGS data suggests they are dominant clones capable of causing healthcare–associated infection. The ST5 cluster comprised 10 isolates, two separated by 5 non-recombination SNPs but geographically distant. The ST9 cluster (21 isolates) spanned the entire time period constituting 9 clusters with self-mapping suggesting as few as 1 SNP apart, with epidemiological links to hospital and clinic visits. *M. abscessus* subsp *abscessus* has two dominant healthcare-associated clones which should be monitored routinely in cystic fibrosis patients. The outbreak is still under investigation however the conclusion thus far is that in situations where transmission of infection is suspected and to determine efficacy of infection control interventions, WGS is required to support investigation of *M. abscessus* complex in this vulnerable population. The fellow chaired many of the teleconferences meetings with experts in all involved disciplines as well as circulating agendas and minutes with action points. The fellow also completed all the information governance documentation required for epidemiological investigations. The fellow prepared an outbreak report and presented the investigation at a Scottish Microbiology conference May 2019 as well as an oral presentation at ESCAIDE, Stockholm, November 2019.

Supervisors: Alison Smith-Palmer, Christopher Redman and Gill Hawkins

B. Outbreak of STEC O157 *in NHS Scotland & UK and Monkeypox in UK – August 2018 and September 2018 respectively*

On the 7th August 2018, a problem-assessment group (PAG) meeting was held by teleconference following an alert that there were two small WGS clusters of E.coli O157 PT 8 that had been reported across the UK. Health Protection Scotland (HPS) participated as two confirmed and two probable cases were identified in Scotland. The fellow attended these meetings as part of the Gastrointestinal Infections and Zoonoses (GIZ) team in HPS and participated with tracing and interviews of identified patients. The fellow completed trawling questionnaires and input data into HPZone using password protection.
On the 12th September 2018, an incident management team meeting was called due to the identification of two cases of monkeypox virus in the UK. As this was a very unusual diagnosis for the UK, a large team with representation from the devolved nations was required to investigate and mitigate the impact of this disease. Scotland did not have any confirmed cases, just suspicion of potential travel of a contact person therefore the role of the fellow in this investigation was observational.

Training modules

The EPIET/EUPHEM/EAP introductory course and the outbreak investigation module familiarised participants with the "10 steps of an outbreak investigation" and how to write an outbreak investigation report. In addition, the fellow took part in an outbreak control plan exercise organised at a local level as part of outbreak preparedness activities. The outbreak investigation module further developed skills in STATA, phylogenetic analysis and epidemiological analysis of case studies. The management, leadership and communication module provided fellows with many tools in which to use during multidisciplinary team projects.

Educational outcome: Participation in national outbreak control meetings and teleconferences; questionnaire design and computer/software tools; participation in outbreak investigation from incident meeting and case definition to trawling questionnaires, data input and data analysis; communication and liaison with public health colleagues in HPS and clinical disciplines; preparation of outbreak report; presentation of investigation at national and international conferences.

1.2. Surveillance

Supervisors: Claire Alexander and Christopher Redman

A. One year evaluation of enhanced Schistosomiasis surveillance data

The aim of this study was to evaluate the first year of enhanced surveillance in Scotland to determine it was fulfilling the aim and objectives set out at inception. Features of the system that were being assessed included the simplicity, acceptability, data quality and representativeness and was meant to provide evidence of whether the surveillance should be kept, improved or discontinued. The fellow performed every stage of this evaluation of data from both the laboratory and the enhanced surveillance forms for the period spanning from 1st April 2017 to 31st March 2018. Although the system was simple in its design, there was some ambiguity around some of the stages of data collection. There was a very poor completion rate of the enhanced surveillance forms and a further questionnaire developed by the fellow also had a poor response rate but suggested that users were unaware of the existence of the system. Presentation of the results to the national surveillance and liaison group included the recommendation by the fellow that the system be discontinued and resources reallocated to other aspects of

reducing the public health risk in returning travellers. This recommendation was unanimously accepted at a national level.

Training modules

The EPIET/EUPHEM/EAP introductory course provided an introduction to the basic concepts of a surveillance system which were integral to this evaluation. The module "multivariable analysis" also provided further concepts for the analysis including the principles, application and interpretation of statistical analysis. The outbreak investigation module further developed skills in STATA and epidemiological analysis of case studies. The EUPHEM "management, leadership and communication in public health" module provided fellows with many tools in which to use during multidisciplinary team projects.

Educational outcome: understanding the concepts of a surveillance system and what function it serves; communication and engagement with multiple disciplines; formulation of recommendations for public health action; report preparation and presentation at stakeholder meetings.

2. Applied public health microbiology research

Supervisors: Alison Smith-Palmer, Chris Robertson, Claire Alexander

A. Cryptosporidium in Scotland – a ten year descriptive survey 2008-2017

Cryptosporidium is an apicomplexan protozoan pathogen that is one of the major causes of parasitic diarrhoeal disease worldwide. It is acquired through the ingestion of water or food contaminated with faeces containing infective oocysts, which are robust and can survive many months in temperate and moist conditions. The transmission dynamic of *Cryptosporidium* spp. in Scotland is not well understood so using a combination of epidemiological and typing data and population density data the project describes the temporal distribution of cases. The fellow performed a descriptive analysis using SPSS and Excel to determine age and sex trends, frequency of infection by health boards, seasonality of infection, incidence rates by level of deprivation and urban/rural classification. There is an increased risk of *Cryptosporidium* infection in males under the age of 15, however a second peak of infection is associated with females between 20 and 39 years. There is an increased incidence of *C. parvum* in Scotland compared with the rest of the UK and was more associated with rural loacations. *C. hominis* was statistically more likely to be associated with urban areas. The fellow was working with a senior statistician and is waiting for results of spatial analysis to expand this study further. An initial report has been prepared and a manuscript is planned for preparation post fellowship.

Training modules

The EPIET/EUPHEM/EAP introductory course had a week dedicated to the development and presentation of study protocols. The EUPHEM module "management, leadership and communication in public health" also covered time management, team collaboration and communication skills. "Multivariable analysis" covered many of the statistical methodologies for employing in analysis. The "outbreak investigation" module further developed skills in STATA and epidemiological analysis of case studies.

Educational outcome: preparation of research study protocol including the development of dummy tables; employing statistical analysis to large data set; preparation of descriptive report; communicating and liaising with colleagues in HPS and University of Strathclyde for planning and executing study objectives.

3. Applied public health microbiology and laboratory investigations

Supervisors: John Coia and Derek Brown

A. Implementation of capillary ribotyping of Clostridioides difficile (prev. Clostridium difficile) within a Scottish reference service to streamline current protocol and improve recognition of C.difficile ribotypes

C.difficile is an anaerobic, spore-forming environmental organism and was reclassified from *Clostridium* to *Clostridioides* in 2016. The spores can remain in the environment for prolonged periods of time and are highly resistant to drying, alcohol and many common detergents making it suited to become a hospital infection control problem. The organism is made up of different PCR ribotypes which can be determined with PCR-ribotyping. The basis for this technique relies on the presence o f 11 RNA operons at different locations in the DNA. The number and location of these operons varies per strain. Consequently the number and size of fragments that lie between the operons also varies. Each PCR ribotype has a specific band pattern that can be determine either by capillary or traditional gel electrophoresis after amplification with specific primers. The gel based method has more

disadvantages than the capillary method. Firstly the method itself is more time consuming with extended steps required for the amplification of products and then the preparation/running of the gel. Second, the agarose that is used is expensive and has shown instability across handlers causing poor quality results. With this level of inconsistency there is the problem of achieving a result in a timely manner, particularly during time sensitive public health events. Another disadvantage of the gel system is that the results are only interpretable locally and if comparison is required, the isolate needs to be sent to the enquiring laboratory. The aim of this study was to determine the applicability of capillary ribotyping for *C.difficile* isolates from Scottish patients.

The objectives of this study were: (i) develop the protocol within the current laboratory service to ensure it is workable; (ii) evaluate the new system against the current system to assess the advantages and disadvantages of each *in situ*, and (iii) validate the new system against ISO standards. The fellow has developed a method that is robust and can be integrated in to the routine workflow when time and staff pressures ease. The method has been developed with support from the *C.difficile* Reference Network (CDRN) in the UK to ensure the protocol is standardised across the UK. Data analysis is the most complex part of this technique and the fellow has developed an algorithm using BioNumerics and GeneMapper software. Standard operating procedures (SOPs) have been produced however validation is still required before the new method can be implemented.

Supervisors: Rory Gunson

B. A rapid review on the effect of introducing point-of-care (PoC) or dried blood spot (DBS) analysis on the uptake of hepatitis C virus testing in high-risk populations

Hepatitis C virus (HCV) is a member of the flavivirus family and there is an estimated 140 million infections with HCV worldwide. It is transmitted via parenteral routes and occurs in the developed world most commonly following blood-to-blood contact via intravenous drug routes or invasive sexual practices. Historically, testing for HCV relied upon blood samples taken under traditional phlebotomy techniques for laboratory processing. In recent years, advances in testing methods to utilise dried blood spots and point-of-care testing has enabled easier access to high risk populations who have less frequent contact with healthcare professionals. The rationale behind the overall project was to feedback the findings of this review and that of the method review for reengaging HCV positive people in care. Previously, a short-life working group (SLWG) had been formed, consisting of members of the NHS and third sector, to identify novel ways of accessing at risk HCV populations which in turn should aid in identifying those who are currently unaware of their HCV status. The fellow performed a rapid review of the literature and the search was presented in the form of a report and summary of findings presented to the SLWG. Following this, the fellow then presented the findings to a large national stakeholder event where the recommendations were considered by digi-voting. A final recommendations document was produced by the Scottish Health Protection Network (SHPN) with contributions of the fellow acknowledged.

Training modules

The EPIET/EUPHEM/EAP introductory course developed the concept of robust laboratory investigation and encouraged fellows to move out of their field of expertise. The "Biorisk and Quality Management" module gave targeted information for the production of robust quality manuals and risk assessments. The "Management, Leadership and Communication in Public Health" module provided fellows with many tools in which to use during multidisciplinary team projects and allowed the fellow to develop their communication styles and ways to convey important public health messages to different target audiences. The PRM modules were good platforms for discussing various projects and ways to progress from an epidemiology perspective. The fellow was previously introduced to capillary electrophoresis ribotyping for *C. difficile* at a workshop in Vienna (2016) run by ECDC and the Austrian Agency for Health and Food Safety (AGES).

Educational outcome: Preparation of SOPs, work instructions and analysis pathways; liaison with experts at a national level; troubleshooting both wet laboratory techniques and computer software programmes;; performing literature searches and preparing evidence for national stakeholder meeting

4. Biorisk management

A. International transport of infectious substances

The fellow completed the Shippers' Training course based on WHO ISST training materials and successfully passed the competency test.

B. Biosafety level-3 experience report

The fellow detailed the previous BSL-3 experience that has been gained throughout her career including working with the BSL-3 organism *Francisella tularensis* while doing her post-doc. Further experience also included working on sputum samples for the identification of *Mycobacterium tuberculosis* in the BSL-3 facility within the diagnostic

microbiology laboratory during her clinical scientist training, and developing antimicrobial sensitivity testing for Verotoxigenic *E.coli* (VTEC) during 3 months higher specialist training in the Scottish VTEC laboratory. This previous knowledge was used during the outbreak investigation when communication was required with the reference laboratory and consultant microbiologist to then feedback to epidemiologists and public health colleagues when discrepancies occurred.

C. Evaluation report of audit on Scottish Microbiology Reference Laboratories, Glasgow

The fellow performed an audit of the reference laboratories to a set template and provided conclusions for the department to consider. This audit contained aspects of biorisk management as indicators of good practice.

Training modules

The EUPHEM module 'Biorisk Management' provided training on the techniques used for both biorisk and biosafety assessment as well as mitigation. An overview of containment level 4 facilities was provided and included a visit to the BSL-4 laboratory at the Public Health Agency of Sweden, Stockholm.

Educational outcome: Formal assessment and certification for the international transport of infectious substances; ability to apply knowledge to situations within fellowship to facilitate communication between disciplines; biorisk assessment and biorisk mitigation.

5. Quality management

Supervisor: Alistair Leonard

A. Scottish Microbiology Reference Laboratories Service Review of MRSA

The Scottish MRSA Reference Laboratory (SMRSARL) was established in April 1997 in response to a rapid increase in the number of MRSA infections in Scottish Hospitals. The laboratory is commissioned by Health Protection Scotland (HPS) which is part of the National Services Division (NSD) for Scotland. The rationale of this project was to review a service that had been running for over twenty years to explore areas for improving and to determine the impact of implementing rapid assays on turnaround times, staffing profiles, public health benefits and cost efficiencies. The current service workflow, testing algorithms and procedures were observed as part of an audit of the department by the fellow. A report was written outlining the current workflow and options for streamlining the service. The report contained recommendations that included tightening rejection policies, discontinuation of redundant testing, implementation of automated DNA extraction and a real-time assay to replace the older, more time consuming and less safe techniques. This report was shared with the Reference Laboratory Management Group who agreed to the recommendations in principle. The fellow formed a short life working group and tasks were divided between the members of the group to take forward the changes. A Gantt chart provided a visual timeline for progress to be monitored. Within eight weeks of the initial audit, the service has been transformed in to a more robust and relevant public health service. Implementation of a replacement service for the discontinued antimicrobial sensitivity testing will be put together as a separate business case by the management group.

B. Evaluation report of audit on Scottish Microbiology Reference Laboratories, Glasgow

The fellow performed an audit of the reference laboratories to a set template and provided conclusions for the department to consider. This audit contained sections relevant to the current quality management system of the department including quality policies and quality manual.

Training modules

The EUPHEM module 'Quality Management' summarised the concepts of quality management in diagnositic laboratories according to the ISO 15189 standard. The fellow presented a lecture based on the organisation of a quality management system. There were also topics on factors that influence quality in laboratories, internal and external quality control, how to maintain documentation and importance of accurate record keeping. Accreditation was also a feature and the processes involved.

Educational outcome: experience of reviewing a current service to assess the needs of the department, users and ultimately patient; managerial skills for considering all aspects of a service; greater understanding of the requirements for a quality system and the importance of all those involved; understanding of how accreditation works and what is required to achieve it.

6. Teaching and pedagogy

A. BSAC Educational Workshop

The 2017 Educational Workshop series was jointly hosted by the British Society for Antimicrobial Chemotherapy (BSAC), Healthcare Infection Society (HIS) and British Infection Association (BIA). The workshop was held on the 30th October 2017 and the topic was *Unfriendly Fungi; infections, diagnosis, antifungals and management.* Through plenary lectures, case presentations and workshop discussion, delegates hear about the latest developments and have opportunities to share and discuss common and rare issues faced in every day practice. The workshops are attended by microbiologists, infectious disease consultants, scientists, pharmacists, infection control specialists and other interested health professionals working in areas of infection prevention, diagnosis and treatment. The fellow was in charge of the logistics of the event (house-keeping, attendance register, welcoming delegates) and therefore received all the material relating to the day and prepared the rooms for use by the delegates. The fellow also participated in these sessions.

B. Medical Student Case Based Learning

The University of Glasgow School of Medicine, Dentistry and Nursing provide the curriculum and teaching for the undergraduates in the Medical School. As part of the learning activities for the students, there are sessions within the Clinical Microbiology and Infection module for case based learning. This allows the students to learn and interact in a smaller group where they are asked to participate more actively in their learning. The fellow was assigned groups based upon availability and facilitated two groups on both 1st November and 10th November 2017. There were seven clinical microbiology cases and scenarios to be discussed with material prepared by the University for the students. The fellow also prepared extra notes and questions for the students to aid further discussions.

C. Laboratory Educational Workshop

This was the first workshop organised and developed in response to changes that have taken place across the microbiology and virology laboratories within NHS Greater Glasgow and Clyde health board, held on the 30th January 2018. The aim of the workshop was to increase infection control nurses knowledge of the roles each of the laboratories have in their daily workload and to explain the relevant changes that have impacted on their priorities. The fellow was approached by a lead consultant to provide an overview of the laboratories testing repertoire, explanation of how each of the tests are performed and result interpretation.

D. Masterclasses for trainees from infectious diseases, microbiology, veterinary and public health disciplines

The fellow was approached by the lead consultant clinical scientist to prepare two sessions for March 21st 2918: (1) an overview of vancomycin resistant enterococci and the current testing processes (2) the current situation with *C. difficlie* ribotyping, how it is performed and the interpretation of the results.

E. Glasgow Science Festival: Make your own microbe "Stitch a Schisto"

Schistosomiasis is a parasitic disease of significant public health importance with over 200 million cases worldwide. Infections occur during exposure to fresh water containing infected snails. Approximately 1000 tests are performed annually at the Scottish Parasite Diagnostic and Reference Laboratory (SPDRL) with around 200 positive cases identified - over 80% have no symptoms at the time of diagnosis. The asymptomatic nature combined with the fact that many travellers have never heard of schistosomiasis are significant issues. It is therefore extremely important to raise awareness to ensure those with fresh water exposure in endemic regions are fully aware of the risks and can be tested, and treated if positive. The fellow was involved in assisting with preparation for this event and then participated with the full session held on10th June 2018 at Glasgow Univeristy. The event involved interacting with children and adults in the general public who attended the event out of interest. The fellow worked with young children to make lollipop puppets of various stages of the life cycle of the shistosome and explained the relevance of the event and disease to them. There were also older children who were assisted to make their own 'cuddly' version of a stage in the schistosome life cycle. A summary of the event was presented as a poster at the Scottish Microbiology Association Autumn meeting in November 2018 and at their PanCeltic meeting in May 2019.

Training modules

The EPIET/EUPHEM/EAP introductory course provided fellows with a platform to begin polishing their presentation skills. There was a EUPHEM-specific task which was problem-based learning and this enabled fellows to prepare their own lectures and teaching styles. At the "Project Review" modules, the fellows were given constructive feedback on their presentation delivery which was always beneficial and different styles of delivery for different audiences were provided. The EUPHEM module "management, leadership and communication in public health" also covered time management, team collaboration and communication skills.

Educational outcome: communication and preparation of teaching materials for different levels of microbiology knowledge (e.g. children, nurses, public health trainees); utilising different teaching methods for educational purposes; engaging with different disciplines to respond to requests for specific information needs.

7. Public health microbiology management

Supervisor: Jim McMenamin

A. Call for papers for special edition of Eurosurveillance on POCT experience

In March 2019 there was a call distributed by Eurosurveillance for papers on **"how point of care/point of impact (POCT/POIT) and self-testing impact surveillance and public health"**. A UK-wide group of influenza experts decided this would be a good opportunity to put together an opinion piece based on collective experience. The fellow volunteered to take notes and draft a summary piece for distribution around all authors. Further work and teleconference meetings were established and the fellow redrafted the paper until the final version was submitted to Eurosurveillance in June 2019. At the same time, it was decided that HPS had access to unprecedented levels of information gathered from influenza POCT within Scotland and therefore a concurrent paper was developed by the fellow and co-authors. The fellow distributed drafts and collated the changes to prepare a final version that was also submitted to Eurosurveillance in June 2019. The fellow is lead author on both papers. A subsequent paper documenting a protocol for the estimation of influenza mortality is in preparation with the fellow as lead author.

B. Public health microbiology management during project work

Public health microbiology management was an important component of all projects and activities during the entirety of the fellowship. The service review detailed in the quality management section involved consideration of all aspects of a management system, with particular focus on more streamlined practices and relieving staff pressures. It was also a good opportunity to create and implement a Gantt chart for monitoring progress of changes. The *C. difficile* ribotyping project required working with external collaborators as well as support staff in technical help teams of the software companies. All projects required working in a multidisciplinary team often comprised of (but not exclusively) microbiologists, infectious disease consultants, epidemiologists, statisticians, clinicians and public health officers.

C. Management during workshops

The co-organisation of workshops and the facilitation of the BSAC workshop required good communication skills, organisation and time management.

D. Management during outbreak investigations

During the *Mycobacterium abscessus* complex outbreak, the fellow was responsible for the preparation of agendas and summarising action points from the investigation group meetings. The fellow also had to manage all the information governance paperwork which involved collating evidence from involved parties and meeting public health consultants to discuss issues requiring attention. The fellow also prepared an outbreak report for dissemination among the members of the incident management team and the acting clinical director of HPS. During the STEC outbreak, the fellow participated with trawling questionnaires and attended national outbreak control team meetings.

Training modules

The EUPHEM module "management, leadership and communication in public health" focused on the understanding of roles and responsibilities in public health management. There was good coverage of the different management styles that can be encountered and providing the fellow with tools that can be employed when interacting with different personalities. There were also good examples of team roles and how teams can evolve and ways in which to prioritise tasks and delegation skills.

Educational outcome: experience of working in a multidisciplinary public health team requiring close liaison with microbiologists, scientists, epidemiologists, bioinformaticians and clinicians within HPS, NHS health boards, and universities; managing teams and providing constructive feedback; establishing external collaborations to ensure synchronised approaches to organism identification; communication of findings to different audiences such as stakeholders or outbreak control teams.

8. Communication

Publications

1. **Dickson EM**, Zambon M, Pebody R, de Lusignan S, Elliot AJ, Ellis J, Lackenby A, Smith G, McMenamin J. 2019. Do Point of Care Tests (POCT) offer a new paradigm for the management of patients with influenza? *Eurosurveillance* (Manuscript submitted for review).
2. **Dickson EM**, Marques DFP, Currie S, Little A, Mangin K, Coyne M, Reynolds A, McMenamin J, Yirrell D. 2019. The experience of point of care testing for influenza in Scotland in 2017/18 and 2018/19 – no gain without pain. *Eurosurveillance* (Manuscript submitted for review).
3. **Dickson EM**, Marques DFP, Bishop J, Watson H, Kennedy S, Reynold A, McMenamin J. Scottish influenza mortality protocol (in preparation).

Reports

1. Dickson EM. Report on Educational Workshop, October 2017.
2. Dickson EM. Report on Medical Student Case Based Learning, November 2017.
3. Dickson EM. Report on NHS GG&C Outbreak Control Plan Exercise, December 2017.
4. Dickson EM. Report on Laboratory Educational Workshop, January 2018.
5. Dickson EM. Report on Masterclass, March 2018.
6. Dickson EM, Leonard A. MRSA Service Review for NHS GGC Microbiology Management Team, May 2018.
7. Dickson EM, Gunson R. Report on the rapid review of literature on point of care (POC) or dried blood spot (DBS) analysis on uptake of hepatitis C virus testing in high-risk populations, May 2018.
8. Dickson EM. Report on NHS Scotland and UK-wide STEC O157 outbreak, August 2018 and Monkeypox virus incident, September 2018.
9. Dickson EM. Biosafety level-3 Experience Report, October 2018.
10. Dickson EM. Implementation of Capillary Electrophoresis Ribotyping for *C. difficile* in to the Scottish Microbiology Reference Laboratory, Glasgow. SBAR Report, December 2018.
11. Dickson EM, Munro J, Perrow K, Alexander C, Redman C. HPS report: One year evaluation of enhanced Schistosomiasis surveillance data for Scottish National Advice, Investigation and Liaison (SNAIL) Group, May 2019.
12. Dickson EM, Robertson C, Smith-Palmer A. *Cryptosporidium* in Scotland – a 10yr descriptive survey, July 2019.
13. Dickson EM, Holden MTG, McMenamin J. *Mycobacterium abscessus* in Cystic Fibrosis patients in Scotland, August 2019.

Conference presentations

1. "'Stitch a Schisto' Public Engagement Event", Scottish Microbiology Association Autumn Meeting, Stirling, November 2018. (Poster presentation).
2. "*M. Abscessus* in Cystic Fibrosis patients in Scotland: A complex genomic and epidemiological investigation", Scottish Microbiology Association Panceltic Meeting, Peebles, May 2019 (Oral presentation).
3. "A genomic profile of *Mycobacterium abscessus* isolates from Cystic Fibrosis patients in Scotland", ESCAIDE Stockholm, November 2019 (Oral presentation).

Other presentations

1. "Antimicrobial resistance in carbapenamase-producing *enterobacteriaceae*, Problem Based Learning". Introductory module, Spetses, October 2017 (oral presentation).
2. "Reference laboratory results explained?" Infection Control Nurses Educational Workshop, January 2018 (oral presentation).
3. "Quality Management Organisation", Biorisk and Quality Management module, Stockhom, February 2018 (oral presentation).
4. "Implementation of whole genome sequencing (WGS) in Scotland and England for surveillance and outbreak management", Management, Leadership and Communication in Public Health Module, Stockholm, February 2018 (oral presentation).
5. "*Clostridium difficile* ribotyping", Masterclass for medical, veterinary and public health trainees, Glasgow, March 2018 (oral presentation).
6. "Vancomycin Resistant Enterococci", Masterclass for medical, veterinary and public health trainees, Glasgow, March 2018 (oral presentation).
7. "Rapid evidence review: 1. Dried blood spot testing; 2. Point of care testing 2014-2018", National Stakeholder Event, Edinburgh, May 2018 (oral presentation).
8. "EUPHEM – mid term review". ECDC site visit and mid-term evaluation of the fellowship, Glasgow, June 2018 (oral presentation).
9. "Enhanced Schistosomiasis surveillance – first year report" Scottish National Advisory and Implementation Group meeting, December 2018 (oral presentation).
10. "One year evaluation of enhanced Schistosomiasis surveillance – preliminary data". HPS Educational Seminars, January 2019 (oral presentation).
11. "EUPHEM – what does it entail?" NHS GGC Microbiology Seminar Series, January 2019 (oral presentation).

Other

1. "EUPHEM from the perspective of the fellows – Rolf Kramer and Elizabeth Dickson" EAN News Editorial EUPHEM special edition, October 2018.

Training modules

The EPIET/EUPHEM/EAP introductory course provided fellows with a platform to begin polishing their presentation skills. There were opportunities in all the modules to examine and write scientific reports and many of the fellows were encouraged to assist with the delivering of material for the modules. Constructive feedback was always beneficial and different styles of delivery for different audiences were provided.

9. EPIET/EUPHEM modules attended

1. EPIET/EUPHEM introductory course, Spetses, Greece (September 2017, 3 weeks).
2. ESCAIDE conference, Stockholm, Sweden (November 2017, 3 days).
3. Outbreak Investigation Module, Berlin, Germany (December 2017, 1 week).
4. Quality and Biorisk Management Module, Stockholm, Sweden (February 2018, 1 week).
5. Leadership, Management and Communication in Public Health Module, Stockholm, Sweden (February 2018, 1 week).
6. Multivariable Analysis Module, Nicosia, Cyprus (April 2018, 1 week).
7. Rapid Assessment and Survey Methods Module, Athens, Greece (May 2018, 1 week).
8. Project Review Module, Lisbon, Portugal (August 2018, 1 week).
9. ESCAIDE conference, Malta (November 2018, 3 days).
10. Project review module, Prague, Czech Republic (August 2019, 1 week).
11. ESCAIDE conference, Stockholm, Sweden (November 2019, 3 days).

10. Other training

1. "Unfriendly fungi: infections, diagnosis, antifungals and management" Educational Workshop hosted by British Society of Antimicrobial Chemotherapy (BSAC) and British Infection Association (BIA), Edinburgh, October 2017.
2. NHS Greater Glasgow and Clyde Outbreak Control Plan Exercise, Glasgow, December 2017.
3. *C.difficile* Reference Network (CDRN) training day on capillary electrophoresis ribotyping, Leeds, March 2018.
4. Recommendations on Hepatitis C Virus Case Finding and Access to Care National Stakeholders Event, Edinburgh, May 2018.
5. *C.difficile* Reference Network (CDRN) training day on BioNumerics and GeneMapper, Leeds, October 2018.
6. TrakCare training for patient tracing, Glasgow, October 2018.
7. Scottish Microbiology Association Pan Celtic meeting, Peebles, May 2019.
8. Scottish Microbiology and Virology Network (SMVN) Scientific Meeting, Edinburgh, May 2019.

Discussion

Coordinator's conclusions

EUPHEM programme exposes fellows to diverse and multidisciplinary public health experiences and activities, thus enabling them to work across different disciplines. This report summarises all activities and projects conducted by Elizabeth Dickson during her two-year EUPHEM fellowship (cohort 2017) as a member state track fellow at Scottish Microbiology Reference Laboratories, Glasgow and Health Protection Scotland. The EUPHEM Member State track pathway is a unique and represents an excellent opportunity for all Member States to train their own scientists and medical specialists as public health microbiologists and thus strengthen communicable disease surveillance through integrated public health microbiology and epidemiology networks. This has been successfully demonstrated in Glasgow by Elizabeth who after extensive experience in clinical microbiology has substantially contributed to the training site revising all the Scottish Microbiology Reference Laboratories activities with the aim to innovate and propose options for streamlining the service. Evaluating the Schistosomiasis surveillance data, implementing capillary ribotyping for *Clostridium difficile* and contributing to the country wide evaluation on the impact of point of care/point of impact (POCT/POIT) and self-testing as a new paradigm for the management of patients with influenza. Epidemiological studies consisted of outbreak investigations and surveillance activities that requested a wide effort in terms of multidisciplinary work and teamwork on all levels, showing strength of the fellow and ability to work within an extended environment(s). The laboratory projects covered diverse range of disease programmes.

Activities were in in line with the 'learning by doing' and 'on the job training' ethos of the EUPHEM programme and fulfilled the core competency domains described for professionals in their mid-career. Nine training modules provided complementary theoretical knowledge. The contribution made by this Elizabeth indicates the importance of developing a future critical mass of highly skilled field public health microbiologists within Member States to contribute towards national preparedness. The EUPHEM Coordinator Team concludes that the fellow has succeeded in performing all her tasks with a professional attitude and remarkable communication skills. We wish the fellow every success in her future career as a public health microbiologist.

Supervisor's conclusions

The EUPHEM programme has encouraged and supported essential training of our future leaders within Public Health Microbiology. Collaborations between the national Reference services within Scotland and the rest of the EU have been achieved through Elizabeth's contributions towards various projects which have been kindly supported by public health colleagues. In addition, further networking for both Elizabeth and myself has been possible through the attendance at workshops and training courses. Elizabeth has brought together expertise and ideas which has led to service improvements and better patient management. As part of Elizabeth's experience, a number of essential projects have been completed which have resulted in significant service improvements and a better understanding of disease surveillance. The project involving the national surveillance system for schistosomiasis was an excellent opportunity for Elizabeth to be the first in the UK to evaluate this novel system. The project supported excellent collaborations with a wide range of professionals including infectious diseases consultants, general practitioners, health protection experts, school leads, travel nurses, parasitology experts and Reference laboratory healthcare scientists. Elizabeth has also greatly improved her understanding of statistical analysis through valuable liaisons with clinical statisticians, and the mentoring received at the excellent modules she attended.

The EUPHEM programme has permitted Elizabeth to gain essential managerial skills and verbal communications skills through attending and presenting at national and EU meetings. In addition, valuable experience has also been attained writing national reports and laboratory guidance, as well as preparing manuscripts for peer-reviewed publications. Attendance at various training modules has given Elizabeth an excellent opportunity to experience countries outwith the UK and to interact with other fellows, supervisors and co-ordinators. This has permitted the formation of a close network of colleagues which is certain to promote future improvements within PH Microbiology through continued positive interations. It has been a delight to supervise Elizabeth and be involved in the EUPHEM programme. We look forward to continuing to support the EU in developing the skills of our future PH Microbiology leaders.

Personal conclusions of fellow

The EUPHEM fellowship is a unique opportunity for fellows to receive and develop their professional training and experience in public health microbiology. It has allowed me to diversify from the narrow subject field I was working in to expand my knowledge and skills in a broad range of pathogens and disciplines. This has given me unprecedented access to experience in outbreak investigations, surveillance and public health microbiology research as well as developing my public health microbiology management skills, teaching methodologies and rapid needs assessment. I feel that the fellowship has given me the confidence I was previously lacking when leading on various projects, particularly in outbreak teams, surveillance evaluation and manuscript preparation. It has given me the access to the national public health system that I would not have gained elsewhere and I have forged some excellent working relationships as a result. The two years very much focuses on bridging the gap between microbiology, epidemiology and public health by strengthening the connections with the European Programme for Intervention Epidemiology Training (EPIET) and Field Epidemiology Training Programme (FETP) networks. This in turn leads to greater multi-disciplinary cooperation and strengthens the European network of the public health professionals which is a key objective of the programme.
In particular, I have enjoyed attending the training modules which have been a tremendous learning experience for me. It has been a great privilege to become a part of this prestigious network of public health professionals and I feel honoured to be able to call many of them friends. I hope to be able to continue developing and strengthening the relationships that I have made at local, national and international levels in order to support and build capacity for preparedness within my home laboratory and public health teams.

Acknowledgements of fellow

I would first like to thank my EUPHEM supervisor, Claire Alexander, who was propelled into the lead role following the unexpected departure of Professor John Coia. Claire has been an excellent mentor and has been a great support throughout the fellowship. It was with great sadness that John left to pastures new as he had been

instrumental in getting the EUPHEM fellowship to Scotland, and played an active role at the introductory course in Spetses. I hope to have the opportunity to work with him again, perhaps with a Scottish/Danish collaboration. I also owe a very special thank you to Jim McMenamin who, as an EPIET supervisor, has been a tremendous support during my time at HPS and without whom I would have struggled to maintain momentum throughout my many projects. I would also like to thank Alistair Leonard who took up a deputy role when John left and has given me support and advice during the fellowship.
Special thanks go to my frontline EUPHEM coordinator, Loredana Ingrosso (ECDC) and secondline coordinator, Aftab Jasir (head of EUPHEM, ECDC), for all the excellent mentorship, support and constructive feedback they have given me throughout the fellowship.
All the members of the EUPHEM forum as well as the EUPHEM and EPIET coordination team deserve a massive thank you for all the hard work that they put in to delivering all the modules and training. Thank you to the fellowship programme office at ECDC for their administrative assistance and help during my fellowship.
I would like to express my overwhelming gratitude to Stephen Hughes, Isobel Neil and Bernadette Findlay at NHS GGC reference laboratories for supporting my application to the fellowship and all my colleagues who have been fulfilling my prior responsibilities during this two year secondment.
I would sincerely like to thank all my project supervisors for giving me the opportunity to work on these interesting and challenging projects; Alison Smith-Palmer, Rory Gunson, Derek Brown, Alistair Leonard, Chris Redman, Kali Perrow, James Munro, Chris Robertson, Christine Peters and Matt Holden. I am extremely grateful to all my colleagues within HPS who have supported and mentored me unconditionally; Diogo Marques, Naoma Williams, Karen Voy, Arlene Reynolds, Louise Primrose, Michael Lockhart, Ruth Robertson, Amanda Burridge, Josie Murray, David Yirrell, Annette Little, Michael Coyne and Kirsty Licence. A very special " thank you" to Warren Fawley at CDRN Leeds for his patience and humour during my project on *C.difficile*.
A very big "thank you" to all my co-fellows in Cohort 2017, for their friendship, knowledge, support and laughter throughout these two years. It is their team spirit that carried me through this journey and I will always be in their debt. A special thanks to Diogo Marques (EPIET Cohort 2015) who has been instrumental in helping me reach the end and has been a brilliant sounding board. I would also like to thank Janine Thoulass (EPIET Cohort 2015), Beatrix von Wissman (PAE Cohort 2009) and Alex Sanchez-Vivar (EPIET Cohort 2013) whose previous experiences and invaluable advice were shared generously.
A final" thank you" to my supportive and understanding husband, who endured a very sullen dog during the modules and a busy wife for two years. My parents have been with me throughout every step of my varied and unpredictable journey and their continued belief in me is overwhelming. Thank you.