EUPHEM

EUPHEM REPORT

Summary of work activities

Anne Carroll
European Public Health Microbiology Training Programme (EUPHEM), 2013 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 2015

This report summarises the work activities undertaken by Anne Carroll, cohort 2013 of the European Public Health Microbiology Training Programme (EUPHEM) at the Public Health Laboratory, Dublin and the Health Protection Centre (HPSC), Dublin, Ireland. Anne Carroll is a Molecular Biologist (PhD) at the Public Health laboratory, Health service Executive, Dublin Ireland. Before EUPHEM, Anne worked on the introduction of molecular methodologies particularly for the VTEC Reference service at PHL, HSE, Dublin.

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.

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 project or activity work 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

Supervisors: Eleanor McNamara, Paul McKeown, Muthu Saba, Jennifer Martin

A. Investigation of a national outbreak of verotoxigenic E. coli *(VTEC) in Ireland, 2013*

Ireland has the highest incidence of VTEC in the European Union (12 cases per 100 000 population in 2012). In August 2013 the VTEC Reference Laboratory, Dublin (VTEC-RL) alerted the Health Protection Surveillance Centre (HPSC) of a number of VTEC O157 isolates from all over Ireland with one of two closely related PFGE patterns. Neither pattern had been previously observed in Ireland. A multidisciplinary outbreak team was convened to investigate. A confirmed case was defined as 'a person with VTEC O157 *vtx2* with PFGE profile A) IE-O157-029 or B) IE-O157-271 with a date of onset of symptoms on or after 1 August 2013. Probable cases were VTEC O157 *vtx2*, but awaiting PFGE analysis. Trawling questionnaires were undertaken on cases and epidemiological, microbiological and environmental data collated. Between August 2013 and December 2013, 51 cases of VTEC O157 belonging to one of the two outbreak PFGE profiles were reported. Cases were observed in seven of the eight Irish Health Regions. When data from cases associated with PFGE profiles A and B were analysed, significant differences in the two groups were observed with respect to date of onset (profile A median week 37, profile B median week 40, p=0.013), geographical distribution (profile A predominantly south, profile B predominantly west, p=0.008) and age group (Profile A median 22 years, profile B median 50 years, p=0.042). The outbreak was declared over in March 2014 without a source being defined. It was concluded that two national VTEC outbreaks were running concurrently in Ireland at this time. Neither of these outbreaks would have been detected and investigated without PFGE profiling, however, because initial PFGE indicated the predominance of a single profile so early outbreak investigations may have been untargeted. Therefore, it is important to have combined laboratory and epidemiological investigations to identify specific sources of outbreaks.

[1] European Centre for Disease Prevention and Control. European public health training programme. Stockholm: ECDC; 2013. Available from: http://ecdc.europa.eu/en/publications/Publications/microbiology-public-health-training-programme.pdf

B. Investigation of an outbreak of Campylobacter Jejuni *in a nursing home in Dublin in 2013*

Campylobacter organisms are the most common cause of bacterial food-borne illness. Most reported *Campylobacter* infections are sporadic and outbreaks of *Campylobacter* illness are rare. Most outbreaks have been associated with consumption of unpasteurised milk, unchlorinated water, or poultry. Person-to-person transmission is uncommon. In December 2013 the Department of Public Health was notified of a possible outbreak of *Campylobacter jejuni* in a nursing home in Dublin. Eight cases were identified.

The fellow, in collaboration with epidemiology and public health colleagues, was involved in formulating the case definition, participating in site visits to examine hygiene and infection control practices, devising a food consumption questionnaire to aid case finding, interviewing nursing home residents and staff and performing a cohort study. The cases occurred over a three-week period and in two instances the lag time between onset of symptoms of cases was greater than the incubation period of *C. jejuni*, indicating multiple sources or a continuing common source of infection. A site inspection identified potential infection prevention control (IPC) issues related to facilities. Food histories were taken using the questionnaire and menus provided by the nursing home. Some deficiencies in IPC practices were identified during the site inspection; these were related to the nursing home not being a purpose built facility. Accommodation was over three floors with just two sluice rooms, the sluice rooms were also too small to wash commode frames which were washed in the residents' bathrooms. Recommendations were made to upgrade facilities to include an additional sluice room for the washing of commodes and bedpans. No source of the outbreak was identified.

C. Investigation of an outbreak of VTEC in a childcare facility in Ireland in 2013

Verotoxigenic *Escherichia coli* (VTEC) is an enteric pathogen of public health concern worldwide. VTEC causes a range of symptoms, from diarrhoea to the more severe haemolytic-uremic syndrome (HUS) which is characterised by kidney failure, thrombocytopenia and microangiopathic haemolytic anaemia. HUS can be fatal, particularly in young children. In October 2013 two children aged one year presented to two different hospitals with bloody diarrhoea. Faecal specimens were referred to the national VTEC reference laboratory (VTEC-RL), both children were positive for *E. coli* O26 *vtx1* and *vtx2.* Both children attended the same childcare facility in a rural area in the east of Ireland. All staff and children in the childcare facility were screened for VTEC at the VTEC-RL. In total eight cases of VTEC infection were identified, five were positive for the outbreak strain, one was positive for ungroupable *E. coli vtx1*, two were positive by PCR only (one for *E. coli vtx1*, and one for *E. coli vtx1*+*vtx2).* No source of the outbreak was identified. Cases were excluded from the childcare facility until they provided two negative faecal specimens 48 hours apart.

D. Training modules

The EPIET/EUPHEM introductory course introduced the concepts of 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 such as how to contribute to cohort and case–control studies, including descriptive and stratified analyses using STATA. The 'Multivariable analysis' module provided a more comprehensive understanding of the principles of multivariable analysis; the analysis situations that require use of multivariable analysis (i.e. third factors, including effect modification and confounding and how to manage these factors); identifying the type of multivariable analysis (linear, logistic, conditional, poisson, etc.) that is adapted to a particular study objective or design; interpreting the results of a regression model; corresponding inferences; and how to understand and use/interpret regression models.

Educational outcome: Participation in multidisciplinary outbreak control teams, 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

Supervisors: Eleanor McNamara, Paul McKeown, Rob Cunney

A. Evaluation of the national surveillance system for respiratory syncytial virus (RSV) in Ireland

Since 1988 the National Virus Reference Laboratory (NVRL) has been providing comprehensive data on RSV infections. The NVRL data are a good indicator of seasonal patterns. There was concern, however, that this did not capture the full picture of RSV, as data from hospital laboratories who conducted their own testing for RSV were not included. In particular, given the importance of RSV as a disease in children, the fact that some paediatric hospitals conducted their own testing for RSV suggested that using solely the NVRL dataset might provide a skewed picture of the RSV burden in Ireland, with children potentially under-represented. Since 2012, when RSV became notifiable in Ireland, clinical and laboratory-confirmed cases of RSV have been captured in the national Computerised Infectious Disease Reporting (CIDR) system. The fellow evaluated completeness, timeliness and representativeness of the national RSV surveillance system. One of the aims was to evaluate whether the data from the RSV surveillance system could be used to characterise the timing of RSV seasons and thus inform the timing of prophylaxis treatment. The other was to determine whether, three years post- implementation, the system is providing good baseline data, which is necessary in order to measure the disease burden, and to evaluate whether this baseline data is being captured in an accurate and timely manner. The evaluation was carried out using the CDC's 'Updated Guidelines for Evaluating Public Health Surveillance Systems' from 2001. In general the RSV CIDR surveillance system is timely and representative, however the reporting was slower outside of the RSV season and in the eastern part of the country.

Completeness of the system varied across regions. As there are only three years of data, it was recommended that the system be re-evaluated in 3–5 years' time to determine whether it remains timely and representative, and to confirm that the system can be used to characterise the timing of RSV seasons. This was a joint EUPHEM/EPIET project.

B. Molecular surveillance

Molecular typing of pathogens that cause infectious diseases complements traditional epidemiological surveillance by providing appropriate discriminatory analyses to foster the rapid and early detection of dispersed international clusters or outbreaks, to detect and investigate transmission chains and the relatedness of strains, and to detect the emergence of antimicrobial resistance and new evolving pathogenic strains. It also supports studies to trace back to the source of an outbreak and identify new risk factors, as strains can be linked more accurately to epidemiological and clinical data. The fellow was involved in setting up a platform for exchange of PFGE data from Ireland to ECDC. This project focused on VTEC. However, the policies and procedures put in place will facilitate similar transfer of molecular typing data on other pathogens in the future. The Irish national clinical VTEC database was first transferred to Bionumerics 7. Access to TESSy was granted and relevant software required for the interface to be installed. The final steps for the transfer of data are ongoing.

C. Training modules

The EPIET/EUPHEM introductory course familiarised participants with the development, evaluation and analysis of surveillance systems. Building on this course, the module on 'multivariable analysis' demonstrated the principles, application and interpretation of multivariable analysis and its role in field epidemiology.

Educational outcome: Participation in disease-specific networks at the national and European levels; analysis of laboratory-based surveillance systems at hospital, country and European level; familiarity with multivariable analysis; phylogenetic analysis in order to provide surveillance systems with microbiological support; scientific articles and the formulation of specific public health recommendations.

2. Applied public health microbiology research

Supervisors: Eleanor McNamara, Paul McKeown, Rob Cunney, Breida Boyle, Richard Drew

A. Prolonged contamination of wash-hand basins: a potential source of *Pseudomonas aeruginosa* infections in augmented care areas of an acute adult hospital

In 2013, an increase in colonisation and infection with multidrug-resistant (MDR) *P. aeruginosa* was noted in patients of two augmented care units (ACU) in an acute adult hospital in Dublin. Water and patient samples were examined to determine whether the water from the hand hygiene wash basins was a possible source of exogenous acquisition of *P. aeruginosa* by patients in the units. Swabs and pre-flush water samples from forty WHBs in two ACUs were screened for *P. aeruginosa*. WHBs from which samples were positive for *P. aeruginosa* had subsequent pre- and post-flush water samples taken to ascertain the extent of the contamination. Environmental and patient isolates were characterised by pulsed field gel electrophoresis (PFGE) to determine relatedness. Fifteen ACU patients were either colonised or infected with *P. aeruginosa* over a 15-month period. Water samples from three WHBs were positive for *P. aeruginosa*, from the initial screening and from pre- and post-flush samples. All pre-flush counts were higher than post-flush, indicating a local WHB problem and not a systematic contamination of the water supply. All water and swab isolates from WHBs in one ACU and two isolates from two patients who were admitted to this ACU had indistinguishable PFGE profiles. This study suggests that exogenous infection may have occurred in one ACU. Water microbial surveillance and water treatment strategies should be in place in ACUs to minimise the risk to susceptible patients. *P. aeruginosa* may persist for prolonged periods despite routine cleaning and remain a potential source for *P. aeruginosa* Healthcare Associated Infection (HCAI) in ACUs.

B. Group B streptococcal disease (GBS) in Irish infants

A case–control study was carried out to determine risk factors for neonatal group B streptococcal (GBS) disease in a large Dublin maternity hospital over a 13-year period. Historical clinical data from babies with GBS bacteraemia and controls was used. Cases were defined as infants <90 days old who were born in the Rotunda hospital, Dublin, between 2001 and 2013, and from whom GBS was isolated from a blood culture. Controls were neonates born in the Rotunda hospital during the same period who did not have GBS bacteraemia. Uni-and multivariate analysis was carried out using STATA 12.0. During the study period 96 cases of GBS bacteraemia were reported. The majority of cases (82%, n = 80) were early onset cases. Univariate analysis on early onset cases showed that the following were associated with early onset GBS disease: young maternal age ($p = 0.045$), being resident non-Irish ($p < 0.001$), primigravida ($p < 0.001$), ruptured membranes on admission ($p < 0.001$), induction due to PROM ($p = 0.003$), gestation < 37 weeks ($p = 0.046$), maternal GBS bacteiruria ($p \leq 0.001$), positive GBS test from a vaginal swab ($p = 0.001$), prolonged labour stage 1 ($p = 0.017$), stage 2 ($p < 0.001$).

Multivariable logistic regression analysis found statistically significant associations with being a case were: primigravida (OR 46.69), being non-Irish (OR 44.33), GBS bacteiruria (OR 6.85) and induction due to PROM (OR 4.44). This study suggests that non-Irish primigravidae or those with PROM or GBS bacteiruria could benefit from intrapartum antibiotic prophylaxis.

C. Training modules

The EPIET/EUPHEM introductory course focused on the development and presentation of study protocols, including study objective and aims, methods and expected outcomes.

Educational outcome: Preparation of study protocols; questionnaire design; organisation of a multicentre study; interpretation of typing results; data analysis; writing of scientific articles; scientific presentation at a conference.

3. Applied public health microbiology and laboratory investigations

Supervisors: Eleanor McNamara, Paul McKeown, Rob Cunney, Brian O Connell

A. Evaluation of molecular and culture methods to determine the optimum testing strategy for VTEC in faecal specimens

In Ireland all suspected or confirmed VTEC isolates and all stool samples positive for *vtx* genes are referred to the National VTEC Reference Laboratory, Dublin (VTEC-RL). Similarly, any specimens thought to be high risk for VTEC (Guidance for laboratory diagnosis of human verotoxigenic *E. coli* infection, HPSC, 2014) where PCR is not available locally are also referred to the VTEC-RL. Since 2013, a change in VTEC-RL workload due to receipt of stool specimens that are PCR-positive for *vtx,* has prompted a review of the five VTEC methods used at the VTEC-RL and consequently an optimisation of internal workflow patterns. The aim of this study was the development of an optimal VTEC testing algorithm for VTEC-RL to provide the most sensitive, specific and rapid VTEC methodologies utilising PCR and culture confirmation. A total of 681 stool specimens were examined using up to five diagnostic molecular and phenotypic methods that are used routinely in the VTEC-RL. A testing strategy incorporating a two-step approach that included a single RT-PCR and one culture-based method yielded the highest sensitivity, specificity, PPV and NPV (98.21%, 100% 100% and 99.43%, respectively). The implementation of this testing algorithm at VTEC-RL allows quicker turnaround times of specimens. This provides faster results to public health doctors and thus aids faster detection of VTEC sources, has an impact public health interventions and minimises the spread of VTEC.

B. Comparison of *S. aureus* from cannula-related blood stream infection (BSI) and S. aureus from nasal swabs of healthy carriers

Staphylococcus aureus is one of the most common causative pathogens of bloodstream infections (BSIs). Meticillin-sensitive *Staphylococcus aureus* (MSSA) is also commonly found in the nasal cavity of healthy individuals. It is unknown if there are differences in MSSA strains from these two groups at a genetic level. The aim of this study was to examine the presence or absence of virulence and adhesin genes in isolates that were recovered from blood cultures and from isolates from healthy MSSA carriers, to determine if cannula-related BSI have specific virulence and/or adhesin gene profiles. MSSA was recovered from blood cultures of 40 patients where the source was considered to be a line or catheter. DNA microarrays were performed on these isolates. DNA microarray data were available on MSSA isolated from nasal swabs of 40 healthy carriers. Data from the two groups were compared using STATA 12. Analysis is ongoing.

Educational outcome: application of virology, bacteriology, and immunology concepts to public health disciplines, identification of the use and limitations of diagnostic and typing methods and their interpretation in patient diagnosis, outbreak investigations, surveillance and epidemiological studies.

4. Biorisk management

A. Review of BSL3 laboratory design

The fellow was invited by a university to inspect a new BSL3 laboratory and advise on its suitability as a diagnostic microbiology laboratory. The inspection includes physical specifications, workflow designs and laboratory management procedures.

B. Audit of BSL2 and BSL3 laboratories

The fellow carried out complete and comprehensive safety audits of the BSL2 and BLS3 laboratories at the Public Health Laboratory, Dublin and the National VTEC Reference laboratory, Dublin, respectively.

C. Internship, Madrid

The fellow spent two weeks in ISCII, Madrid. One of the activities undertaken during this visit was to observe the processing of Ebola specimens, with particular focus on biorisk management (see Section 10A for further details).

D. Training modules

The EUPHEM module 'Biorisk management' provided training on techniques for biorisk and 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.

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

Supervisor: Eleanor McNamara

A. Implementation of ISO 15189

The fellow was responsible for designing and directing validation procedures for molecular assays for initial accreditation to ISO 15189 in the Public Health Laboratory, Dublin. The fellow also wrote standard operating procedures, devised internal quality control programmes, devised a method for witness audits and monitoring of the quality system in the molecular laboratory. The fellow was part of the accreditation team on the day of the audit by the Irish National Accreditation Board (INAB).

B. Maintenance of ISO 17025

The Public Health Laboratory, Dublin, has been accredited for molecular assays under ISO 17025 since 2011. The fellow was responsible for the maintenance of the quality system of the molecular laboratory, such as non-conforming work reports, internal quality control, external quality assessment, environmental monitoring,. The fellow also designed validation protocols for extending the scope of the molecular laboratory.

C. VTEC external quality assessment

The Statens Serum Institut (SSI), Denmark, runs a yearly EQA scheme (funded by ECDC) for VTEC. The VTEC reference laboratory participates in this scheme. The fellow was responsible for supervising the processing of this EQA, submission of results, and putting remedial actions in place if necessary.

D. Training modules

The EUPHEM '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; manage a laboratory quality system.

6. Teaching and pedagogy

A. Final year biomedical science student

Supervision of a final year biomedical science student. The project was a 12-week project and accounted for 40% of the student's BSc grade. The project was titled 'An epidemiological study of verotoxin subtypes in Ireland'. The student obtained a first class honours degree.

B. Trained scientists

Scientists were trained on how to set up a diagnostic microbiology laboratory.

C. Lectures

Lecture 'VTEC: pathogenesis, diagnosis and epidemiology' delivered to MSc students from the Dublin Institute of Technology (DIT).

The lecture 'IVD v LDA in diagnostics' explored the advantages and disadvantages of both in vitro diagnostic (IVD)-certified kits and laboratory-developed assays (LDA) in the diagnostic microbiology laboratory.

Educational outcome: Plan and organise lectures, define learning objectives, teach laboratory and microbiology topics, organise meetings and workshops and plan public health research projects for students.

7. Public health microbiology management

A. Laboratory diagnosis and environmental testing of water heater-cooler units for *Mycobacterium chimaera* associated with cardiothoracic surgery

Environmental microbiology investigations have been initiated in several cardiothoracic surgery centres across Europe following alerts made after an outbreak report in a hospital in Switzerland (Sax et al., 2015). They are being conducted into potential sources of peri-operative contamination of patients who underwent open chest cardiovascular surgery with cardiopulmonary bypass and who later developed surgical site or disseminated infection with *M. chimaera*,. In response to 'Multicentre environmental survey protocol for investigation of potential sources of *M. chimaera* surgical infections in Europe' (ECDC), Ireland has set up a national implementation management team to liaise with ECDC and to investigate cardiac water heater-cooler units in Ireland. The fellow was tasked with development and validation of a national water testing method. This validated method has been disseminated to laboratories nationally. The fellow is also involved with the management of screening water samples nationally, this included devising testing strategies and coordinating laboratory testing schedules.

B. Management of varicella zoster virus (VZV) in an intravenous drug detoxification unit

In January 2014 there was a case of shingles in an intravenous drug detox unit in a Dublin hospital. The fellow reviewed infection control procedures to be put in place, and issued a recommendation to redeploy a pregnant nurse with unknown immune status from the unit. The fellow also interviewed and reviewed medical records of residents of the unit to determine their immunity to VZV. The case was placed in isolation with additional contact precautions. It was ascertained that all residents were immune to VZV, so no further action was required.

C. VTEC national guidance on laboratory diagnosis

The fellow was part of a national sub-committee that was set up to write national guidelines on the laboratory diagnosis of VTEC in Ireland. The guidance document is published on the Health Protection Surveillance Centre (HPSC) website[2]:

D. VTEC national workshop

The fellow was part of a multidisciplinary group that met for a two-day workshop whose function was to outline and explore ideas that would facilitate rationalisation and improved investigation, control and management of VTEC in Ireland.

E. Management of *Legionella* in hospital water supply

Hospital water systems have frequently been identified as a source of hospital-acquired infections. In Ireland each healthcare institution is responsible for the quality of water once it enters its premises. The fellow was a member of a multidisciplinary group responsible for *Legionella* management in a Dublin hospital. This involved risk assessment of each area, devising sampling and testing schedules, ongoing surveillance and recommendation of remedial actions where necessary.

F. 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.

[2] Guidance for Laboratory Diagnosis of Human Verotoxigenic *E. coli* Infection produced by The Laboratory Sub-Group of the VTEC Sub-Committee of the Health Protection Surveillance Centre Scientific Advisory Committee, Ireland. 2014. Available from: www.hpsc.ie/AZ/Gastroenteric/VTEC/Guidance/ReportoftheHPSCSubCommitteeonVerotoxigenicEcoli/File,4544,en.pdf

G. Training modules

A one-week module entitled 'Initial management in public health microbiology' focused 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, communication with higher autorities and working under presure in a complex situation.

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. Carroll AM, Talento A, Keating S, Rose L, Boyle B, McNamara EB. Prolonged contamination of wash hand basins: a potential source of *Pseudomonas aeruginosa* healthcare-associated infections in augmented care areas in an acute adult hospital (submitted).
2. Carroll AM, Cobban E, McNamara EB. Evaluation of molecular and culture methods to determine the optimum testing strategy for VTEC in faecal specimens (submitted).
3. Group B streptococcal disease (GBS) in Irish infants (submitted).
4. Evaluation of the national surveillance system for respiratory syncytial virus (RSV) in Ireland (submitted).
5. Comparison of *S. aureus* from line/catheter infection and *S. aureus* from nasal swabs of healthy carriers (in preparation).
6. Investigation of a national outbreak of Verotoxigenic *E. coli* (VTEC) in Ireland, 2013 (in preparation).
7. Garvey P, Carroll A, McNamara E, McKeown PJ. Verotoxigenic *Escherichia coli* transmission in Ireland: a review of notified outbreaks, 2004-2012. (Accepted Epidemiology and infection).

B. Reports

1. Investigation of an outbreak of *Campylobacter jejuni* in a nursing home in Dublin in 2013.
2. Evaluation of the national surveillance system for respiratory syncytial virus in Ireland.
3. National VTEC reference laboratory annual report

C. Conference presentations

1. Carroll AM, Garvey P, McKeown P, McNamara EB. A national outbreak of verotoxigenic *E. coli* (VTEC) in Ireland 2013. Oral presentation at the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), Stockholm, 2014.
2. Carroll AM, Forde K, McNamara EB. HUS caused by VTEC including non-O157 *stx*1 in Ireland. Oral presentation at the 25th European Congress of Clinical Microbiology and Infectious Disease (ECCMID), Copenhagen, 2015.
3. Carroll AM, Garvey P, McKeown P, McNamara EB. Increased Prevalence and diversity of VTEC in Ireland. Oral presentation at the Irish VTEC network annual conference, Dublin 2014.
4. Carroll A. Current trends in laboratory diagnosis of VTEC in human infections. Academy of Medical Laboratory Science, annual conference. Dublin, November 2013.

D. Other presentations

1. Carroll A. Introduction of PCR Screen: Impact on National VTEC Reference Laboratory. Serosep user group meeting, Limerick, September 2014.
2. Carroll A. VTEC virulence genes and their association with clinical symptoms. Trinity College Dublin annual research day, April 2014.
3. Carroll A. Prolonged contamination of wash-hand basins: a potential source of *Pseudomonas aeruginosa* healthcare-associated infections in augmented care areas in an acute adult hospital. EUPHEM module: Initial management in public health microbiology, ECDC, February 2014, Stockholm.
4. Carroll AM. Effective detection of verotoxigenic *E. coli* (VTEC) by a two-step algorithm including PCR and culture . ECDC stay module: ECDC, September 2014, Stockholm.
5. Carroll AM. Automation and its effect on the diagnostic laboratory. Roche satellite symposium, Copenhagen, April 2015.
6. Carroll AM. Review of EUPHEM activities year one. Presented to medical and scientific staff invited to midterm review opening meeting. Dublin, August 2014.
7. Carroll AM. A national outbreak of verotoxigenic *E. coli* (VTEC) in Ireland 2013. EPIET/EUPHEM project review module, Stockholm, August 2014.

E. Other

1. SafeFood (the food safety promotions board) in Ireland produces an information document called 'The food chain'. The fellow was interviewed by a journalist about VTEC in Ireland, the interview was published in 'The food chain' September 2014.
2. Reviewed paper for the journal of clinical microbiology and infectious diseases.

F. Training modules

Initial management in public health microbiology, ECDC, Stockholm, Sweden.

9. EPIET/EUPHEM modules attended

1. EPIET/EUPHEM introductory course, Spetses, Greece (three weeks)
2. Computer tools in outbreak investigations, Robert Koch Institute, Berlin, Germany (one week)
3. Sampling and rapid health assessment module, Athens, Greece (one week)
4. Biorisk and quality management module, ECDC, Stockholm, Sweden (one week)
5. Initial management in public health microbiology, ECDC, Stockholm, Sweden (one week)
6. Vaccinology, Public Health England, London, United Kingdom (one week)
7. Project review module, ECDC, Stockholm, Sweden (one week)
8. Multivatiable analysis module, Vienna, Austria (one week)
9. ECDC stay module, ECDC, Stockholm, Sweden (one week)

10. Other training

1. The fellow travelled for two weeks to ISCII Madrid, Spain, to the laboratory responsible for viral vector-borne diseases. Training on the laboratory diagnosis of dengue, chikungunya, Rift Valley fever, Toscana and Ebola. The fellow worked in validating two commercial assays for dengue and chikungunya.
2. The fellow attended Bionumerics training at Applied Maths HQ, Ghent, Belgium. (optional EUPHEM module).
3. The fellow was trained by the infection control nurse and domestic supervisor to carry out hygiene audits on hospital wards. This included all aspects of infection control, hygiene and safety.
4. The fellow spent one week in the Irish Meningococcal and Meningitis Reference Laboratory (IMMRL) and the Epidemiology and Molecular Biology Unit (EMBU) in Temple Street Children's Hospital. Training focused on the diagnosis and typing of GAS, GBS, *N. meningitides* and *S. pneumoniae.*
5. The fellow spent one week in the virology laboratory in St James hospital, Dublin. Training focused on the diagnosis of sexually transmitted infections.

Discussion

Coordinator's conclusions

This report summarises all activities and projects conducted by Anne Carroll during her two-year EUPHEM fellowship (cohort 2013) at the Public Health Laboratory, Heath Service Executive, Dublin, together with a consortium of Reference Laboratories and the Health Protection Surveillance Centre.

The projects described here show the breadth of public health microbiology. Outbreak and surveillance activities extended from small, local-community and nursing home outbreaks to a nationwide outbreak of Verotoxigenic *E. coli* (VTEC) and evaluation of the national surveillance system for respiratory syncytial virus. Anne successfully set up a molecular surveillance platform for exchange of PFGE data from Ireland to ECDC. Laboratory and epidemiological projects covered bacterial and viral pathogens across a variety of disease programmes, such as emerging vector-borne diseases, food- and waterborne diseases, respiratory tract infections, vaccine-preventable diseases and antimicrobial resistance. Projects involved different professional groups, such as 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 service approach of the EUPHEM programme and followed the core competency domains described for professionals in mid-career and above. Activities were complimented by nine training modules providing theoretical knowledge. Projects had a clear educational outcome, with results communicated in scientific journals and at conferences.

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

Supervisor's conclusions

Anne Carroll was the first EUPHEM fellow to be trained in Ireland at the Public Health Laboratory, Heath Service Executive, Dublin, together with a consortium of Reference Laboratories and the Health Protection Surveillance Centre. She rapidly availed herself of the opportunities afforded by the programme to develop her professional skills to a high level in the broad range of public health microbiology and epidemiology disciplines. She undertook relevant research projects from planning, problem solving and completion to submission of papers to peer-reviewed journals. In addition she developed a robust scientific basis of public health risk assessment and management, while participating in multidisciplinary outbreak control teams. Her significant leadership qualities, tempered with excellent interpersonal skills and an ability to work independently, were evident in completion of many of the fellowship milestones. She is an excellent EUPHEM-trained specialist in applied disease prevention and control. The introduction of the EUPHEM programme to Ireland has been beneficial in emphasising the value of public health microbiology to colleagues in clinical microbiology and multidisciplinary public health practitioners, facilitating collaboration between different institutes involved in public health microbiology research and strengthened our public health microbiology capacity to deal with public health incidents both nationally and internationally when responding to alerts generated by ECDC.

Personal conclusions of fellow

The EUPHEM programme provides a fantastic opportunity to receive professional training and experience in public health microbiology across a broad range of pathogens and spanning the entire field of public health microbiology. The program succeeds in bridging the gap between epidemiology and microbiology, through its close association with the EPIET programme. EUPHEM provides an excellent platform for forming collaborative links and personal networks among the growing number of public health microbiologists across Europe.

Acknowledgements of fellow

I would like to thank my EUPHEM supervisor, Eleanor McNamara, for her encouragement, support and excellent mentorship throughout the programme and my supervisors in the Health Protection Centre Rob Cunney and Paul McKeown. I would like to thank the project supervisors and those who so generously gave their time to help me: Richard Drew, Brieda Boyle, Alida Talento, Brian O'Connell, Brendan Crowley, Anne Walsh, Mary Meehan, Grainne Brennan, Patricia Garvey, Margaret Fitzgerald, Muthu Saba. I would also like to acknowledge the support and encouragement from the staff of the Public Health Laboratory, Dublin. I would like to thank Mari-Paz Sanchez for the valuable opportunity to spend two weeks in her laboratory at ISCIII, Madrid. I would like to thank my front-line coordinator Androulla Efstratiou for her support and feedback. Thank you also to my EUPHEM coordinator Aftab Jasir (ECDC) and also other members of the EUPHEM forum, EPIET coordination team and fellowship programme office for their support and guidance throughout the fellowship. Finally, I would like to thank the EUPHEM, EPIET and EPIET-associated programme fellows of cohort 2013 for their companionship and collaborative spirit.