

A circular photograph of a diverse group of people, including men and women of various ethnicities, with their hands stacked in the center, symbolizing teamwork and collaboration. The photo is set within a series of concentric grey circles.

Summary of work activities

Mathieu Bangert
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 related from a microbiological perspective.

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

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

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Stockholm, September 2015

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This report summarises the work activities undertaken by Mathieu Bangert, cohort 2013 of the European Public Health Microbiology Training Programme (EUPHEM) at the Centro Nacional de Microbiología, Instituto de Salud Carlos III, Majadahonda, Madrid, Spain. Mathieu Bangert is a French-German immunologist with an interest in Tropical Diseases. Before EUPHEM he was researching host-pathogen interactions in the UK, Gambia, Malawi and the USA.

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 demonstrating the competencies acquired during the EUPHEM fellowship by specific projects, activities and theoretical training modules.

Specific projects included epidemiological investigations (outbreaks and surveillance); applied public health research; applied public health microbiology and laboratory 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

Objectives of these core competency domains were achieved partly through project/activity work and partly through participation in the modules. Results are presented in accordance with the EUPHEM core competencies, as set out in the EUPHEM scientific guide¹.

1. Epidemiological investigations

1.1. Outbreak investigations

Project supervisor: José Francisco Barbas del Buey

A. Norovirus outbreak in a retirement home, Madrid, 2014

In the summer of 2014, an outbreak of gastroenteritis in a retirement home in Madrid was notified to the local public health officials by the resident clinician. A team of epidemiologists from the local public health office and the EUPHEM fellow performed a cohort study on the 66 residents and nursing staff (30 cases, 36 non-cases) in the affected section. In addition, food samples from the kitchen were sent to the local public health laboratory. The investigation could not demonstrate an association between any food consumption and developing illness. One kitchen staff reported having gastroenteritis three days before the peak of the outbreak among residents, during which period he had worked. A paella seafood dish was tested PCR positive for norovirus. Minor breaches in food safety procedures were found leading to the recommendation to improve kitchen hygiene and retrain staff on working while infectious. By participating in the questionnaire development, administration and analysis as well as the site inspection and discussions, the fellow was able to obtain an overview of how local public health authorities respond to gastroenteritis outbreaks.

Educational outcome: Participation in the initial response to a suspected outbreak; integration of microbiological and epidemiological knowledge to investigate outbreaks; insights into the epidemiologist and microbiologist's activities regarding a foodborne disease outbreak investigation; understanding of the need for a cooperative teamwork between clinicians, microbiologists and epidemiologists.

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

B. Modules

The EPIET/EUPHEM introductory course familiarised participants with the methods and logistical aspects of outbreak investigations. The module 'Computer tools in outbreak investigations' taught essential data management skills (entering, validating and cleansing data), dataset management and how to perform case-control studies (descriptive and cohort studies, including stratified analyses).

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

1.2. Surveillance

A. Inventory of national surveillance system for food- and waterborne parasitic diseases in the EU

Project supervisors: Johanna Takkinen, Polya Rosin and Aftab Jasir

Food and waterborne parasitic diseases (FWPD) surveillance at EU level is particularly variable, subject to both apparent gross under-ascertainment and non-reporting, in comparison with surveillance of other food and waterborne diseases. This results in limited utility of EU level surveillance in this area, for both EU and Member State's level communicable disease prevention and environmental health policy, and other purposes. The reasons for these limitations are not known consistently across all member States. An expert panel consisting of epidemiologists, veterinarians and laboratory professionals were invited to provide scientific advice, together with the ECDC FWD unit, for the development and optimisation of a questionnaire. The questionnaire comprised two sections: (1) a ranking exercise for the 24 FAO globally important FWPD and (2) perceived opinions on the importance of factors associated with the FWPD burden for the parasites under the EU mandate for surveillance. The perceived importance of the 24-FAO parasites in Europe could be divided into top (n=7, average-high importance), middle (n=5, low-average importance) and bottom (n=12, least-low importance) groups. The parasites in the top group included all those under surveillance by the ECDC and the middle group included *Toxocara spp.*, *Entamoeba histolytica*, *Taenia saginata*, *Ascaris spp* and *Taenia solium*. The ability to cause outbreaks was considered the most important factor for *Trichinella*, *Cryptosporidium* and *Giardia*. The perceived burden due to the presence of risk groups was considered between average and high importance for *Toxoplasma* and between low and average importance for the remaining parasites. The cost of screening with regards *Toxoplasma* and *Trichinella* was perceived of average importance, but markedly more important than the other parasites, which were ranked as low. The cost of screening with regards to *Toxoplasma* and *Trichinella* was perceived of average importance, but markedly more important than the other parasites, which were ranked as low. This study acts as an evidence base for improvement of FWPD surveillance at the EU level. An improved surveillance system would have added public health value in allowing for a better estimate of the true burden of FWPD disease in Europe, and as a consequence allow for the assessment of intervention measures and the need for new existing prevention programmes, to reduce this burden. The study, from questionnaire design to data analysis and manuscript preparation, was conducted jointly by the fellow and SSI EUPHEM fellow Orla Condell.

Educational outcome: Design of the questionnaires data analysis, working in a multidisciplinary team, communicating with experts at ECDC and in Member States, presenting the data at expert meeting and preparation of a scientific article.

B. Virological and epidemiological surveillance of influenza in Spain

Project supervisors: Francisco Pozo, Inmaculada Casas and Amparo Larrauri

This project assessed the methods used for virological and epidemiological surveillance of influenza activity in Spain in the 2014-15 influenza season. The project was performed in liaison with the Spanish Reference Influenza Laboratory (National Centre for Microbiology) and the Influenza Surveillance Unit (National Centre for Epidemiology).

In the Influenza Laboratory, the fellow identified and characterised types, subtypes and strains of circulating influenza viruses, assessed emergence of antiviral resistance, and analysed strains to contribute to the annual determination of the influenza vaccine content. The fellow contributed to the national laboratory influenza surveillance by analysing weekly data for reporting in the National Weekly Surveillance Report and contributed to international laboratory surveillance by uploading virological information to The European Surveillance System (TESSy).

In the Influenza Surveillance Unit, assessment of the intensity and trend of influenza activity is currently estimated using historical data from the Spanish Influenza Sentinel Surveillance System (SISSS) using qualitative indicators from the European Influenza Surveillance Network. These indicators are subjective and prone to their own interpretation. The Moving Epidemic Method (MEM) has been proposed by ECDC for harmonising the reporting of intensity and trend indicators, but the impact of implementing MEM within the SISSS has not been explored. To investigate the potential value of using MEM in the standardisation of influenza reporting indicators among regions

in Spain, the fellow in collaboration with Spanish MS-EUPHEM track fellow Horacio Gill, applied the MEM method to the 2014-15 influenza season at the national and regional level within the SSISS. Specifically, we compared the start, intensity and trend levels of the influenza epidemic using reported indicators, with those obtained from MEM. Five networks reported higher pre-epidemic thresholds in comparison with the MEM. Ten of 17 sentinel networks, and also nationally, reported a peak intensity level that did not differ to the level calculated with the MEM ($p=0.74$). Influenza trends reported from 13 networks were increasing prior to the start of the epidemic wave, in contrast to the stable trend estimated with MEM. Differences between MEM calculated intensity and the SSISS reported levels were non-significant.

This pilot study suggests implementing MEM will not create significant differences in reporting indicators compared with current methods. In order to compare and harmonize reported indicators at national and international level, our recommendation is to encourage the networks of the SSISS to adopt the MEM.

Educational outcome: Understanding of the need to integrate microbiological and epidemiological data in disease surveillance; identification of common goals; pilot a new system proposed by ECDC for harmonizing the reporting of intensity and trend indicators; laboratory-based surveillance; multidisciplinary teamwork.

C. Evaluation of the WHO Plan for the Elimination of Measles in Spain, 2013.

Project supervisor: Juan Emilio Echevarria

All countries in the WHO European Region include a measles vaccine in their vaccination programmes; however, due to persistent gaps in immunisation coverage, outbreaks of measles continue to occur. WHO/Europe places a high priority on eliminating measles and rubella from the Region by 2015 and yearly progress reports by Member States allows them to monitor and quantify the progress made in achieving this goal. The role of the fellow was to assess the performance of national control measures in achieving elimination according to WHO guidelines using data of suspected and confirmed measles cases in Spain in 2013. The *Rate of Laboratory Investigation* indicator, where more than 80% of suspected cases are tested in a laboratory was achieved with 92% (200/217) of suspected cases tested. The *Outbreaks Investigated in Laboratories* indicator, where more than 80% of outbreak isolates are investigated for genotype, was achieved with 82% (10/12) outbreaks genotyped. The *Origin of Infection* indicator, where the origin of infection is identified in more than 80% of cases was nearly achieved, with 74.2% (95/128) origins identified. Room for improvement was noted in the *Rate of Discarded Cases* and *Timeliness of Investigation* indicators. The annual evaluation of the WHO Plan for the Elimination of Measles in the EURO region is an important exercise for combining microbiological and epidemiological data to assess the performance of national measles control and prevention measures. We recommend continued close collaboration between all institutes involved as well as encouraging general practitioners to rapidly notify suspected cases in order to effectively reach the WHO goals for the elimination of Measles in Spain and the EURO zone.

Educational outcome: Understanding of the need to integrate microbiological and epidemiological data in disease surveillance; identification of common goals; evaluating of indicator of a surveillance system; laboratory-based surveillance; multidisciplinary teamwork.

D. Imported chikungunya amongst travellers returning to Spain, 2008-2014

Project supervisor: Maria Paz Sánchez Seco and Leticia Franco

Since the first documented autochthonous transmission of chikungunya virus in the Caribbean island of Saint Martin in 2013, the infection has spread within the Caribbean region as well as North, Central and South America. The risk of autochthonous transmission of chikungunya establishing in Spain may be elevated due to the large numbers of travelers returning to Spain from countries affected by the current epidemic in Latin Caribbean and South America, as well as the existence of the competent vector in certain parts of Spain. Jointly with epidemiologists and clinicians, the fellow retrospectively analysed the laboratory diagnostic database of the National Centre for Microbiology, Institute of Health Carlos III (CNM-ISCIII) from 2008 to 2014. During the study period, 264 confirmed cases out of 1,371 suspected cases were diagnosed at the CNM-ISCIII. 234 confirmed cases were in 2014 alone. The highest number of confirmed cases came from the Dominican Republic (136) followed by Venezuela (30) and Haiti (11). Six cases were viraemic in areas of Spain where the vector is present. This report demonstrates a spillover of the Caribbean chikungunya outbreak to an EU Member State. The findings suggest a need for integrated active case and vector surveillance in Spain and other parts of Europe where the vector has been observed. Guidelines for case management of imported chikungunya should be developed in order to improve response time and mitigate the risk of imported infections leading to autochthonous transmission.

Educational outcome: analysis of laboratory and clinical databases; mapping of vector and disease burden, understanding the importance of laboratory-based surveillance.

E. 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

Validation of a Leishmaniasis rapid detection test (rK39) in Spain

Project supervisor: Israel Cruz, Maria Delmans Flores Chavez

From the early 1980s to 2015, a gradual increase of leishmaniasis cases has been reported in endemic parts of Europe. Visceral leishmaniasis (VL) is the most severe form of leishmaniasis observed in this region. Most established methods for VL diagnosis are culture, PCR, indirect immunofluorescence test (IFAT), ELISA, and Western Blot, and lately an immunocromatography test (ICT). In other endemic regions, such as East Africa and the Indian subcontinent, the direct agglutination test (DAT) and ICTs based on the rK39 antigen (rK39-ICT) are widely used. These two tests have not been evaluated in European countries using a large series of patients, and no guidance is available on what diagnostic tests are most applicable in hypoendemic VL setting as seen in some EU Member States. In this study, the aim was to assess the diagnostic accuracy of rK39-ICT and DAT in comparison to IFAT, PCR and culture on VL patients from Spain. Well-characterised samples were selected considering clinical-epidemiological background and results of conventional tests. This panel consisted of sera from individuals with VL (n=50), malaria (n=55), Chagas disease (CHD, n=51), other parasitic infections (n=57) and from non-infected individuals (n=175). A second panel of non-characterised samples was obtained from individuals with a suspicion of VL (n=119, from April to November 2013). All samples were tested with rK39-ICT (InBios Kalazar Detect Rapid Test, USA), DAT (ITMA-DAT/VL, Belgium) and IFAT. The fellow performed all tests, analysed the data and helped prepare the manuscript. Both rK39-ICT and DAT are adequate for VL diagnosis in the European context. Each test or a combination of them should be chosen according to the epidemiological particularities of each setting. The ease-of-use of rK39-ICT makes it suitable for an initial screening; DAT could be the most suitable out of the three serological test, given its higher sensitivity even in the presence of HIV co-infection.

Educational outcome: Development of a validation study, understand application and limitations of laboratory diagnostics for trypanosoma parasites; analysis of clinical and laboratory data; scientific presentation at a conference; writing of a scientific article.

Phylogenetic analysis of Measles virus B3 strains in Spain

Project supervisor: Aurora Fernandez

In Spain, outbreaks of Measles are thoroughly investigated in line with the WHO aim for elimination of Measles in Europe. An important aspect is the ability to trace the origin of measles infections and outbreaks. Focusing on the measles virus genotype B3, the fellow assembled a set of sequences from Spain in 2013 and aligned them to B3 sequences available in a global database (MeaNS) in order to determine the spread and origin of imported genotypes. Cases in Spain in 2013 could be traced back to the World Cup Sporting Event in South Africa via Brazil and Argentina. This project showcased the use of bioinformatics in investigating imported cases as well as the challenges in eliminating Measles in the European region while other regions are still strongly affected.

Educational outcome: Use of microbiological results to construct phylogenetic trees to support the epidemiological tracing of infection sources; comprehensive knowledge of phylogenetics: construct and interpret phylogenetic trees

Whole Genome Analysis of *Salmonella* Kentucky strains

Project supervisors: Isabel Cuesta and Jorge Barrera

Antibiotic-resistant *Salmonella* Kentucky has spread throughout Africa and the Middle East in the space of only a few years. In Spain, more than 100 isolates of *Salmonella* Kentucky from animals, food and humans (domestic and Africa-linked cases) were isolated and studied by traditional methods. A subset of well characterised isolates including epidemiological and non-epidemiological linked cases and different sources have recently been sequenced at the Instituto de Salud Carlos III using whole genome sequencing (WGS) technology. With guidance from the bioinformatics unit, the fellow assisted in developing an analysis pipeline that assembled whole genome

sequencing data and determined differences in single nucleotide polymorphisms (SNP) of each strain analysed. Importantly, this data was combined with MLST and PFGE methods in order to assess whether the level of discrimination resulting from WGS-SNP analysis is comparable to traditional methods. Ongoing results suggest that WGS-SNP analysis in this subset of samples is equally or more discriminatory to traditional methods. While WGS remains an expensive tool with complex analysis, the ability to process whole genomic data sensibly and in a standardised manner is an important part for future genomic surveillance, as WGS can determine several *Salmonella* microbiology characteristics (virulence factors, resistance genes, MLST profile, serotype) at once, and WGS is becoming more cost-effective. We recommend further development and sharing of whole genome analysis pipelines with other national public health institutes in order to refine and standardise analysis pipelines at EU level. Furthermore, we recommend sharing of WGS data, in order to enhance the quality of genomic comparisons of *Salmonella* strains found in EU Member States and abroad.

Educational outcome: Conduct and interpret automatic sequence alignments, use and troubleshoot phylogenetic software.

C. Modules

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

Educational outcome: Development of a validation study, preparation of study protocols; bioinformatics tools for investigation of outbreaks; interpretation of typing results; data analysis; writing of scientific articles; scientific presentation at a conference.

3. Applied public health microbiology and laboratory investigations

Supervisors: Maria Cuevas, Fernando de Ory

Virological and epidemiological characterisation of HIV strains Spain

Project supervisors: Maria Teresa Cuevas and Lucía Perez

In addition to primary and follow-up diagnostics, the National HIV reference laboratory uses genomic technologies to assess resistance and clustering of HIV strains in order to inform clinicians on treatment efficacy and regional public health authorities on epidemic hotspots. To better understand how National Microbiological Centres undertake routine testing, this activity followed the process of culturing blood samples, extracting and sequencing viral genomes and querying results against an antiretroviral resistance database in addition to phylogenetical mapping. This activity highlighted how diagnostic and resistance testing services can also support surveillance systems through the use of genomic techniques. Specifically, where genomic sequences of isolated strains have a high degree of similarity, a cluster of infection is identified and notified to the hospital, allowing the clinician to address and prevent further transmissions from within the cluster. We recommend increasing sharing of genomic data from regional centres and at EU level to enhance the ability to detect and respond to clusters in order to break the cycle of transmission.

Educational outcome: Detect antiviral resistance by sequencing, determine the source of infection by genotyping population samples;

Characterization of confirmed cases of Congenital Rubella Infection

Project supervisor: Fernando de Ory

This project introduced the fellow to the wide range of techniques and applications of serology against vaccine preventable diseases in a public health institute. In Spain the MMR vaccine schedule requires of one dose at the age of 15 months and another at the age of 3–6 years. Reported disease incidence is less than one case per 100 000 people for measles and rubella, and 23 cases per 100 000 people for mumps. It is especially important to ensure immunity against Rubella in pregnant women to prevent Congenital Rubella Infections. The case definition for congenital rubella requires isolation of rubella virus, or detection of rubella-specific immunoglobulin M (IgM) antibody, or infant rubella antibody level that persists at a higher level and for a longer period of time than expected from passive transfer of maternal antibody, or a specimen that is PCR-positive for rubella virus. In order to fully characterise congenital rubella virus infection at the National Centre for Microbiology, rubella PCR positive serum samples without IgM testing from pregnant women from Spain, 2011–2014, were retrieved and retrospectively tested for IgM reactivity by the fellow. Out of 20 samples retrieved, 19 rubella PCR positive samples were negative for IgM reactivity, while one sample returned low avidity results. Upon further investigation, we

found that the sample was also positive for Rubella and Measles IgM, suggesting the IgM result was due to recent MMR vaccination. As PCR positive samples were also tested negative for IgM, this study underscores the importance of PCR testing in serum samples taken early after onset of symptoms, and the need for multiple serum samples for IgM testing. Other techniques learnt during the project include ELISA, agglutination, complement-fixation, and the use of fluorescent antibodies.

Educational outcome: Understanding laboratory-based surveillance and investigation using serological technique.

4. Biorisk management

A. Biorisk management module, ECDC, Sweden

This five-day module provided techniques for biorisk/biosafety assessment and mitigation, including WHO recommendations on biosafety management in laboratories. One day focused on international regulations for the transportation of dangerous goods, as determined by ICAO (International Civil Aviation Organization). This module allowed the fellow to work safely with a BSL4 pathogen and in implementing biosafety processes in laboratory setting at the host site.

Educational outcome: Understand processes associated with BSL3/BSL4 laboratories; experience different personal protective equipment; understand the principles and practices of biorisk management; biorisk assessment, biorisk mitigation.

5. Quality management

External Quality Assessment (EQA) study for diarrheagenic *Escherichia coli*

Project supervisor: Sergio Sánchez

In order to monitor and respond to diarrheagenic *E.coli* infections at EU level, it is fundamental that EU Member States demonstrate a standardised capacity and ability for microbiological diagnosis. ECDC has commissioned the Statens Serum Institute (SSI) to perform an External Quality Assessment (EQA) for diarrheagenic *E.coli* diagnosis on behalf of the ECDC food and water borne disease network. Blinded samples were identified and characterised using PFGE, PCR and other Microbiological techniques by the fellow. All samples were correctly identified confirming effective use of current methods by the ISCIII. Annual external quality assessment is important to assess the competency of standard diagnostic techniques and therefore comparability of results across laboratories from EU/EEA countries.

Educational outcome: Understanding of specialised methodologies relating to diarrheagenic *E. coli* diagnosis; efficacy of quality assurance systems; principles and practices of quality assurance according to international and EU directives; concepts of EQA.

Internal Quality Audit of a National Mycobacteria Reference Laboratory

Project supervisor: Maria Soledad Jiménez

The annual quality control of laboratory standardised operating procedures in Spain is conducted internally by the institute's quality department prior to National accreditation. The evaluation of the mycobacteria laboratory aim to establish use of Documentation, Registries, Preventative actions, Method validation, Assay quality insurance, Purchases, Installation and storage of equipment, Equipment calibration and Reagents storage and usage, Reference samples and Traceability were according to Institutes regulation. The fellow discussed the pre-audit checklist and performed spot-checks with the head of laboratory, participated as observer during the audit and discussed and helped implement the recommended improvements. This activity highlighted the challenges and importance of quality management and traceability in laboratories in order to ascertain good laboratory practice and detect systematic errors.

Educational outcome: Understanding and applying the principles and practices of biorisk management, quality assurance and quality control.

6. Teaching and pedagogy

Supervisor: Silvia Herrera-Leon

Coordination of a Masters course at the Universidad de Alcalá de Henares

With the help of the principle coordinator Silvia Herrera-Leon, the content for Module 2 (Waterborne Disease) was developed for this new Masters course. Potential lecturers were contacted to discuss course content, learning objectives, style of teaching (theoretical, case studies, oral presentations), assistance in management of the virtual learning environment (BlackBoard), as well as all logistical issues (room bookings, time allocation, etc.). A case study from the EPIET/EUPHEM introductory course on a norovirus outbreak in Denmark was implemented to give students a better understanding of public health microbiology in practise. This project was beneficial in appreciating the whole process of organising teaching modules, including the development of teaching material. Feedback from students should be taken into consideration to improve the module for the next academic year.

Lectures given:

- Rapid Assessment Module, ECDC Module, Athens National School of Public Health
- Bioinformatics for beginners: 20 hour practical class for the Masters of Public Health Microbiology. ISCIII in collaboration with University of Alcalá

Educational outcome: Identify training needs, organising training, case study moderation and pedagogical teaching.

7. Public health microbiology management

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

This one-week module focused on understanding roles and responsibilities in public health management. Topics included the identification of different management styles, team roles and team evolution, the delegation of tasks and the provision of structured feedback.

Educational outcome: Understanding the role and responsibilities of a people manager within a public health environment; understanding different management styles; understanding team roles and team evolution to ensure team success; motivation of teams; conflict management: structured feedback to improve performance and minimise disruption in a conflict; communicating with authorities, the public and the media.

B. Public health microbiology management components as part of regular projects

Public health microbiology management was an integral component of all projects and activities during the fellowship. This included laboratory management, ethical and integrity considerations, team building and coordination, research collaboration, time management, management of cultural differences in international contexts and working in a multidisciplinary team with microbiologists, physicians, laboratory technicians, epidemiologists, statisticians, government officials, public health officers and logisticians.

Educational outcome: Working in a multidisciplinary public health team; understanding team management; planning, scheduling and organising research projects.

8. Communication

A. Publications

1. Bangert M, Gill H, Delgado C, de Mateo S, Larrauri A. Pilot study to harmonize the reported influenza intensity levels and trends within the Spanish Influenza Sentinel Surveillance System using the Moving Epidemic Method. 2015 (in preparation)
2. Bangert M, Condell, Jasir A, Rosin P, Takkinen J. Perceived priorities and burden of food- and waterborne parasitic diseases in the EU. 2015 (in preparation)
3. Fernandez D, Bangert M, de Ory F, Potente A, Hernandez L, Lasala F, et al. Imported chikungunya infections amongst travellers returning to Spain. 2015. (Submitted to Eurosurveillance)
4. Delmans-Chavez M, Bangert M, Llanes-Acevedo P, Arcones C, Cruz I. Evaluation of serological tests for the detection VL infection in an endemic European country. 2015 (in preparation)
5. Condell O, Bangert M, Jasir A, Rosin P, Takkinen J. Surveillance of foodborne parasites in the European Union: current practices and perceived barriers. 2015 (in preparation)
6. Painter J, Coronado F, Dahl B, Bangert M, Martin M, Rodier G, et al. Strengthening Ebola virus disease contact reporting and outbreak response monitoring – Conakry, Guinea, 2014 (in preparation)
7. Jusot JF, Neill DR, Bangert M, Bricio-Moreno L, Lawan K, Moussa M, et al. Inhaled dust and extreme temperatures are risk factors for bacterial pneumonia and meningitis. (Submitted to LID)

B. Reports

1. Bangert M, Prieto S, Herrera-Leon S. External Quality Assessment of *E. coli*. CNM ISCIII. 2015
2. Bangert M, Barbos del Buey J. Informe de un brote de gastroenteritis. July 2014
3. Bangert M. Ebola outbreak response: Guinea-Conakry, August-September 2014.

C. Teaching materials

1. Bangert M, Llanes-Acevedo P, Cruz S, Cruz I. Importancia de la caracterización molecular en un sistema de vigilancia de la Leishmaniasis. Book chapter (with editor)
2. Bangert M. Dangerous pathogens: Ebola virus disease contact management in the field. ISCIII internal training.

D. Conference presentations

1. Bangert M. Evaluation of serological tests for the detection VL infection in an endemic European country (Spain), ESCAIDE 2014, Stockholm, Sweden

E. Selection of other presentations

1. Experiences of Ebola outbreak in Guinea (in Spanish), Caixa Forum.
2. Pneumococcal research in Liverpool: immune responses to carriage and treatments against invasive pneumonia.
3. Measles in Spain: WHO Annual Report, 2013. ISCIII, Madrid, Centro Nacional de Microbiología

9. International missions

Ebola outbreak, Guinea, September 2014

Project supervisor: Guénaél Rodier, William Perea

An epidemic of Ebola viral haemorrhagic fever was declared in Guinea on 24th March 2014. In response, the fellow was deployed through WHO/GOARN to Guinea Conakry in September 2014 for a period of six weeks. As part of the response, the fellow's tasks included coordination of field teams, data quality management, strategic planning as well as teaching. Coordination activities involved responding to unusual notifications of cases by facilitating the deployment of teams and following up on any needs signalled by staff on site. The fellow helped develop strategic plans to strengthen surveillance in Conakry and to Guinea's national response in the face of rising cases, such as prioritising regions on where new teams should be deployed or where new treatment centres should be built. Data issues, such as missing symptom onset, contact names or final status of patient were addressed by establishing a more direct data and communication link from treatment centres to the WHO data management team in order to ensure data collected at treatment sites reached the database and any queries could be quickly and directly resolved. A major gap identified was the lack of oversight on the status of contact tracing activities. To address this, the fellow, with input from staff involved in contact tracing, devised a simple contact tracing database system to allow management of contacts at local level and analysis of contact tracing at national level. The database was piloted in the Conakry region, implemented at national level and an evolved version is still in use as of September 2015. In collaboration with the CDC, the fellow also prepared practical and theoretical teaching material for maintenance and analysis of databases as well as for contact tracing activities, specifically creating chains of transmission, communicating with the community, and the importance of contact tracing in the Ebola response.

Educational outcome: Working in high-risk, high-pressure setting; Coordination of surveillance and active case-finding activities; analysis of surveillance databases; training, writing of surveillance reports and study report; development of training programme; collaboration with emergency response team.

10. EPIET/EUPHEM modules attended

- EPIET/EUPHEM introductory course, Spetses, Greece (three weeks)
- Computer tools in outbreak investigations, Robert Koch Institute, Berlin, Germany (one week)
- Rapid risk assessment module, Athens, Greece (one week)
- Biorisk and quality management module, ECDC, Stockholm, Sweden (one week)
- ECDC-ECCMID exposé, ECDC, Stockholm, Sweden (one week)
- Initial management in public health microbiology, ECDC, Stockholm, Sweden (one week)
- Vaccinology, Public Health England, London, United Kingdom (one week)
- Project review module, ECDC, Stockholm, Sweden (one week)
- Project review module, National Public Health Institute, Lisbon, Portugal (one week)

11. Other courses

Masters of Virology module: Enfermedades humanas producidas por virus, University Complutense de Madrid, Spain.

Discussion

Coordinator's conclusions

Dr Mathieu Banger started his fellowship as one of the youngest fellow of EUPHEM since start of the programme in 2008. Despite his young age he showed a very mature attitude and was an effective team player within the training site and the EUPHEM network. Epidemiological investigations ranged from small community outbreaks (Norovirus outbreak in a retirement home, Madrid,) to international response to Ebola in Guinea. Mathieu contributed to a number of surveillance projects at national, EU and international level which had a clear public health outcome; the Virological and epidemiological surveillance of influenza in Spain by implementing The Moving Epidemic Method (MEM) which has been proposed by ECDC for harmonising the reporting of intensity and trend indicators; analysing data on imported chikungunya amongst travellers returning to Spain; inventory of national surveillance system for food- and waterborne parasitic diseases in the EU; and evaluation of the WHO Plan for the Elimination of Measles in Spain. The joint collaborative study with ECDC was undertaken to determine the barriers encountered by Member States for case ascertainment and reporting of these diseases in conjunction with the laboratory practices and capabilities amongst Member States.

He also gained experience in response to international crises during his international assignment working with Ebola in West Africa, where a key learning activity was his participation and contribution within a multidisciplinary outbreak team, working with Ministry of Health and communicating with different authorities and international organisations. Additionally, Mathieu's portfolio comprised both laboratory and epidemiological projects that covered bacterial, viral and parasitic pathogens across a variety of disease programmes, such as vector-borne diseases, sexually-transmitted diseases, food and waterborne diseases, respiratory tract infections, vaccine-preventable disease and antimicrobial resistance. Projects involved different professional groups, such as physicians, laboratory technicians, epidemiologists, statisticians, government officials, public health officers and logisticians, strengthening the fellow's ability to work in a multidisciplinary team. Projects had a clear public health outcome, with results communicated to public health authorities, in scientific journals and at conferences. The fellowship programme has provided the fellow a unique and excellent experience as demonstrated by the outputs from the various projects.

The EUPHEM coordinator team concludes that the fellow has succeeded in performing all his tasks to a very high standard and with a professional attitude. The contributions made by this EUPHEM fellow in Guinea as with all the others have highlighted the need to further develop a future critical mass of highly skilled field public health microbiologists within Member States, to contribute capacity to national preparedness as well as being available for international response in the interest of the EU.

Supervisor's conclusions

Dr Mathieu Bangert was the second EU-EUPHEM fellow based at the National Centre for Microbiology (Institute of Health Carlos III). This two years training programme has turned out to be very successful for both the fellow and the training site. For the host institution it gives the opportunity to build new bridges and strengthen collaboration between the different stakeholders in the field of Public Health i.e. various disciplines of microbiology, epidemiology and clinical medicine. As Mathieu was already an experimented microbiologist, we also learnt from other experiences alongside the discussions during all the projects and activities. During the two-year fellowship, Mathieu developed both personally and professionally and gained new skills through his involvement in a large variety of public health activities in microbiology and epidemiology. Those activities were organised trying to obtain a good outcome for both, the fellow and the training site. The projects allow him to gain confidence in the fields of public health microbiology that were not in his background and at the same time allow project supervisors to carry out projects that would otherwise have been hard to achieve. He accomplished all assigned tasks in a highly competent manner, with a high degree of independence and accuracy, occasionally seeking advice and assistance from supervisors and co-workers. Mathieu is also a good team player and highly appreciated by his colleagues and superiors as has been highlighted during his collaborations with the EPIET and MS-EUPHEM fellow based at the same Institute. I have no doubt that Mathieu will continue to do excellent work in the public health arena and wish him every success for the future.

Personal conclusions of fellow

Within a two-year period, the EUPHEM programme presents the unique opportunity to learn and contribute to all aspects of regional, national and European public health microbiology, thereby developing a broad range of competencies and skills. The learning by doing approach has the benefit of getting first hand experiences in the advantages and disadvantages of microbiological methods and practises. By engaging both epidemiologists and microbiologists in joint projects, the fellowship is able to bridge the gap between these disciplines and maximise the potential of any public health investigation or intervention. The opportunity to work with international

organisations such as the ECDC or the WHO gives important experience in how disease prevention and control measures are developed at the international level. The numerous courses held in Public Health institutes across Europe not only develops important theoretical and practical skills in public health management and leadership, but also fosters communication with public health professionals across Europe. This has been a valuable learning experience with many competencies and skills gained that will be of benefit in a future role as a public health microbiologist.

Acknowledgements of fellow

My fellowship experience at the ISCIII-CNM could not have been possible without the resolute and invaluable support from my primary supervisor Silvia Herrera-Leon. Combined with instrumental mentoring from my co-ordinators Aftab Jasir and Androulla Efstratiou, my supervision ensured that the EUPHEM fellowship built upon my previous experience so that I could develop a public health microbiologist mind-set. Equally important were the warm and engaging project supervisors at the ISCIII-CNM who welcomed me into their groups and ensured that I would receive high quality training through participation in interesting projects. Finally, I need to thank my fellow EUPHEM and EPIET fellows who supported me on a professional and personal level throughout the fellowship.