

The section header "Summary of work activities" in a bold, white, sans-serif font, set against a blue background.The author's name "Amrish Y. Baidjoe" in a white, sans-serif font, positioned below the section header.The programme title "European Public Health Microbiology Training Programme (EUPHEM), cohort 2015" in a white, sans-serif font, positioned below the author's name.The section header "Background" in a bold, blue, sans-serif font.

According to the European Centre for Disease Prevention and Control (ECDC) Advisory Group on Public Health Microbiology ('national microbiology focal points'), public health microbiology is a cross-cutting area that spans the fields of human, animal, food, water, and environmental microbiology, with a focus on human population health and disease. Its primary function is to 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.

This report summarises the work activities undertaken by Amrish Y. Baidjoe, cohort 2015 of the European Public Health Microbiology Training Programme (EUPHEM) at the Institut Pasteur, Paris, France.

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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

The fellow has a theoretical, as well as applied academic background: In 2007, he obtained a customized BSc. diploma from Wageningen University and Research Centre (the Netherlands) with a focus on molecular and immunological mechanisms of infectious disease. Thereafter he followed a research Master of Sciences in the biology of infectious disease which he completed in 2009. The fellow worked in Tanzania and Kenya for several years on applied and operational field studies in malaria research at different institutes such as the Radboud University (Nijmegen the Netherlands) and the London School of Hygiene and Tropical Medicine, where he conducted his PhD. research objectives on targeted malaria interventions in areas of declining transmission. His natural affiliation lays in combining different research disciplines as epidemiology and microbiology with a scope in designing tailor-made public health solutions for each specific context.

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; 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 guide¹.

1. Epidemiological investigations

1.1. Outbreak investigations

A. **An outbreak of *Salmonella* Dublin in France 2015-2016 linked to raw-milk cheeses, a combined next generation molecular and epidemiological perspective.**

Supervisors: Simon le Hello and Nathalie Jourdan-da Silva

The National Reference Centre for Salmonella (NRC Salmonella) in France reported an excess of *Salmonella enterica* serotype Dublin (*S. Dublin*) infections in January 2016. A joint outbreak investigation was launched together with the French National Health institute (Sante Publique France) and other actors. The outbreak investigation was driven by both the EUPHEM fellow at Institut Pasteur as well as an EPIET fellow at Sante Publique France. The NRC reported 83 cases between 17 November 2015 and 11 March 2016, 10 deaths were recorded. Multiple-Locus Variable number tandem repeat Analysis (MLVA on 192 isolates) and Whole Genome Sequencing (WGS on 233 isolates) were performed to identify similarities between clinical cases and potential animal and food sources. We compared clustered cases with other cases (case-case study) and with controls recruited from a web-based cohort (case-control study). Findings from both studies indicated that successive *S. Dublin* outbreaks due to different sources had arisen between November 2015 and February 2016, pointing to Morbier cheese and Vacherin Mont d'Or cheese. Based on these results, the Ministry of Agriculture launched a reinforced control plan for processing plants of raw-milk cheeses in the region of production, to prevent future outbreaks. The fellow liaised between different actors and demonstrated and designed new methods of data visualisation to inform all involved actors of the complexity of such outbreaks. A manuscript was submitted to Eurosurveillance and the data was presented at ESCAIDE 2016 and a national focal point meeting with US-CDC [publications, 1].

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>

B. Assist with validation of diagnostic assay during the global ZIKA PHEIC in French Guyana

Supervisors: Dominique Rousset and Maria vanKerkhove

In February 2016, the Zika epidemic became categorized as a Public Health Emergency of International Concern (PHEIC) by the Director General of the WHO. At the time, the Zika epidemic was considered as an outbreak with many unknown factors regarding disease specific pathogenesis and transmission potential hence relying strongly on a research focussed agenda while in parallel implementing intervention strategies. Key in this was the detection of current and past infections. A major problem both for clinical and epidemiological monitoring of Zika Virus (ZIKV) disease is the lack of properly standardized diagnostic tools. Due to a relative short acute phase, short detectability and often moderate or low viremia, as well as often subclinical or asymptomatic presentation in adults, the majority of Zika infections could be 'asymptomatic' while still contributing onwards transmission. The fellow was asked to select a well characterised panel of clinical isolates to be used for future testing and validation of current and future molecular diagnostics candidates. The fellow selected a panel of 204 well characterized clinical samples out of a biobank containing 10.000 confirmed Zika cases with different characteristics, from an area which is endemic for arboviruses. The panel was essential in the onward testing of clinical differential diagnostics between infections of arbo-viruses. The fellow's role in this part of the outbreak of Zika in French Guiana was to assist on the laboratory and clinical side and provide a selection of samples to facilitate the validation of diagnostics which in turn would help surveillance and outbreak control efforts [.

C. Analyses of the Zika outbreak in Suriname during the PHEIC

Supervisors: Claude Flamand and Mirdad Kazanji

During the WHO announced Public Health Emergency of International Concern (PHEIC) the fellow was stationed in French Guiana (EU territory). During this time, a request was made by the Surinamese ministry of health to assist with the epidemiological analyses of confirmed Zika cases in Suriname. The fellow assisted with the typical spatio-temporal epidemiological analyses of molecular confirmed cases. First cases were reported on October 2nd, 2015 making Suriname one of the first countries in South-America to report Zika virus infections after Brazil and Colombia. The outbreak gradually spread to western coastal areas and remained active for an extended period in the western districts, the majority of cases were reported in the most densely populated urban areas. A peak of suspected and confirmed case was reported in week 4 of 2016. After week 17 in 2016 a steep decline of cases was observed. The Zika outbreak in Surinam followed almost directly after an outbreak of Chikungunya hinting to the complex interplay of Flaviviridae which share similar vectors. The fellow participated in several cross-country meetings and was involved in an urgent response analyses demonstrating how the outbreak spread and what type of interventions were required in different localities [publications, 2].

D. Training modules

1. Introductory Course, Spetses, Greece, 28th September-16th October 2015 – This three-week EPIET and EUPHEM introduction airy course; consisting of lectures, interactive case studies and writing a research protocol on a subject spanning both public health epidemiology and microbiology.
2. Bioinformatics and Phylogeny module, Stockholm, Sweden, 16th – 18th November 2015 – During this course the basics of phylogeny and bioinformatics were explained, the fellows were familiarized with a large variety of software suites and next generation sequencing analyses.
3. Outbreak Investigation module, Berlin, Germany, 7th-11th December 2015 – During this module skills were obtained in the 10-steps of an outbreak investigation. Fellows were trained in the basics of STATA and epidemiological analyses on the bases of complex case-studies based on real scenarios and GIS tools.
4. Initial Management in Public Health Microbiology, Stockholm, Sweden, 8th-12th February 2016 – This module focussed on personality traits relevant to professional development and management tasks. Included were exercises on time management, communication in the field, and with different authorities.
5. Multivariable Analyses module, Vienna, Austria, 14th-18th March 2016- A course focussing on applied statistics for epidemiological analyses introducing multivariable analyses, stratified analyses, interaction of variables, building both logistic and binominal regression models in STATA
6. Rapid Assessment module, Athens, Greece, 20-26th June 2016: A highly interactive course focussing on field surveys and investigations. Subjects that were covered were sampling strategies, multidisciplinary research efforts in emergency situations, the use of mobile tools for data collections and the utilisation of GIS tools.

Educational outcome:

The fellow gained first hand experience in outbreak investigations and complex multi-stakeholder emergency situations. From the start of an outbreak to the complex implementation of control measures. He was involved in all steps of an outbreak investigation including all epidemiological and microbiological analyses. As one of the principal investigators the fellow co-coordinated a multi-disciplinary team and was responsible for communication among different stakeholders

1.2. Surveillance

A. A. Evaluation of the circulation of influenza A virus minority genetic variants for analysis of spatio-temporal spread and as predictors of virus evolution

Supervisors: Sylvie van der Werf and Vincent Enouf

Predicting which influenza strains will predominate six months ahead of the upcoming season remains a considerable challenge for matching vaccine composition. Although rare, vaccine mismatch for A(H3N2) virus occurred in the 2014-2015 season resulting in low vaccine effectiveness. Current understanding of the quasi-species structure and predictive value in virus evolution is limited. Ultra-deep sequencing (NGS) allows the finest resolution insights into the composition of genetically distinct quasi-species. The objective of this study was to assess whether viral quasi-species offer predictive value regarding emergence of antigenically distinct influenza viruses within and between subsequent seasons. Clinical specimens from the primary care surveillance systems (Seasons: 2013-2014 & 2014-2015), confirmed as positive for influenza A (H3N2) by the National Influenza Center, were selected based on their occurrence during the pre-defined early-peak-end periods of the respective epidemic periods. NGS (Illumina) was performed targeting the HA gene. Sequences were assembled and different algorithms were used to call minority variants at a threshold value between 0.5 and 0.05%. Variants occurring in all three algorithms were selected for intra and inter-seasonal trend analyses based on SNP divergence and translational changes. Minority variants were retrieved from 163/219 samples (mean coverage: 978, range: 1-2276). A total of 441 unique SNPs, translating into 213 translational changes were identified in all quasi-species variant algorithms. Differential trends were observed among the different quasi-species both intra and inter-seasonal indicating possibly predictive temporal trends. Results are preliminary. Initial results indicate that in depth NGS-analyses provides data about quasi-species variants that potentially allow to more accurately predict trends of viral evolution. Development of NGS bioinformatics-pipelines integrated into surveillance systems can be used to augment more accurately informed definitions of the vaccine composition earlier in time as well as enhancing surveillance efforts. We recommend to further investigate the potential of quasi-species data. The fellow was the main supporting lead in all aspects of this specific project as well as recruitment of collaborators. The main output will be a manuscript on the longer term and implementing this pipeline in routine surveillance of the NRC of influenza in the northern region of France [publications, 3].

B. The role whole Genome Sequencing in the detection of outbreak involving rare serotypes of Salmonella in France

Supervisor: Simon Le Hello

The main aim of this project was to assess different molecular typing schemes on which Salmonella surveillance in France. Current gold standard laboratory techniques like serotyping, Pulse Field Gel Electrophoresis (PFGE), Multi Locus Sequence Typing (MLST), making use of clustered regular interspaced short palindromic repeats (CRISPOL) and Multi Locus Variant Analyses (MLVA) are used to confirm cases in the context of outbreak situations and routine surveillance. These techniques were particularly developed for the detection of the most common and prevalent serotypes and are up to date still routinely used. Although these techniques are suitable to detect epidemic cases in the context of routine surveillance they might lack sufficient resolution when it comes to linking cases to sources in outbreak investigation involving rare serotypes. In the scope of the proposed project, hosted and supervised by the National Reference Centre (NRC) of Salmonella at Institut Pasteur we aimed to evaluate the possible contribution of WGS approaches in the investigation and detection of rare and emerging serotypes of this pathogen by identifying new loci and possibly creating new specific tools (cgMLST or SNP approaches) which can assist in rapid outbreak detection and more common surveillance activities revolving around the emergence of rare serotypes. Three outbreaks were analysed. A *Salmonella* Dublin outbreak from France in 2015-2016, *Salmonella* Kedougou and *Salmonella* Havana both occurring in France in 2014. Based on the detailed analyses of these three outbreaks it was concluded that WGS certainly adds to the detailed context of outbreaks and source identification where in some cases very specific farms were indicated as an outbreak starting point. From a more practical point of view, it was determined that the average turnover time for WGS was around three days after sample arrival. We recommended the use of WGS in outbreak investigation in France, which was adopted since 2016. The fellow was involved in the differential retrospective analyses of different outbreaks as well as providing several presentations to different key stakeholders. New skills were obtained in the area of integrated visualisation of both epidemiological and molecular findings. The findings of this project were discussed and presented at multiple expert meetings and fortified the current practice of routine WGS for surveillance and outbreak situations. In addition, we showcased tools like the Interactive Tree of Life (iTOL) and Microreact which allow us to better visually present complex molecular data to non-microbiologists, like epidemiologists and other public health stakeholders.

C. Enhanced surveillance of enteroviruses in Roma children and waste water reservoirs in Romania

Supervisors: Francis Delpeyroux and Maël Bessaud

This project focussed on enhancing enterovirus surveillance in Romania in collaboration with the Cantacuzene institute in Bucarest, Romania and the WHO-CC Enterovirus Laboratory at Institut Pasteur, Paris where the fellow was attached to. Enteroviruses are the most common group of viruses known to infect humans. Due to a heightened risk of poliomyelitis outbreak in 2015, enterovirus surveillance was enhanced in the region and bordering areas of Romania. However, surveillance was limited to culturing. Molecular typing is not routinely performed. A range of environmental (sewage water, N=66) and clinical samples (healthy cohort of Roma children, sentinel population, N=68) were screened for a broad panel of enteric viruses using Next Generation Sequencing. Molecular findings after a broad BLAST in both clinical as well environmental samples were compared taking in account temporal and spatial frames. Correlations were found between enteric viruses in sewage samples and enteric viruses in children based on the viral VP1 region sequences. This underlines the importance of ongoing surveillance activities as well as the development of universal bioinformatic-pipelines which allow for better and more consistent data comparison across difference EU and global sites. The fellow participated in the analyses of the samples and led the coordination of the design of the bioinformatics pipelines and the epidemiological analyses. Detailed analyses are still pending and results are expected by the end of 2017. The fellow, wrote a manual on analyses, and a scientific manuscript is pending [publications, 4].

D. Training modules

1. Introductory Course, Spetses, Greece, 28th September-16th October 2015 – This three-week EPIET and EUPHEM introductory airy course; consisting of lectures, interactive case studies and writing a research protocol on a subject spanning both public health epidemiology and microbiology.
2. Multivariable Analyses module, Vienna, Austria, 14th -18th March 2016- A course focussing on applied statistics for epidemiological analyses introducing multivariable analyses, stratified analyses, interaction of variables, building both logistic and binominal regression models in STATA
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4. Rapid Assessment module, Athens, Greece, 20-26th June 2016: A highly interactive course focussing on field surveys and investigations. Subjects that were covered were sampling strategies, multidisciplinary research efforts in emergency situations, the use of mobile tools for data collections and the utilisation of GIS tools.
5. Initial Management in Public Health Microbiology, Stockholm, Sweden, 8th-12th February 2016 – This module focussed on personality traits relevant to professional development and management tasks. Included were exercises on time management, communication in the field, and with different authorities.

Educational outcome:

The fellow gained substantial experience in entry of complex data, and designing bioinformatics pipelines for routine surveillance. In addition the fellow developed skills in integrating both epidemiological and microbiological data from different stakeholders and actors and managing international projects.

2. Applied public health microbiology research

A. ESBL emergence in countries with frequent travellers to the EU and risk of spread

Supervisor: Maya Nadimpali

The fellow participated in a research study which looked at associations between multidrug resistant bacteria found in Cambodia and travellers returning to France. International travel, especially from low-income countries (LIC), has been described as an important mechanism for the spread and acquisition of multi-drug resistant bacteria among Europeans. European travellers to southeast Asia are 33% more likely to be colonized with ABR Enterobacteriaceae upon their return than travellers to other countries. Colonization has also been shown to persist over several months. With an estimated 30 million Europeans traveling annually to LIC (4.2 million from France to Asia in 2014). Colonization is a risk factor for subsequent infection, particularly in the clinical setting, and increases risks for human-to-human and human-to-environment transmission. During this project, the fellow compared genetic and phenotypic profiles of β -lactam-resistant Enterobacteriaceae detected among meat and fish sold in markets in Phnom Penh, Cambodia to strains observed among cases in France and Europe with recent travel history to Cambodia. We found high rates of ESBL carriage in Cambodia in both clinical as well as food samples (>75% compared to 12% in France). There were similarities found in profiles of *E.coli* ESBLs in travellers and local strains. Contamination levels in foods (mostly pork and fish) were extremely high. We recommend increasing food safety standards and maintain proper food preparation practices where meat is sufficiently heated. Similarly, for travellers we enforce recommendations to only consume properly heated food. More detailed results will be provided by the end of 2017. The fellow participated in the phylogenetic analyses and advised on some analytical

aspects of the study as well writing of the research proposal part relating to travellers from the EU. This study will result in a manuscript. [publications, 5]

Training modules

1. Introductory Course, Spetses, Greece, 28th September-16th October 2015 – This three-week EPIET and EUPHEM introduction airy course; consisting of lectures, interactive case studies and writing a research protocol on a subject spanning both public health epidemiology and microbiology.
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4. Multivariable Analyses module, Vienna, Austria, 14th-18th March 2016- A course focussing on applied statistics for epidemiological analyses introducing multivariable analyses, stratified analyses, interaction of variables, building both logistic and binominal regression models in STATA

Educational outcome:

The fellow played a coordinating function between different research institutes to set up an international research project. He gained substantial experience in time-management and project writing, interpreting and intergrating results. The fellow additionally gained insights in WGS technologies and analyses of such complex data.

3. Applied public health microbiology and laboratory investigations

A. Influenza A quasi-species analyses, design of laboratory methods

Supervisors: Sylvie van der Werf and Vincent Enouf

For the detection of quasi-species new technological platforms like the next generation sequencing platforms from Illumina can be used. For accurate detection of quasi-species of influenza in clinical samples it is essential that primary samples from nasopharyngeal swabs are used. If viral RNA loads are too low, one option could be to increase these in-vitro by passing the samples over culture. However, this would yield viral quasi-species which are not representative of the original viral quasi-species population in the host. The fellow tried to determine what the limitations are of samples that can be directly analysed and designed the bioinformatics pipelines. It was found that samples with an initial viral load as determined by rt-PCR $C(t) \leq 30$ could be directly analysed on the Illumina platform. Samples with $C(t)$ values higher than that could be pre-processed by PCR to increase yields of template material without compromising the individual quasi-species snapshot. Initial results indicate that in depth NGS-analyses provides data about quasi-species variants that potentially allow to more accurately predict trends of viral evolution. Development of NGS bioinformatics-pipelines integrated into surveillance systems can be used to augment more accurately informed definitions of the vaccine composition earlier in time. The fellow participated in the laboratory activities, and pipeline design.

B. Assisting with WHO emergency use assessment and listing during the Zika Public Health emergency of international concern

Supervisor: Dominique Rousset

The fellow was asked during the PHEIC to assist in the testing and validation of tree different molecular tests for Zika virus in an ISO17025 accredited laboratory in possession of a well characterized set of clinical samples. The tests were performed at the department of virology at Institut Pasteur in Cayenne, French Guiana, a French territory which at that point was receiving many cases of confirmed Zika infections. Tests were performed as per WHO EUAL protocol in a strict fashion hence guaranteeing a direct comparison of sensitivity and specificity of the different molecular tests. The fellow selected samples, performed the selection of positive samples as well as samples containing other flaviviruses as references. In addition, he performed the calibration of the instruments and familiarized himself with the procedures required to perform tests under high accreditation standards. The results of the test were summarized in a [WHO EUAL report](#) [reports, 1].

C. Design and validation of bioinformatics pipelines for molecular enterovirus surveillance (WHO-CC)

Supervisors: Francis Delpeyroux and Maël Bessaud

During this project the fellow was requested to design bioinformatics pipelines that would allow *de-novo* assembly of enterovirus specific sequence data from a next generation sequencing platform and subsequently BLAST the sequences against tree different databases including an internal database containing all viral protein (VP1) sequence data. The goal of the pipeline was to generate a method for quick, consistent and automated analyses of sequences where hits with characterised viruses are stored in a database so that new sequence data can be quickly compared and merged with epidemiological parameters. Since the laboratory from which the request originated is a WHO-Collaboration Centre, a lot of enteroviruses are being analysed and consistent data storage is important for quick and accurate comparisons. The designed pipelines were tested against older methodologies and performed better, faster and more autonomous meaning the process requires less interaction with its user and databases are readily delivered for analyses. The fellow was involved in all steps of the work and interacted on a regular basis with a professional team of bioinformaticians and experts on enteroviruses. The fellow obtained additional skills in the design of bioinformatics pipelines and got a look into European and global enterovirus surveillance networks.

Training modules

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3. Initial Management in Public Health Microbiology, Stockholm, Sweden, 8th-12th February 2016 – This module focussed on personality traits relevant to professional development and management tasks. Included were exercises on time management, communication in the field, and with different authorities.
4. Multivariable Analyses module, Vienna, Austria, 14th-18th March 2016- A course focussing on applied statistics for epidemiological analyses introducing multivariable analyses, stratified analyses, interaction of variables, building both logistic and binomial regression models in STATA
5. Bio-risk and Quality Management module, Stockholm, Sweden, 1st-5th of February 2016 – During this one-week module the fellow gained knowledge on bio-risk and control management. Included in this are the identification and mitigation of bio-risks, biological sample shipment and methodologies for quantitative and qualitative test controls including WHO guidelines on biosafety management in laboratories and a visit to a BSL-4 facility.

Educational outcome:

The fellow gained knowledge on applied concepts in virology in relation to public health microbiology including those during a public health emergency of international concern (PHEIC) when dealing with novel pathogens. As well as scientific writing, report writing, presentations at scientific conferences and the generation of hypothesis.

4. Biorisk management

A. Assessment of prevention strategies in the National Reference Laboratory of Rabies

Supervisors: Monica Sala, Laurent Dacheux, Marianne Lucas-Hourani, Christophe Joubert

For this specific project the fellow was introduced with the specific procedures involving intake and processing of samples suspect of Rabies infection. Since Rabies is not considered a high treat pathogen, processing of samples can be done under BSL-2 conditions. However, tracking of such samples is an essential process in a National Reference Centre, as well as properly trained staff with restricted access to laboratories and the instalment of separate laboratories where infected material is handled and stored. The fellow was also familiarized with the used IT systems (Kalilab). Additionally, the laboratory underwent reaccreditation for ISO/IEC 17025 certification, a process which the fellow shadowed. Sufficient credits were obtained for re- accreditation. The fellow joined a team of technical experts and was familiarized with biosafety and quality management aspects in this specific laboratory and allowed the fellow to observe procedures for risk assessment as well as corrective action in case of nonconformities.

B. Preparedness laboratory training Institut Pasteur, Paris

Supervisors: Monica Sala, Laurent Dacheux, Marianne Lucas-Hourani, Christophe Joubert

As part of the fellowship related activities, the fellow was selected to participate in an extensive biosafety training (at Institut Pasteur), which was customized to preparedness in the case of (re-)emerging pathogens. This specific project also consisted of generating output in terms of risk-assessment scenarios in several laboratories at Institut

Pasteur and a visit to the BSL-4 facilities managed by the French Ministry of Defence which was all done under the guidance of technical staff. The training included the following subjects; Notions of hazards and risks, identifying hazards, using chemicals and risks involved, taking protective measures, the use of personal protective equipment, emergency procedures (specific to Institut Pasteur), what to do in specific emergency scenarios with release of pathogenic agents, biological agents/classifications and associated risks. All modules were concluded with a score of 95% or higher. A BSL-3 training of two days was completed as well as training on the auto-clave facilities. The fellow put his training in practice at the National Reference centre for measles, where he was allowed to observe the standardized BSL-3 workflow. The fellow obtained extensive knowledge in the area of biorisk management, and witnessed the procedures and conducts in several laboratories on campus at Institut Pasteur Paris.

Training modules

1. Bio-risk and Quality Management module, Stockholm, Sweden, 1st-5th of February 2016 – During this one-week module the fellow gained knowledge on bio-risk and control management. Included in this are the identification and mitigation of bio-risks, biological sample shipment and methodologies for quantitative and qualitative test controls including WHO guidelines on biosafety management in laboratories and a visit to a BSL-4 facility.

Educational outcome:

The fellow gained an understanding of principles and applied practices for bio-risk management, included among these are the use of personal protection equipment in BSL3 facilities, working with known and unknown infectious agents, understanding processes associated with BSL3 and BSL4 work environments, and biosafety and security risk assessments and mitigation procedures to maintain a safe and responsible work environment.

5. Quality management

Supervisor: Monica Sala, Andrea Rajaonarison, Christophe Joubert, Dominique Rousset

A. ISO17025/15189/EDM/NF96900 re-accreditation visits across Institut Pasteur Paris

For this project, the fellow met with several key departments responsible for the coordination of Quality Management at Institute Pasteur Paris and the 32 global satellite institutes. The re-accreditation procedures at the institute are centrally arranged. The fellow participated in several ISO17025/15189/EDM/NF96900 re-accreditation visits with technical experts (including the French accreditation committee COFRAC) which were essential in the reassignments of the National Reference Laboratory status for several units. The aim of this project was to follow the different steps of the reaccreditation procedures with experts overseeing their procedures of external quality assessment and an overview of procedures involving corrective actions for non-conformities. Together with the technical experts we reviewed standard operating procedures (SOPs) and workflows in laboratories as well as interviews with technical laboratory staff. In total 4 laboratories were visited by the fellow. Only minor non-conformities were observed in these labs and minor corrective actions were required for consideration of reaccreditation.

B. Implementation of Eligibility criteria for the application of a WHO EUAL during the Zika PHEIC

In this project, the fellow was tasked with the implementation of criteria required to perform a WHO EUAL ahead of the evaluation of molecular diagnostics during the Zika PHEIC. This project involved the ordering of supplies, creating systems specific to the recording of reagent characteristics (lot and batch numbers, expiration dates, and other unique identifiers) as well as designing of detailed SOP for both laboratory testing, as well as the analyses of the data from the real-time thermal cyclers. The fellow obtained skills in diagnostic development and testing in emergency settings.

Training modules

1. Biorisk and Quality Management module, Stockholm, Sweden, 1st-5th of February 2016 – During this one-week module the fellow gained knowledge on bio-risk and control management. Included in this are the identification and mitigation of bio-risks, biological sample shipment and methodologies for quantitative and qualitative test controls including WHO guidelines on biosafety management in laboratories and a visit to a BSL-4 facility.

Educational outcome:

The fellow was familiarized with standardized ISO protocols for quality assurance accreditation and certification of National Reference Centres and WHO-Collaborating Centres. In addition, he observed both internal and external quality controls for the assurance of reproducible, accurate and reliable results from the laboratory. The fellow was also involved in the validation of novel diagnostics according to a WHO EUAL.

6. Teaching and pedagogy

A. **Outbreak Investigation Course for public health professionals Institut Pasteur, Paris**

Supervisors: Maria vanKerkhove and Arnaud Fontanet

The fellow co-designed a two-week course aimed at senior public health scientists and actors from various disciplines and organisations, including scientists from the Institut Pasteur Network. The course was designed in coordination with WHO GOARN and WHO communication experts as well as expert from the Institut Pasteur international network. The fellow was requested to conduct an array of tasks. Among these tasks was the design of seven interactive case studies (on H5N1, EVD, MERS-CoV and others) and the design and delivery of three lectures; the outlines of outbreaks; 10-steps of outbreak investigations, the use of sero-prevalence studies in outbreak studies, online trainings and MOOCs focussing on outbreaks and surveillance in emergency context. The fellow participated in the course as well. Key in this was the aspect that most participants were not European which allowed an external reflection on EU practices and a detailed insight into real-life scenarios of outbreaks of pathogens which have not occurred in a European context. Participants had diverse backgrounds and came from different organisations. A certificate was provided by the end of the course, accreditation (ECTS) was available for the Institut Pasteur Diploma candidates and participants of the Mastère Santé publique Pasteur-CNAM. This course offered exchanges of perspectives from different stakeholders at a more senior level. The training was rated with a satisfaction score over 90%. The fellow obtained skills into course organizing and curriculum design and designing of case studies for participants from multi-disciplinary backgrounds. Such courses or workshops are aimed to participants at a more senior level and familiarize them with current practices in outbreak control, as well as allowing them to exchange their practical experience among each other.

B. **The design of a training on the use of mobile tools for data collection in the field for the ECDC Rapid Assessment Module**

Supervisor: Kostas Danis

Together with several ECDC-EPIET colleagues, the fellow designed a training aimed at ECDCs EPIET and EUPHEM fellows as part of the Rapid Assessment Module. This novel training focused on the collection of data during field epidemiology activities but is also very useful for microbiologist working in the field. Modern data collection software suites can utilize the full potential of mobile devices like mobile phones, allowing the users to collect data such as GPS information, utilize cameras to scan barcodes from clinical samples and have future potential to directly gather clinical data and link these to case records. During field exercises data can be collected from different sources and automatically and wirelessly aggregated into a single database. The training was designed to showcase the potential of novel data collection tools and used Epicollect+ and Kobocollect to illustrate its potential. Fellows designed their own survey and later collected dummy data in the field. A training manual was designed as well. The fellow obtained skills in training manual writing and designing training lectures.

C. **Teaching on large scale cross-sectional studies and sampling for the purpose of sero-prevalence studies**

During the Zika PHEIC the fellow was requested to illustrate the use and deployment of sero-prevalence studies in French Guiana and Suriname. Both countries suffer from frequent outbreaks of vector-borne disease. Of recent, Chikungunya, Dengue and Zika. Malaria is still endemic in these regions. Due to the short acute phase of arboviruses and the high expenses, molecular tests cannot always be used to determine infection status. The use of sero-prevalence studies offers a resolve here since samples can be easily collected on filterpaper and multiplex analyses can be performed against multiple antigens on Luminex platforms. The fellow showed examples of large scale sero-prevalence studies where spatial models were used to determine so-called hotspots of intense disease transmission which can assist with decision making in terms of regional intervention prioritisation. Also, subjects like community involvement as well as technical aspects and SOP design and deployment strategies and timing were covered. The teaching was done in one day for an audience of public health professionals and scientists from Institut Pasteur Cayenne and the Ministry of Health in Suriname. The fellow obtained skills in adapting detailed teaching to a level where is understandable for a larger professional audience of different backgrounds.

Educational outcome:

Part of this objective was identifying educational needs for different target groups. The fellow developed case studies and lectures for both senior and junior professionals with a wide diverse background (medical staff, epidemiologists, microbiologists, entomologists, policy makers and logistical support, etc.). The fellow organised meetings for the design of a workshop and was involved in the evaluation of the educational material. Lectures were given to international public health professionals, presenting new technologies for field studies.

7. Public health microbiology management

A. General management of projects and meeting

During the complete fellowship the fellow was engaged in a large range of activities surrounding public health management and this was at all times an integral part of all his projects. During the Salmonella Dublin outbreaks the fellows liaised between different actors involved in outbreak control and source identification as well as epidemiologist at the French National Health Institute. For the influenza, quasi-species and surveillance project the fellow setup several collaborations including with mathematical modellers at Institut Pasteur and INSERM in Paris. For the enterovirus surveillance projects, the fellow maintained the communication with collaborators in Romania on data exchange and progress as well did he engage with all required actors to setup the bioinformatics pipelines. For the AMR research project, the fellow setup collaborations with teams in the Netherlands and France regarding travellers. During the entire fellowship, the fellow was a member of the Institut Pasteur Outbreak Taskforce where he regularly consulted on teaching methodologies and was on a deployment roster to support with global epidemics. The fellow also was a part of the Zika Taskforce hosted at Institut Pasteur during the duration of Zika having the official status as Public Health Emergency of International concern (PHEIC), for this purpose he participated in several meetings and was part of a team that followed all literature. During his deployment in French Guiana he interacted with public health and government officials and attended stakeholder meetings in Suriname for potential future collaborations on arbo-virus and malaria surveillance and control between neighbouring countries Brazil and French Guiana.

B. PREDEMICS Meeting

The fellow was involved with aspect of organisation for this two-day workshop of the EU PREDEMICS (Preparedness, Prediction and Prevention of Zoonotic viruses, Challenges and opportunities) consortium in Gouvieux, France. Activities involved assisting with the selection of speakers, practical aspects of the day as well as chairing one part of the meeting. The meeting was a selection of people working on surveillance and outbreaks from different stakeholder positions like government organisation, NGOs, and science. During the meeting scientific activities under the PREDEMICS consortium were presented as well.

Training modules

Initial Management in Public Health Microbiology, Stockholm, Sweden, 8th-12th February 2016 – This module focussed on personality traits relevant to professional development and management tasks. Included were exercises on time management, communication in the field, and with different authorities

Educational outcome:

The fellow gained substantial experience in working in ad-hoc multidisciplinary teams and gained valuable knowledge on team management, time management and prioritizing, presenting data and result to a varied audience and conflict resolution strategies.

8. Communication

A. Publications relating to the EUPHEM fellowship

1. A. Ung*, A.Y. Baidjoe*, et al., "Disentangling a complex nationwide Salmonella Dublin outbreak associated with raw-milk cheese consumption, France, 2015-2016: findings from a case-case and a case-control study using Multiple-Locus Variable number tandem repeat Analysis and Whole Genome Sequencing." — status: under review at Eurosurveillance
2. J. Codrington, J. Roosblad, A.Y. Baidjoe et al. "Zika virus outbreak in Suriname, a report based on laboratory surveillance data" – status: under review at PloS Current Outbreaks
3. A.Y. Baidjoe et al., "Novel insights into French (2013-2015) influenza (A) virus quasi-species in human specimens using Next Generation Sequencing (NGS): A toolbox to accurately predict intra and inter-seasonal evolution?" - Status: In preparation

4. A.Y. Baidjoe*, Anda Baicus* et al., "Enterovirus surveillance in Roma populations and sewage waste water facilities in Romania; enhancing surveillance by using next generation deep-sequencing" – Status: In preparation
5. Maya Nadimpali, [..], A.Y. Baidjoe et al., "Multidrug-resistant Enterobacteriaceae in meat, fish, and healthy mothers in Phnom Penh, Cambodia and associations with travelers from European territories" – Will be co-author somewhere – Status: In preparation

**authors contributed equally*

B. Other publications

1. A. Y. Baidjoe et al., "Factors associated with high heterogeneity of malaria at fine spatial scale in the Western Kenyan highlands," *Malar. J.*, vol. 15, no. 1, p. 307, 2016.

C. Reports

1. Zika virus disease (IVDs) emergency use assessment and listing (EUAL) report on Zika molecular diagnostics (diagnostic performance report; [WHO EUAL report Zika](#))
2. Outbreak update of *Salmonella* Dublin in France 2015-2016
3. IP Zika taskforce January update 2017

D. Other communications and publications

1. A.Y. Baidjoe, "Science as a candle in the dark*", *Epiet Alumni Network (EAN) newsletter*, spring, May 2017
2. A.Y. Baidjoe, L. Ehlkes, P. Keating, M. Djurdjica, A. Spina., "The strengths of peer learning: how to fully utilise the joint potential of fellows, facilitators and alumni for continued development of the EPIET and EUPHEM fellowship", *Epiet Alumni Network (EAN) newsletter*, summer, September 2017
3. A.Y. Baidjoe, "An introduction to the EUPHEM fellowship at Pasteur, and the bridge to interdisciplinary science in the scope of public health"- *Institut Pasteur Newsletter*, November 2015

E. Teaching materials

1. Case study on ZIKV outbreak in Cape Verde for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016*
2. Case study on Unconfirmed Ebola cases in a remote village in Liberia for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016*
3. Case study on a suspected case of MERS-CoV in Bangladesh for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016*
4. Case study on a yellow fever outbreak in Ghana for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016*
5. Case study on a suspected outbreak of a pandemic H5N1 strain in for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016*
6. Case study on ZIKV outbreak of a Pneumonic Plague outbreak in Northern Madagascar for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016*
7. Lecture on the use of sero-prevalence studies in surveillance for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016
8. Lecture on community involvement in outbreak situations and surveillance studies in low resource settings for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016
9. Lecture on current epidemiology and practices in treatment of Gonococcal disease, ECDC teaching materials
10. Lecture on online trainings focussing on outbreaks and surveillance for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016
11. Lecture on the 10-steps of outbreak investigations for the Institut Pasteur Outbreak investigation course on behalf of the Outbreak Investigation Taskforce, Paris, 4-15 April 2016
12. Lecture on the use of mobile tools for data collection for the ECDC Rapid Assessment Module, Athens, Greece, 20-26th of June 2016
13. Training manual on the use of mobile tools for data collection (Kobocollect and Epicollect) for the ECDC Rapid Assessment Module, Athens, Greece, 20th-26th of June 2016/2017
14. Lecture on ISO9001/ISO/IEC17025 certification and accreditation during the ECDC Biorisk and Quality Management module, Stockholm, Sweden, 1st-5th of February 2016
15. Lecture on the design of bioinformatics pipelines to detect influenza-quasi-species from deep-sequencing NGS data for the National Reference Laboratory Influenza, Institut Pasteur, Paris, 16th of February 2017

16. Lecture on the use of quasi-species data derived from NGS technologies for Mathematical modellers from INSERM and Institut Pasteur, Paris, France, March 14th 2017
17. Lecture on the use of designed NGS bioinformatics pipelines in enterovirus surveillance for the enteric virus group at Institut Pasteur, Paris, France, 5th of September 2017

F. Conference presentations

1. A.Y. Baidjoe. "The use of sero-prevalence studies in the surveillance of vector-borne disease; enhancing temporal-spatial analyses.", Oral presentation at the Institut Pasteur International Network Scientific Symposium. Paris, France, November 29th- December 2nd, 2016
2. A.Y. Baidjoe. Explaining epidemiological micro-heterogeneity in malaria transmission, new tools and methods. Poster presentation at the Young Researchers in Life Sciences Conference, Institut Pasteur, Paris, May 18th -20th, 2016
3. Amrish Y. Baidjoe, Laetitia Fabre, Nizar Fawal, Marie-Leone Vignaud, Aymeric Ung, Nathalie Jourdan-Da Silva, Sabrina Cadel-Six, Renaud Lailier, Simon Le Hello, "Whole Genome Sequencing (WGS) offers high resolution discriminative data for rare serovars of Salmonella; examples from epidemiologically well characterized outbreaks in France in the period 2014-2016", Oral presentation at the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), 28-30 November 2016, Stockholm, Sweden
4. Ung A*, Baidjoe A*, Van Cauteren D, Fawal N, Guerrisi C, Morand A, Donguy MP, Lucas E, Rossignol L, Vignaud ML, Cadel-Six S, Lailier R, Jourdan-Da Silva N, Le Hello S, "Disentangling a complex nationwide Salmonella Dublin outbreak associated with raw-milk cheese consumption, France, 2015-2016: findings from a case-case, a case-control study and Whole Genome Sequencing". Oral presentation at the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), 28-30 November 2016, Stockholm, Sweden
5. Amrish Y. Baidjoe*, Gillian Stresman*, John Bradley, Philip Knight, William Stone, Victor Osoti, Euniah Makori, Chrispin Owaga, Wycliffe Odongo, Pauline China, Shehu Shagari, Ogobara K. Doumbo, Robert W. Sauerwein, Simon Kariuki, Chris Drakeley, Jennifer Stevenson, Jonathan Cox, Teun Bousema, "The Impact of Hotspot-Targeted Interventions on Malaria Transmission in Rachuonyo South District in the Western Kenyan Highlands" - Oral presentation at the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), 28-30 November 2016, Stockholm, Sweden
6. Amrish Y. Baidjoe*, Gillian H. Stresman*, Jennifer Stevenson, Lynn Grignard, Wycliffe Odongo, Chrispin Owaga, Victor Osoti, Euniah Makori, Shehu Shagari, Elisabeth Marube, Jonathan Cox, Chris Drakeley, Teun Bousema, "Utilizing a novel focal screening and treatment approach to identify clusters of subpatent infections of malaria in the Kenyan Highlands" - Poster presentation at the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), 28-30 November 2016, Stockholm, Sweden
7. A.Y. Baidjoe, Chiara Poletto, Vincent Enouf, Cyril Barbezange, Sylvie Behillil, Louis Jones, Vittoria Colizza, Sylvie van der Werf, "Novel insights into French (2013-2015) influenza (A) virus quasi-species in human specimens using Next Generation Sequencing (NGS): A toolbox to accurately predict intra and inter-seasonal evolution?", Oral presentation at ESCAIDE, November 6th -8th 2017, Stockholm, Sweden

**authors contributed equally*

G. Other Submitted abstracts

8. A.Y. Baidjoe, Chiara Poletto, Vincent Enouf, Cyril Barbezange, Sylvie Behillil, Louis Jones, Vittoria Colizza, Sylvie van der Werf, "Novel insights into French (2013-2015) influenza (A) virus quasi-species in human specimens using Next Generation Sequencing (NGS): A toolbox to accurately predict intra and inter-seasonal evolution?", Selected as poster presentation at the 9th TEPHINET Global Scientific Conference, August 7th -11th 2017, Chiang Mai, Thailand

H. Selection of other presentations

1. Presentation on the use of sero-prevalance studies to address the spatial heterogeneity of disease. Scientific Seminar at institute Pasteur, Paris, 18th of February 2016
2. Presentation of the usefulness of Whole Genome Sequencing in outbreaks of rare serovars of Salmonella, experiences in France. United States Centres of Disease Control and Prevention and Salmonella experts in France. At Santé Publique France, Paris, France, 9th of June 2016

9. EPIET/EUPHEM modules attended

5. Introductory Course, Spetses, Greece, 28th September-16th October 2015
6. Bioinformatics and Phylogeny module, Stockholm, Sweden, 16th – 18th November 2015

7. Outbreak Investigation module, Berlin, Germany, 7th-11th December 2015
8. Biorisk and Quality Management module, Stockholm, Sweden, 1st-5th of February 2016
9. Initial Management in Public Health Microbiology, Stockholm, Sweden, 8th-12th February 2016
10. Multivariable Analyses module, Vienna, Austria, 14th-18th March 2016
11. Rapid Assessment module, Athens, Greece, 20-26th June 2016
12. Project Review module, Lisbon, Portugal, 22st-26th August 2016
13. Project Review Module, Lisbon, Portugal, 28th August-1st September 2017

10. Other training and meetings

1. Institut Pasteur Zika Taskforce meeting (seven days during the Zika PHEIC in 2016/2017)
2. PREDEMICS consortium meeting; Preparedness, Prediction and Prevention of Zoonotic viruses, Challenges and opportunities, Gouvieux, France (two days)
3. Institut Pasteur international conference on biomarkers (two days)
4. Institut Pasteur international Zika conference (two days)
5. Institut Pasteur/WHO Outbreak Investigation course (two weeks, certification)
6. Medecins Sans Frontieres; Preparation Primary Departure Course (seven days, certification)
7. Institut Pasteur BSL-3 training (one week)
8. BSL-4 introduction meeting by the French Ministry of Défense (one day)
9. Institut Pasteur Vaccinology MOOC (4 weeks, certification)
10. Institut Pasteur biosafety and biosecurity courses (1 week, certification)
11. Qiagen course on CLC workbench workshop (1 day, certification)
12. Vector-borne disease meeting Suriname (3 days)
13. United Nations Department of Safety and Security online training Basic security in the field and Advanced security in the field (USDSS) (two days, certification)
14. INTERREG project meeting on Vector-borne Disease French Guiana (two days)
15. Humanitarian Congress: Forced to Flee, humanity on the run, Vienna (four days)

Coordinator's conclusions

This portfolio is testimony to the excellent contribution of the site staff at the Institut Pasteur to the wholesome development of Amrish Baidjoe's EUPHEM fellowship. The site supervisors exposed Amrish to a variety of disciplines and field situations that can be measured by the outputs of the fellowship and by his contribution to teaching and capacity development programmes. The summary of activities and projects in this portfolio highlights how a very bright and enthusiastic fellow was able to become a public health microbiologist thanks to the multidisciplinary projects offered. Amrish was not only able to investigate outbreaks that were relevant to France and Europe but beyond, helping along the way to standardise and validate molecular assay and data analyses pipelines in real time for Salmonella, influenza, Zika and enteroviruses. His work within the various multidisciplinary teams informed and contributed to redesign surveillance systems to move with technological advances in sequencing technologies. The outputs of projects carried out at Institut Pasteur will also contribute documents that can be used as reference in the formulation of policy by WHO and other international health organisations. The Fellow's leadership skills were developed through collaboration with colleagues in diverse disciplines, including medics, epidemiologists, microbiologists, entomologists, mathematical modellers, policy makers and laboratory support staff. He was able to connect and foster collaborations between these multidisciplinary teams in a wide range of subjects, as evidenced by the abundant conference presentations and teaching materials developed. These outputs, in conjunction with the modules undertaken, fully accomplish the range of competences required by the fellowship programme and I congratulate Amrish and the supervisory team at Institut Pasteur on their achievements through the Fellowship programme.

Supervisor's conclusions

Amrish has learnt a lot at the Institut Pasteur and similarly has brought a lot to our Institution. By his very active personality, he gained the trust of many renowned scientists of the Institut who agreed to collaborate and supervise him. By that very constructively and team-player attitude, Amrish could accede not only to different Parisian Departments of interest for increasing his knowledge in field microbiology and outbreak investigation, but also to two out of our 32 Pasteur institutes in the world. He also collaborated with our Centre for Global Health which is our frontline in intervention epidemiology and microbiology for major health crises worldwide as well as with external organisations like the World Health Organisation and Medecins Sans Frontieres. Amrish was able to build up and maintain scientific exchanges with the national organism in charge of epidemiology studies in France and is co-author of a paper which shows the interest in joining microbiology to epidemiology in public health studies, this is in frame with the recent development of the ECDC fellowships programs.

Amrish showed a great ability in interdisciplinary communication, scientific collaboration, networking and a great personal investment in public health issues. The tremendous amount of work he has engaged in during the two-year period clearly testifies of his motivation and ability to assimilate new knowledge in excellent manners not only in public health microbiology, but also in epidemiology and in public health management.

As supervisor, I had a great pleasure to interact with him in productive scientific discussions where I was always impressed by Amrish solid personality and strong motivation to deal with public health subjects. Amrish is the kind of person that can scientifically and psychologically be an efficient actor on the frontline of a major infectious disease outbreak. And at the same time, he has scientific, diplomatic and management capacities which can allow him to assume the management of such a crisis.

Finally I, would like to thank the ECDC EUPHEM/EPIET program for allowing us to participate to this excellent training program in field microbiology. A great experience to be renewed.

Personal conclusions of fellow

The EUPHEM fellowship provided me with newfound opportunities to expand my horizon into a variety of activities in the scope of European and global public health research, outbreaks and surveillance activities. It offers fellows a unique and critical outlook into new cross-cutting areas and opportunity for multidiscipline collaborations between different fields of science, as well as between European and global stakeholders and other actors in the world of public health. It broadened my view in the world of medical related microbiology as well as highlighting where we can find critical anchors of interaction with epidemiologists as well as other essential public health disciplines. The EUPHEM and EPIET network that is founded on fellows and graduates continues to strengthen the European public health frameworks and further stimulates collaborations between different public health laboratories and institutes within and beyond the EU-member states. As a graduated fellow, I hope to continue to stimulate cross-disciplinary and cross-state collaborations in the scope of public health and keep on bringing motivated professionals from all disciplines and professions together to fight the burden of disease, both existing and newly emerging.

Acknowledgements of fellow

I would warmly thank all the EPIET/EUPHEM/PAE/UK-FETP fellows from cohort 2015. It was an enrichment to have met you all both in the professional as well as the personal context. Although the fellowship has come to an end I am sure the valuable formed friendships we have made will serve as a strong fundament to our professional collaborations in the future. I especially want to thank Dr. Monica Sala as my site supervisor for her unconditional support. Virginie Ponticelli for all her support to a newcomer in France and helping me settle down there and always having the time to help me with any administrative issue. Professor Sylvie van der Werf and Professor Francis Delpeyroux for hosting in their laboratories for the last 24 months and their excellent scientific guidance. Thanks to Maria van Kerkhove, Arnaud Fontanet and Rebecca Grant for getting me up to speed with the world of global health and the nice more informal talks which were equally valued. Thanks to Dominique Rousset, Isabelle Dusfour, Claude Flamand and Mirdad Kazinji for the warm welcome and project opportunities during my stay in French Guiana while working on the Zika PHEIC. Thanks to Simon Le Hello, Nathalie Silva-da Jourdan and Aymeric Ung for the pleasant collaborations during the outbreaks of Salmonella and allowing me to look into the world of food and water borne related infections. My EPIET counterparts and friends, Alex Spina, Lutz Ehlikes and Patrick Keating, for the development of novel teaching materials for the RAS module and Kostas Danis for giving us the opportunity to show that fellows can offer unique skills that can benefit the fellowship curriculum development.

I would like to thank my ECDC supervisors. Androulla, for the amazing scientific talks and your always constructive approach to matters. Aura, many thanks for your calls and always quick e-mails when I got stuck. And to Aftab, thanks, for always reminding me that one can only grow both professionally and personally through hardship. I would warmly thank all my other collaborators, without all your support and contributions the fellowship would have been a hollow shell of the great learning experience it was.