



# Summary of work activities

## Hubert Buczkowski

### The ECDC Fellowship Programme

#### Public Health Microbiology path (EUPHEM), 2020 cohort

## Background

The ECDC Fellowship Programme is a two-year competency-based training with two paths: the field epidemiology path (EPIET) and the public health microbiology path (EUPHEM). After the two-year training, EPIET and EUPHEM graduates are considered experts in applying epidemiological or microbiological methods to provide evidence to guide public health interventions for communicable disease prevention and control.

Both curriculum paths provide training and practical experience using the 'learning by doing' approach in acknowledged training sites across European Union (EU) and European Economic Area (EEA) Member States.

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 Hubert Buczkowski, cohort 2020 of the European Public Health Microbiology Training Programme (EUPHEM) at the Public Health Agency of Sweden (PHAS/Folkhälsomyndigheten).

## Pre-fellowship short biography

Dr Hubert Buczkowski is a virologist with 15 years of experience in national and international research institutions. He obtained a PhD in molecular virology at the Royal Veterinary College in London in 2010. He conducted research at British and French scientific organisations in vaccine development and emerging viral pathogens, particularly paramyxoviruses and filoviruses. Prior to the EUPHEM fellowship, he was involved in diagnostic work in Sierra Leone during the 2013–2016 West Africa Ebola epidemic, and in research in capacity building in Ghana. Immediately before the fellowship, Hubert worked as a scientist in BSL-3 and BSL-4 laboratories at Public Health England (now UK Health Security Agency, UKHSA).

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Stockholm, November 2022

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## Methods

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

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

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

## Results

The objectives of these core competency domains were achieved partly through project or activity work and partly through participation in the training modules. Results are presented in accordance with the EUPHEM core competencies, as set out in the ECDC Fellowship Manual <sup>1</sup>.

### 1. Epidemiological investigations

#### 1.1. Outbreak investigations

##### *1.1.a COVID-19 outbreak in Sweden, 2021*

**Supervisor:** Josefine Lundberg Ederth

In February 2021, Hubert was asked to provide support to the COVID-19 Epidemiology Literature Group at the Public Health Agency of Sweden (PHAS). The aim of the group was to provide assistance to the lead epidemiologist at the Agency in searching relevant data required for activities. The other goal was to prepare a reading list of relevant publications which was distributed once a week among scientists at the PHAS.

**Role of the fellow:** In order to conduct the activities for this task, Hubert learnt a new reference management software, Zotero. He attended meetings twice a week between February and June 2021, and contributed to searching, reading, reviewing COVID-19-themed articles of relevance to the work conducted at the PHAS. In all, he reviewed, wrote short notes, categorised their importance and presented brief oral summaries of around 20 research articles. He also contributed in selecting articles for weekly circulation among the PHAS employees.

##### *1.1.b Salmonella outbreak in Sweden, 2021*

**Supervisor:** Nadja Karamehmedovic

In August and November 2021, Hubert visited the Unit for Laboratory Surveillance of Bacterial Pathogens at the PHAS, which is responsible for serotyping and molecular typing of *Salmonella* species in Sweden. The fellow was introduced to the laboratory activities, particularly the typing protocols for *Salmonella*, which are part of laboratory investigations in suspected *Salmonella* outbreaks. During the November visit, the fellow had an opportunity to conduct the first steps of laboratory typing of confirmed *Salmonella* samples sent from clinical laboratories in Sweden.

**Role of the fellow:** The fellow set up bacterial cultures on solid agar plates for DNA isolation and whole genome sequencing. In addition, the fellow set up bacterial cultures in liquid broth and then carried out and analysed the biochemical characterisation of *Salmonella* in a microplate format.

##### *1.1.c Evaluation of the exceedance rate of hepatitis of unknown aetiology in children under 16 years of age in Sweden, 2022*

**Supervisors:** Moa Rehn and Emma Löf

An increasing number of acute hepatitis cases of unknown aetiology have been observed in children since March 2022 in numerous countries, with the highest case numbers in the UK and USA. In the first two quarters of 2022, Sweden reported 11 suspected cases. However, it was not clear whether this number was above what would be expected normally in that time period. In order to investigate this, a baseline level of acute hepatitis cases of unknown aetiology in children in Sweden in the ten years preceding 2022 was established, following the protocol designed and distributed to EU/EEA countries by ECDC in May 2022.

**Role of the fellow:** Hubert was a member of the team investigating the suspected outbreak of hepatitis cases. Together with the project supervisors, and following consultation with a specialist hepatologist, he prepared an outline of data on historical hepatitis cases assigned with specific ICD-10 codes to be requested from the In and Out-patient Registry held by Socialstyrelsen (The Swedish Board of Health and Welfare).

<sup>1</sup> European Centre for Disease Prevention and Control. European public health training programme. Stockholm: ECDC; 2020. Available from: <https://www.ecdc.europa.eu/en/publications-data/ecdc-fellowship-programme-manual-cohort-2021>

Following the data acquisition, he conducted a descriptive analysis to establish the incidence rate of hepatitis cases in Sweden in the 10-year period between 2012 and 2021. He then performed time series analysis and linear regression to reveal any underlying trend and seasonality for both the total under-16-year-old population and more specifically for a population of five-year olds and younger, since the majority of suspected cases in Sweden in 2022 belonged to the latter age category. No seasonality was observed in either of the age groups and the incidence rate was calculated to be 0.9 and 1.1/100 000 people in the under-16 and under-five-years age group, respectively. Comparison to the number of suspected cases in 2022 did not suggest an exceedance of cases of hepatitis of unknown aetiology in either of the age groups in Sweden in 2022.

### *1.1.d Continuous review of the global situation of hepatitis of unknown aetiology*

**Supervisor:** Moa Rehn

In May 2022 Hubert was invited to join the team investigating the suspected outbreak of hepatitis cases in Sweden in 2021/2022.

**Role of the fellow:** Hubert participated in several meetings and his main task was to prepare weekly or twice-a-week updates on the situation in other countries. This task involved conducting regular searches of websites such as The Program for Monitoring Emerging Diseases (ProMED), United Kingdom Health Security Agency (UKHSA), European Centre for Disease Prevention and Control (ECDC) and Centers for Disease Control and Prevention (CDC), collating data gathered through these searches and preparing short updates to the situation document disseminated regularly to all members of the investigation team.

### *Training modules related to the assignment/projects*

**EPIET/EUPHEM Introductory Course:** Fellows were introduced to the broad range of basic concepts related to public health, surveillance and outbreak investigation, which were then expanded in later modules.

**Outbreak Investigation:** Fellows were introduced in depth to the 10 steps of outbreak investigation and participated in case studies which familiarised them with each step, especially with tools used in the descriptive and analytical analyses in an investigation, as well as different types of epidemiological study designs.

**Multivariable Analysis:** This module provided fellows with basic definitions and concepts for the different types of regression models, including linear regression, simple and multivariable logistic regression, conditional logistic regression, Poisson and Cox regressions and how they can be used in outbreak investigations and surveillance.

**Time Series Analysis:** Fellows learnt how to import surveillance data into statistical software, manage different data formats and plot surveillance data over time. They also learnt how to assess and interpret the significance of trend in surveillance data and how to detect exceedances in surveillance data with the use of statistical methods.

**Management, Leadership and Communication in Public Health:** In this module, fellows were familiarised with different management styles, qualities and skills of effective public health leaders and different ways of communicating public health-related information to peers, stakeholders, higher authorities and the general public, especially in emergency situations.

### *Educational outcome*

The fellow took part in several steps of an outbreak investigation: determination of the existence of an outbreak, confirmation of diagnosis, generating and testing hypotheses in descriptive and analytical studies, drawing conclusions and communicating findings. By participating or leading in these activities, the fellow gained a first-hand experience of the important aspects of outbreak investigations, both on a local and a national scale. These newly acquired epidemiological skills complement the fellow's previous experience in using microbiological methods in outbreak investigation.

## **1.2 Surveillance**

### *1.2.a Development of a novel typing method of rotaviruses circulating in Sweden*

**Supervisor:** Nina Lagerqvist

Vaccination against rotaviruses was included in the Swedish childhood vaccination programme in 2019. Rotarix, a live attenuated monovalent human G1P[8] vaccine is used across all counties of Sweden. However, the gold standard molecular typing method used in microbiological surveillance of rotaviruses circulating in Sweden targets VP4 and VP7 genes and does not allow complete differentiation between wild-type and vaccine G1P[8] genotypes. Moreover, the current typing is based on Sanger sequencing, which becomes an outdated method and is planned to be phased out at PHAS. The aim of this project was to develop a MinION-based genotyping method of rotaviruses, allowing vaccine versus wild-type differentiation, which would become a pillar of the epidemiological surveillance of rotaviruses in Sweden. When integrated into the planned surveillance system, this novel typing method will help to answer important public health questions such as the predominant genotypes in Sweden, genotypes distribution both at county and national level, temporal and special changes in genotypes distribution, potential appearance of vaccine escape mutants, effect of vaccine on virus seasonality, changes in total number of samples sent for diagnosis, etc.

**Role of the fellow:** The fellow conducted literature search and identified NSP1 and NSP2 segments as novel targets for wild-type versus vaccine strain differentiation, designed together with the supervisor primers targeting these segments and redesigned existing primers for segments VP4 and VP7. In silico analysis showed that the changes introduced to the existing primers improved their matching to rotavirus A sequences available in the National Center for Biotechnology Information (NCBI) database.

### **1.2.b Investigation of differences in *Clostridioides difficile* incidence rates between regions in Sweden from 2017–2019**

**Supervisors:** Kristina Rizzardi and Sharon Kühlmann Berenzon

*Clostridioides difficile* is an anaerobic, Gram-positive bacillus, which frequently causes hospital-acquired infections and therefore, has a major public health burden. *C. difficile* is a relatively poor competitor in the colon habitat and under normal circumstances rarely causes disease. However, antibiotic treatment can disturb the microbiome of the colon and lead to a quick colonisation of the gut by *C. difficile*. Antibiotic therapy is therefore a major risk factor for *C. difficile* infections (CDI). Some antibiotics are known to be associated with a higher risk of CDI than others. Among these, especially cephalosporins, quinolones, macrolides and lincosamides are usually classified as high-risk. Other risk factors related to CDI are older age, recent stay at healthcare facility, weakened or compromised immune system and previous CDI or known exposure to *C. difficile*. The chemical composition of disinfectants is also considered a risk factor. This project investigated the association between the exposure to several risk factors and the incidence rates of CDI in eight regions of Sweden from 2017 to 2019.

The negative binomial regression model showed that for *C. difficile* high-risk antibiotics, cephalosporins were associated with a 7% increased CDI incidence risk ratio per 100 000 inhabitants for each unit of defined daily dose (DDD) sold. Additionally, using the membrane type ELISA as a diagnostic assay led to a minimum of 28% decrease in detected CDIs when compared to nucleic acid amplification tests.

**Role of the fellow:** The fellow conducted a literature search and wrote the project proposal. He then collated and cleaned available data, and performed descriptive analysis. Under the supervision of a statistician, the fellow performed statistical analysis using STATA software, and reported and discussed the results with the project supervisor. The fellow summarised the results in a project report.

### **Training modules related to the assignment/projects**

**EPIET/EUPHEM Introductory Course:** Fellows were introduced to the broad range of basic concepts related to public health, surveillance and outbreak investigation, which were then expanded in later modules. This included important principles of developing and optimising surveillance systems and using data provided by them to inform public health action.

**Multivariable Analysis:** This module provided the fellow with basic definitions and concepts for the different types of regression models, including the negative binomial regression which was used by the fellow in one of the surveillance projects.

### **Educational outcome**

The fellow was involved in surveillance improvement and interpretation of surveillance data to generate information for action in two surveillance projects related to two distinct pathogen types. The fellow combined his previous experience with new laboratory skills and field knowledge to provide advice on improving the microbiological method used in the surveillance system. He also learnt how to use the existing surveillance data, analyse it using statistical tools and interpret the results in order to provide conclusions and recommendations on important public health matters.

## **2. Applied public health research**

### **2.1. Analysis of COVID-19 vaccine breakthrough infections in Sweden in 2021**

**Supervisors:** Maximilian Riess and Jonas Klingström

SARS-CoV-2 is a causative agent of one of the largest pandemics in the recent history, with over 620 million infections and an estimated 6.5 million deaths as of August 2022. Non-pharmaceutical interventions were the only measures available to limit the spread of the virus before vaccines were developed and introduced. Vaccines available in EU showed high efficacy in the controlled environment of clinical studies, but their effectiveness in protecting from symptomatic disease, hospitalisation and death, including those caused by new virus variants, could only be assessed after the mass roll-out. While a dramatic fall in case numbers and severity of disease was observed in several countries with high vaccination rates, vaccine breakthrough infections (VBI) were also reported. The aim of this project was to investigate if there was an association between certain variants of SARS-CoV-2 and breakthrough infections reported between February and September 2021 in Sweden. The main finding of this project was that in the period between weeks 20 and 32 of 2021 in Sweden, when Alpha and Delta were the two dominant variants in the country, cases infected with the Delta variant were 1.6 times more likely to have been vaccinated, compared to cases with the Alpha variant (95% CI 1.3–2.0). The study showed that the Delta variant was associated with a higher likelihood of vaccine breakthrough infection in fully vaccinated individuals compared to infection with the Alpha variant.



**Role of the fellow:** The fellow performed the descriptive analysis of the available data sets using STATA software and provided structured data for the analytical part of the project. He then worked together with a statistician on the statistical analysis to provide estimates on the association of breakthrough infections and SARS-CoV-2 variants. The fellow presented the outline and initial results of the project at the Nordic Mini Project Review Module 2022 in Oslo. He also prepared the final study protocol and wrote a manuscript for publication in a scientific journal.

### *Training modules related to the assignment/projects*

**EPIET/EUPHEM Introductory Course:** Fellows were introduced to the broad range of basic concepts related to public health, surveillance and outbreak investigation, which were then expanded in later modules.

**Outbreak Investigation:** Fellows were introduced in depth to the 10 steps of outbreak investigation and participated in case studies which familiarised them with each step, especially with tools used in the descriptive and analytical analyses in an investigation, as well as different types of epidemiological study designs.

**Multivariable Analysis:** This module provided fellows with basic definitions and concepts for the different types of regression models, including linear regression, simple and multivariable logistic regression, conditional logistic regression, Poisson and Cox regressions and how they can be used in outbreak investigations and surveillance.

**Vaccinology:** This module provided the participants with the knowledge and skills to undertake projects and routine work in the area of vaccine-preventable disease epidemiology.

**Time Series Analysis:** Fellows learnt how to import surveillance data into statistical software, manage different data formats and plot surveillance data over time. They also learnt how to assess and interpret the significance of trends in surveillance data and how to detect exceedances in surveillance data with the use of statistical methods.

### *Educational outcome*

The fellow conducted all stages of a public health research project from planning to writing a scientific article. This was the first major project where the fellow had an opportunity to learn the statistical software STATA and apply this knowledge in collating, cleaning and analysing data in the descriptive analysis. The fellow disseminated and communicated the project outlines and results, critically discussed the project limitations and acted on the feedback received from peers.

## 3. Applied public health microbiology and laboratory investigations

### 3.1. Development and implementation of a high-resolution typing method for *Cryptosporidium parvum*

**Supervisors:** Abdolreza Advani, Jessica Beser and Ioana Bujila

The incidence of Cryptosporidiosis cases in Sweden has been rising in recent years. However, outbreak investigations and studies of transmission dynamics have been hampered by low resolution of existing subtyping methods. A multi-locus sequence typing (MLST)-based subtyping method of *Cryptosporidium hominis*, has been recently developed, improving the subtyping resolution and ability to investigate outbreaks caused by *C. hominis* in more detail. However, a similar tool is missing for *Cryptosporidium parvum*, which is presently responsible for a majority of Cryptosporidiosis cases in Sweden. This project aimed at developing an MLST subtyping method for *C. parvum* using a set of primers previously designed at the Public Health Agency of Sweden. The project failed to deliver the outlined objectives. Although up to several thousands of sequencing reads were generated for some amplicons, the overall amount of DNA amplicons was not sufficient for further analysis. After 11 rounds of optimisation and a consultation with supervisors, the project was stopped.

**Role of the fellow:** The fellow conducted laboratory work on sample preparation for Ion Torrent sequencing and analysed sequencing data in bioinformatics software. In collaboration with the project co-supervisor, he planned all the optimisation experiments and troubleshoot arising problems. After the conclusion of the project, the fellow wrote the final project report.

### 3.2. Development of a novel typing method of rotaviruses circulating in Sweden

**Supervisor:** Nina Lagerqvist

In the laboratory investigation part of this project, the fellow first assessed the performance of the newly designed primers targeting rotavirus A NSP1 and NSP2 segments, and the redesigned primers targeting VP4 and VP7 segments. Primers for NSP2, VP4 and VP7 performed well and amplified DNA fragments of expected length. Primers to NSP1 failed and were not included in subsequent work. The fellow then researched the existing sample preparation protocols and selected the most suitable one for the project, conducted all work on sample preparation for sequencing in MinION device and analysed the results. Out of 31 samples analysed, G genotype was correctly identified in 30. Similarly, 30 out of 31 analysed samples had P genotype correctly identified.

Among G1P[8] genotype samples, three out of four were correctly identified as vaccine, while nine out of 11 were correctly identified as wild-type related.

**Role of the fellow:** Apart from laboratory work, the fellow prepared and gave an oral presentation of the project results at the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE, 2021), wrote the final project report and is currently preparing a manuscript.

### *Training modules related to the assignment/projects*

**EPIET/EUPHEM Introductory Course:** Fellows were introduced to the broad range of basic concepts related to public health, surveillance and outbreak investigation, which were then expanded in later modules. The module provided the fellows with a clear understanding of the key role played by the laboratory in surveillance and outbreak investigations.

### *Educational outcome*

These projects gave the fellow a great opportunity to learn about two distinct pathogens, *Cryptosporidium* parasites and *Rotavirus*, and their impact on public health in Sweden. By conducting laboratory work, he gained competency in laboratory investigation, learnt new laboratory skills and understood how diagnostic and typing methods were used in surveillance and outbreak investigations. More specifically, the fellow learnt particular challenges in subtyping *Cryptosporidium* parasites. He also familiarised himself with the principles of two Next Generation Sequencing techniques: MinION and Ion Torrent. The fellow learnt how to collaborate and efficiently communicate with persons from multidisciplinary backgrounds in order to manage and take forward complex and time-consuming projects.

## 4. Biorisk management

### 4.1. Introductory training in Biological Safety Level 3 (BSL-3) laboratory at the PHAS

**Supervisor:** Jenny Verner-Carlsson

In October and November of 2021 Hubert took part in a training to use the BSL-3 laboratory at the PHAS in anticipation of a project requiring access to the BSL-3 virology facility at the Agency. Prior to the training, Hubert was required to undergo security checks as per the Swedish law regulations, which consisted of background check by the police and interview with the security protection specialist at the Agency. The training consisted of a series of face-to-face meetings with Jenni Verner-Carlson, the scientist responsible for training new staff, to go through all documentation related to safe work practices in the laboratory and a series of visits to the facility, where the practical part of the training took place.

**Role of the fellow:** After successful completion of the training, Hubert achieved competency in using the BSL-3 laboratory when accompanied by other scientific staff with higher competency levels. However, the project for which this training was required was eventually cancelled due to other responsibilities of the project supervisor in the ongoing COVID-19 pandemic. Hubert worked in the BSL-3 facility on a couple of occasions for a different project involving the isolation of the Omicron variant of SARS-CoV-2.

### *Training modules related to the assignment/projects*

**Biorisk and Quality Management Module:** The module provided theoretical knowledge on concepts related to biorisk and quality management, and their importance in a public health laboratory setting. Hubert was already an experienced BSL-3 laboratory user, however the module offered an opportunity to refresh his knowledge in this area.

### *Educational outcome*

Hubert has an extensive experience in working in high security laboratories in the UK, France and Sierra Leone. The BSL-3 training offered Hubert a great opportunity to compare safety procedures between those countries and Sweden, and how different approaches are used in ensuring safe working practices in laboratories dealing with dangerous pathogens. This is especially important to Hubert with his previous experience from the High Containment Microbiology laboratory at the UKHSA in London. His observations will be of relevance in his future work.

## 5. Quality management

### 5.1. External quality assessment for the molecular diagnostics of Influenza virus A and B

**Supervisors:** Mia Brytting and Maximilian Riess

An external quality assessment (EQA) of the molecular methods used for influenza diagnostics and characterisation is performed on a yearly basis in Sweden to ensure that the methods applied within the national diagnostic capacity are suitable for the detection of circulating strains. Participating laboratories receive a panel of ten influenza A and B specimens representative of the vaccine composition and viruses in circulation in the current year, which they then identify and subtype using the diagnostic method of choice.

Twenty-one laboratories participated in the EQA in autumn 2021 and all of them correctly identified the ten specimens. While the subtyping of influenza A strain is no longer obligatory in Sweden, the five laboratories which performed it, did correctly subtype the virus. The same was the case for the two laboratories which performed influenza B line-typing. None of the laboratories reported false positive results. Considering that four out of ten panel samples had high CT values, these results highlight that laboratories in Sweden are well prepared for the influenza season.

**Role of the fellow:** The fellow participated in the specimen selection process for the EQA panel under the supervisors' guidance, performed part of the laboratory work, and took part in the site visit of the Equalis laboratory in Uppsala, which coordinates the influenza EQA process. He was also part of the results evaluation team, investigated an initial apparent sample mistyping at one of the participating laboratories, and co-wrote the final EQA report.

## 5.2. Internal audit of the HBV laboratory at PHAS

**Supervisors:** Tatjana Tallo and Lottie Schloss

This audit was performed as part of the activities after the Biorisk and Quality Management Module 2022. The audit was done in the hepatitis B virus (HBV) laboratory within the Unit for Laboratory Surveillance of Vaccine Preventable Diseases at the Public Health Agency of Sweden. The audit was held in a series of meetings with the responders, during which 'Process and Quality Control' and 'Documentation' indicators were discussed and assessed in detail. Most indicators were assessed at 100%, with the only areas that could be considered for improvement being pre-analytical processes and specimen management, where some minor details were not recorded. This in turn affected the overall score of the Standardised Report Format indicator. These minor issues did not overall affect the ability of the laboratory to process and identify the samples, as other identifiers were in use instead and recorded in the laboratory database.

**Role of the fellow:** The fellow conducted the assessment interview with Tatjana Tallo, the manager of the HBV laboratory, and Lottie Schloss, the Quality Manager at the unit. He compiled the results, wrote a short summary and submitted the audit form to the ECDC EVA platform.

## 5.3. Internal audit of the BSL-3 virology laboratories at PHAS

**Supervisor:** Sándor Bereczky

An annual internal biosafety audit is carried out at the BSL-3 laboratory at PHAS. In 2021, the fellow was invited to participate in the audit as an observer. The audit team consisted of the biosafety auditors accompanied by the department, unit and laboratory managers. The audit identified minor discrepancies in visited laboratory rooms and storage areas, which were communicated to the persons in charge. Overall, the audit team concluded that there is good commitment for continuous improvement of the biorisk management within the units using the BSL-3 facility at PHAS.

**Role of the fellow:** The fellow familiarised himself with the relevant documentation prior to the audit, learnt how the biosafety audits are conducted at the Agency and read the final audit report. Due to confidentiality reasons, the final report could not be shared externally. An executive summary was written instead and submitted to the ECDC EVA platform.

### *Training modules related to the assignment/projects*

**Biorisk and Quality Management Module:** The module provided theoretical knowledge on concepts related to biorisk and quality management, and their importance in a public health laboratory setting. The learning outcome was vital for conducting the audit-related activities by the fellow.

### *Educational outcome*

The quality management activities helped the fellow to better understand the rationale for quality assurance in a public health microbiology laboratory. The fellow can now take part and evaluate results of internal and external quality audits, assess laboratory methods in order to improve surveillance and diagnostic procedures, ensure that the day-to-day laboratory consistency and appropriate biorisk and biosafety procedures and recommendations are being followed.

## 6. Teaching and pedagogy

### 6.1. Introduction to surveillance and outbreak investigation for master's students at Södertörn University

As part of a long collaboration between the PHAS and the Södertörn University, the EPIET and EUPHEM fellows from cohort 2020 at PHAS delivered lectures to first-year master's degree students in an infectious disease epidemiology course on surveillance and outbreak investigation. The fellows also facilitated an outbreak investigation case study. Hubert gave presentations on the role of PHAS and microbiology as a support tool to surveillance and outbreak investigations. He later facilitated a case study with a group of students. In the final evaluation, students found both the lectures and the case study very interesting and gave positive feedback overall.

In 2022, the fellow gave the same lectures to a new group of students, observed the case study facilitated by an EPIET fellow, and provided technical feedback on matters related to microbiology.

## 6.2. Facilitation of a case study for veterinary students at the Swedish University of Agricultural Sciences in Uppsala

A case study of 'An epidemic of trichinosis in France' was facilitated twice for fifth-year veterinary medicine students at the Swedish University of Agricultural Sciences in Uppsala. The fellow led the case study, explained more complex tasks such as different types of epidemiological investigations and odds ratio calculations, and provided a final summary of the exercise.

## 6.3. Introduction to molecular biology – a lecture for EUPHEM and EPIET fellows

In 2022, a series of lectures designed to introduce microbiology subjects pertinent to laboratory investigations was delivered over the course of a few weeks to fellows from cohorts 2020 and 2021 as well as other public health professionals. Hubert prepared and delivered a lecture on the introduction to microbiology, which covered subjects such as DNA replication, transcription and translation as well as amino acids and protein structures and received very positive reviews. The fellow also provided feedback on presentations prepared by other fellows.

### *Training modules related to the assignment/projects*

**EPIET/EUPHEM Introductory Course:** The fellows were introduced to the concept and principles of adult education, how to develop a course plan and select appropriate facilitation methods based on goals, objectives and audience.

### *Educational outcome*

These activities gave the fellow a valuable opportunity to develop his teaching skills. He learnt how to identify training needs and adapt them according to the target audience, how to formulate objectives and plan, organise and conduct teaching and training events. The fellow practised conducting various teaching methods such as facilitating case studies and giving lectures to students and peers. He also familiarised himself and used tools to enhance active participation and evaluate teaching.

## 7. Public health microbiology management

Public health microbiology management was at the heart of all the projects and activities conducted by the fellow. Each project was initiated with a project proposal, where the public health rationale and benefit as well as parties and stakeholders integral to the project were described in detail. The fellow prepared detailed plans of each project and activity, either in collaboration with project supervisors or independently. In order to progress work, the fellow coordinated his actions with other laboratory staff, laboratory services and also members of other units at PHAS, particularly epidemiologists and statisticians. He organised regular meetings to report progress, discuss limitations and arising problems, and plan future work. The project-based nature of the fellow's work demanded a high degree of flexibility, and gave the fellow an opportunity to train his time management and organisational skills. It also taught him how to prioritise, manage workload effectively and delegate responsibilities to team members, and how to produce high-quality deliverables and collaborate with disciplines across PHAS.

### *Training modules related to the assignment/projects*

**Management, Leadership and Communication in Public Health:** In this module, fellows were familiarised with different management styles, qualities and skills of effective public health leaders, as well as different ways of communicating public health-related information to peers, stakeholders, higher authorities and the general public, especially in emergency situations.

### *Educational outcome*

Carrying out the projects and activities gave the fellow a valuable experience in team, project and time management. The fellow learnt how to plan, schedule and organise projects and ensure timely deliverables. He also gained experience in working and communicating with different public health actors and the scientific community.

## 8. Communication

### Publications related to the EUPHEM fellowship

1. **Hubert Buczkowski**, Henrik Källberg, Hélène Englund, Maximilian Riess and Jonas Klingström. "SARS-CoV-2 vaccine breakthrough infections in Sweden in 2021: a retrospective case-case study". – manuscript submitted to *Scientific Reports*.

### Reports

1. Evaluation of the exceedance of acute hepatitis cases of unknown aetiology in children in Sweden since January 2022.
2. Development of a novel typing method of rotaviruses circulating in Sweden.
3. Investigation of *Clostridioides difficile* incidence rates in Sweden between years 2017 and 2019.



4. Development and implementation of a high-resolution typing method for *Cryptosporidium parvum*.

## Conference presentations

1. Development of a novel typing method of rotaviruses circulating in Sweden; oral presentation, ESCAIDE 2021.

## Other presentations

1. Microbiology in Surveillance and Outbreak investigations; oral presentation at Södertörn University in Stockholm; 18/01/2021 and 25/01/2022.
2. Development of a novel typing method of rotaviruses circulating in Sweden; oral presentation, Nordic Mini Project Review Module 2021, 24/03/2021.
3. Development of a novel typing method of rotaviruses circulating in Sweden; three internal presentations at PHAS in 2021.
4. Midterm Review presentation; 30/06/2021.
5. Analysis of COVID-19 vaccine breakthrough infections in Sweden in 2021; Nordic Mini Project Review Module 2021, 08/03/2022.
6. Molecular Biology; oral presentation for EPIET fellows from cohorts 2020 and 2021, 09/06/2022.
7. Training Site Visit presentation; 16/08/2022.

## Other training modules

1. Nordic Mini Project Review Module, 23–24/03/2021, virtual
2. Nordic Mini Project Review Module, 07–08/03/2022, Oslo, Norway

## 9. Other activities

1. Attending the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), Stockholm, Sweden, 24–27/11/2020

## 10. EPIET/EUPHEM modules attended

1. Introductory Course part 1, 28/09 – 16/10/2020, virtual
2. Introductory Course part 2, Inject Days - Operational Research, 09–10/11/2020, virtual
3. Outbreak Investigation, 07–11/12/2020, virtual
4. Multivariable Analysis, 15–19/02/2021, virtual
5. Introductory Course part 3, 26/04 – 07/05/2021, except 03/05/2021, virtual
6. Rapid Assessment and Survey Methods, 05–06/05/2021, virtual
7. Project Review 2021, 23–27/08/2021, virtual
8. Biorisk and Quality Management, 17–18/01/2022, virtual
9. Vaccinology, 14–18/02/2022, virtual
10. Time Series Analysis, 04–08/04/2022, Rome, Italy
11. Management, Leadership and Communication in Public Health, 13–17/06/2022, Stockholm, Sweden
12. Project Review 2022, 29/08 – 02/09/2022, Lisbon, Portugal

## 10. Other training

1. Swedish language course A1 part 1, Folkuniversitetet, 26/10 – 20/11/2020, Stockholm, Sweden
2. Swedish language course A1 part 2, Folkuniversitetet, 01 – 31/03/2021, Stockholm, Sweden

3. Swedish language course A2, online course, dalarna.pl, 15/09/2021 – up to date
4. Biorisk management in the laboratory - Hantering av biorisker vid laboratorier, 01/02/2021, Stockholm, Sweden
5. GOARN Personal Well-being for Deployment, online course, 30/04/2021
6. GOARN The Public Health Emergency and Humanitarian Landscape & Architecture, online course, 30/04/2021
7. GOARN Working in an International Multidisciplinary Outbreak Response Team, online course, 30/04/2021
8. United Nations 'BSAFE', online course, 03/05/2021
9. CPR training for BSL-3 and BSL-4 staff, 19/10/2021, Stockholm, Sweden
10. BSL-3 training at PHAS, 22/10/2021, Stockholm, Sweden

## Discussion

### Coordinator's conclusions

One of the main goals of the EUPHEM programme is to expose fellows to diverse and multidisciplinary public health experiences and activities, thus enabling them to work across different disciplines. This report summarises all the activities and projects conducted by Hubert Buczkowski during his two-year EUPHEM fellowship (cohort 2020) as an EU-track fellow at the Public Health Agency of Sweden in Stockholm.

The fellowship training in Public Health Microbiology intends to provide scientists who already have a good background in microbiology, with the skills to become public health microbiologists. The programme is based on the premise of 'learning by doing', which allows EUPHEM fellows to gain experience in multidisciplinary public health settings. Hubert was the ideal candidate to undertake the EUPHEM fellowship thanks to his experience of working in multidisciplinary and multicultural environments, and his long experience as a virologist as well as his desire to learn the public health aspects of infection detection and control.

Hubert undertook hepatitis and *Salmonella* outbreak investigations, and the SARS-CoV-2 pandemic provided ample opportunities not only to learn about outbreak management, but also to understand the epidemiological implications of break-through infections. Hubert's work also made a very important contribution to improving the laboratory surveillance of rotavirus infections in Sweden. Data analyses on the impact of antibiotic treatment to *C. difficile* risk is an important baseline for future work at PHAS. And thus, despite the challenges presented by the COVID-19 pandemic, Hubert contributed to the capacity development of the site while acquiring valuable experience in the area of public health microbiology.

It has been a pleasure to work with him in these two years. He came to the fellowship with a solid scientific background and a clear view of his commitment to working in public health, and he contributed greatly to support the COVID-19 pandemic-control efforts at his site. His work in the fellowship has provided him with valuable leadership skills and this report summarises the multidisciplinary aspects of his work during his time at PHAS.

### Supervisor's conclusions

The projects were designed to meet the curriculum of the fellowship, the needs of PHAS, and to challenge Hubert in new areas.

Hubert has provided support in outbreak investigations (1.1) by conducting structured literature search on COVID-19, to inform evidence-based activities. He was part of the outbreak team on hepatitis of unknown aetiology in children and presented regular updates from other countries. He also conducted an analysis of exceedance for Sweden, according to ECDC protocols, which was instrumental in the outbreak investigation.

In the context of surveillance (1.2) Hubert has conducted important work in the development of an improved method for rotavirus typing. Such a method is necessary as Sweden implements a surveillance programme for rotaviruses. He has also conducted a study of the causality of different incidences of *Clostridioides difficile* in different parts of Sweden, corroborating knowledge on the role of cephalosporins as a risk factor for CDI and raising interesting

questions on the impact of different diagnostic methods on surveillance data. The investigation can potentially direct measures to decrease the number of infections and lead to better understanding of regional data.

In applied public health research (2), Hubert has conducted a study on vaccine breakthrough infections of Alpha and Delta variants of SARS-CoV-2. Apart from showing a marked difference between the variants, the project has also shed light on the difficulties and important methodological concerns in the assessment of breakthrough infections with different variants of SARS-CoV-2.

The project in applied public health microbiology and laboratory investigations (3) aimed to develop a better method for the typing of *Cryptosporidium parvum*, important for surveillance. Although the project failed to deliver a method, the laboratory work and trouble-shooting was of great value.

After the training in the BSL-3 laboratory (4), Hubert assisted in isolating Omicron variants of SARS-CoV-2, which was of importance at the time. Within the area of quality management (5), Hubert initiated an audit of the HBV laboratory that ensures the quality at PHAS.

I have highly appreciated working with Hubert during his fellowship. As he has broadened his solid knowledge in laboratory science and biorisk management with epidemiological and statistical skills and understanding, he is now an asset to public health microbiology. As intended by the fellowship programme, he is now able to provide the link between microbiology and epidemiology, that is vital to the global development of public health microbiology.

## Personal conclusions of fellow

The two years of the fellowship were without a doubt one of the most exciting in my professional career. I started my adventure with science by researching animal pathogens, which often cause disease in humans. With time, this initial interest in the impact of zoonotic agents on humans turned into a desire to pursue a career in public health. The EUPHEM fellowship seemed like a perfect way of fulfilling this ambition, and I believe that it has given my career a fresh impetus and direction.

The fellowship coincided with COVID-19, which naturally presented some challenges, but also provided me with a unique experience of working on important public health issues during what might very well be *the* public health emergency of our lifetime. I particularly appreciate the 'learning-by-doing' aspect of the fellowship, and I was extremely lucky to do my fellowship at the Public Health Agency of Sweden, surrounded by scientists with a wealth of expertise in microbiology and epidemiology. I have completed the fellowship enriched with new skills and knowledge, and with a valuable network of like-minded public health scientists from all corners of the world.

## Acknowledgements of fellow

I would like to thank my first EUPHEM supervisor, Katherina Zakikhany-Gilg, for her excellent guidance and mentorship during the first year of the fellowship and helping me to navigate my new life in Sweden. I would also like to thank my next supervisor, Maximilian Riess, for taking over Katherina's responsibilities so smoothly. Finally, I would like to thank Emmi Andersson for stepping in and accepting the role of my supervisor, and helping to steady the fellowship boat during quite a chaotic time. Lastly, I would like to thank the EPIET supervisor, Moa Rehn, for her much-appreciated guidance in all epidemiological matters.

I would also like to thank Mia Brytting for welcoming me to the department and all her hard work to turn Folkhälsomyndigheten into such a strong pillar in the network of EUPHEM sites. Although you are no longer with us, your legacy will be remembered for many years to come.

I would like to thank everyone at the PHAS who was involved in my projects: project supervisors, laboratory staff, statisticians, epidemiologists, and current and past fellows, for providing great projects, your guidance, feedback, support and all the fika breaks.

My deepest gratitude also goes to Aura Georgina Aguirre-Beltran for being an excellent fellowship coordinator. Your support and encouragement were especially crucial during the changeover in supervision.

Thank you to all the people from ECDC: Adam Roth and Aftab Jasir, all the coordinators and facilitators, and the fellowship office. And a huge thank you to all the fellows from cohort 2020 – it was a challenging time for all of us, but we also had some fun along the way.

Last but not least, 'dziękuję' to my family – without you, none of this would have been possible!