

Summary of work activities

Melissa Brady

The ECDC Fellowship Programme

Field Epidemiology path (EPIET), 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 Melissa Brady, cohort 2020 of the Intervention Epidemiology path (EPIET) at the Health Protection Surveillance Centre (HPSC), Dublin, Ireland.

Pre-fellowship short biography

Melissa Brady obtained a BSc in Microbiology at University College Dublin and an MSc in Healthcare Infection Management at Trinity College, The University of Dublin, Ireland. She worked for 10 years in laboratory settings, first as a biomedical scientist in clinical research and then as a laboratory manager in environmental monitoring. These experiences led Melissa to become interested in epidemiology and she subsequently worked in infectious disease surveillance at a tertiary acute care hospital. In 2017 she joined the Health Protection Surveillance Centre in Ireland where she mainly worked on the epidemiology of HIV and sexually transmitted infections, and was involved in day-to-day public health responses for the first six months of the COVID-19 pandemic prior to commencing the EPIET fellowship.

The views expressed in this publication do not necessarily reflect the views of the European Centre for Disease Prevention and Control (ECDC).

Stockholm, November 2022

© European Centre for Disease Prevention and Control, 2022. Reproduction is authorised, provided the source is acknowledged.

Methods

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

Projects included epidemiological contributions to public health event detection and investigation (surveillance and outbreaks); applied epidemiology field research; teaching epidemiology; summarising and communicating scientific evidence and activities with a specific epidemiology 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 EPIET core competencies, as set out in the ECDC Fellowship Manual¹.

1. Epidemiological investigations

Outbreak investigations

1.1 COVID-19 outbreaks among third-level students: a retrospective analysis of the second wave of the COVID-19 pandemic in Ireland, 2020

Supervisor: Suzanne Cotter (Specialist in Public Health Medicine), HPSC, Dublin, Ireland

A national Outbreak Control Team (OCT) was convened in November 2021 to investigate a recent increase in the number of COVID-19 outbreaks among third-level students in Ireland, and to try to identify student subgroups at higher risk of infection. COVID-19 outbreaks notified on the national Computerised Infectious Disease Reporting (CIDR) system of Ireland, between 1 September and 29 November 2021 were analysed. Descriptive analysis included calculation of incidence rates and their 95% confidence intervals (CI), using denominator data from the Higher Education Authority (HEA). Incidence rates by sex, age and region of Higher Education Institute (HEI) enrollment were compared using the Chi-squared test statistic. Eighty-four third-level student outbreaks linked to 887 cases were notified. The rate per 1 000 HEI enrollments was significantly higher in some regions (Midlands: 12.1; 95%CI=9.5–16.0 versus East: 0.7; 95%CI=0.5–0.9), $p<0.001$, and among students aged 18 years (11.0; 95%CI=9.5–13) or 19 years (7.3; 95%CI=6.4–8.3) when compared to students aged 20 years (5.1; 95%CI=4.4–5.9) or older, $p<0.001$. There was no difference by sex. Out of 887 outbreak cases, 504 (57%) were in student accommodation settings and 483 (54%) were related to social events. Cases not related to social settings included housemates ($n=24$), students attending in-person classes ($n=15$) and colleagues in a campus workplace ($n=5$). The nature of the interaction was not reported for 360 (41%) cases; 86 of which were linked to small outbreaks (≤ 3 students) with no specific social event reported. Regional differences did not reflect community incidence and may have been influenced by earlier curtailment of campus activity, highlighting potential benefits of early adoption of public health measures. Future interventions should incorporate tailored risk communication for students by age and HEI region, and ensure that students have sufficient supports for safe remote learning.

Role of fellow: Melissa was a co-investigator of the outbreak and lead on the epidemiological analysis, which involved defining an outbreak case, validating and analysing the data, writing an epidemiological situation report and presenting the findings to the national OCT. She also wrote the outbreak report, presented the findings at the ECDC EPIET/EUPHEM COVID-19 Think Tank, and is first author on a manuscript which is being drafted for submission to a peer-reviewed journal [5.5].

¹ 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>

1.2 Investigation of an acute infectious gastroenteritis (AIG) outbreak in a residential care facility in North-East Ireland, November 2021

Supervisors: Suzanne Cotter (Specialist in Public Health Medicine) and Lisa Domegan (Principal Epidemiologist), HPSC, Dublin, Ireland

Controlling outbreaks in complex settings is challenging. We aimed to describe an acute infectious gastroenteritis (AIG) outbreak in a 76-bed residential care facility (RCF) with four discrete units in North-East Ireland, and to investigate possible risk factors for the outbreak. An infection prevention and control (IPC) audit was conducted onsite by the Regional Public Health team. Data were collected using standardised templates and a semi-structured questionnaire. A case was defined as a resident or staff member with gastrointestinal symptoms (nausea, diarrhoea or vomiting) between 23 November and 24 December 2021. Descriptive analysis included calculation of attack rates (AR), relative risks (RR) and 95% confidence intervals (CI). The AR was 49% (37/76) among residents and 18% (19/108) among staff. All units were affected. The RR was higher in a dementia care unit compared to other (non-specialist) units, for residents (RR=2.0; 95%CI=1.3–2.9) and staff (RR=3.5; 95%CI=1.6–7.6). Residents in two units tested positive for norovirus. Person-to-person transmission was suspected. Delayed recognition in the facility likely contributed to ongoing transmission; the first (resident) case had gastrointestinal symptoms mistaken as atypical COVID-19 and stopped isolating after 24 hours, upon testing negative for SARS-CoV-2. Other resident cases were isolated appropriately, for 72 hours after last symptoms. The IPC audit identified lapses in outbreak control measures including cleaning regimens. Early recognition is essential for AIG outbreak control; national guidance for RCFs on the prevention and management of outbreaks should be updated to reflect urgent checking for other pathogens if SARS-CoV-2/other test results are negative/inconclusive. Community IPC supports can help RCFs to manage outbreaks. Risk of AIG was the highest in a specialist dementia care unit; collection of routine data on dependency, dementia diagnosis and wandering behaviour could help to assess risks and develop preventative measures against future outbreaks.

Role of fellow: Melissa was a co-investigator of the outbreak and lead on the epidemiological analysis, which involved defining an outbreak case, collecting and validating data, compiling the questionnaire and conducting a semi-structured interview, as well as analysing the data collected. She also wrote the outbreak report, presented the findings to co-investigators, and submitted her work to the Irish Faculty of Public Health Medicine Summer Scientific (RCPI) conference where it was presented as a poster.

Training modules related to assignment/projects

EPIET/EUPHEM Introductory Course: This course introduced Melissa to the principal concepts of outbreak investigation including the 10 steps of an outbreak investigation, study design and analysis. It also covered data collection instruments including open-ended questionnaires and the concepts of qualitative interviewing which Melissa used during the norovirus outbreak investigation.

Outbreak Investigation Module: This module built on Melissa's knowledge of outbreak investigation, and included in-depth explanations of the 10 steps, which were followed during both outbreak investigations. A core component was the teaching on different statistical tests and when to use them, with useful examples of test functions in R statistical software.

Educational outcome

The training modules and the epidemiological lead role in investigating two outbreaks provided Melissa with excellent learning experiences and enabled her to work through each step of an outbreak investigation independently. Melissa also gained valuable experience working on multidisciplinary Outbreak Control Teams, collaborating with Regional Public Health departments and communicating findings. The training modules and outbreak studies also facilitated the development of her data analysis skills.

2. Surveillance

2.1 A pilot study to establish severe acute respiratory infection (SARI) surveillance in Ireland, 2021

Supervisors: Lisa Domegan (Principal Epidemiologist), Naomi Petty-Saphon (Specialist in Public Health Medicine), and Joan O'Donnell (Specialist in Public Health Medicine), HPSC, Dublin, Ireland

In 2020 due to the COVID-19 pandemic, the European Centre for Disease Prevention and Control (ECDC) accelerated the development of a European-level severe acute respiratory infection (SARI) surveillance system. We aimed to establish SARI surveillance in one hospital site in Ireland as part of a wider European Union (EU) network called E-SARI-Net. Routine Emergency Department records were utilised to identify cases in one adult acute hospital.

The case definition was partially adapted from ECDC's clinical case definition for a possible COVID-19 case who is hospitalised. An online questionnaire was developed to collect clinical data. SARS-CoV-2, influenza and respiratory syncytial virus (RSV) molecular investigations were performed on all the cases. Whole genome sequencing (WGS) was conducted for SARS-CoV-2 RNA-positive cases. Viral characterisation and sequencing were conducted for influenza RNA-positive cases. Descriptive analysis was conducted for SARI cases hospitalised between July 2021 and April 2022. Overall, 437 cases were identified; ranging from two (0.7/100 000 hospital catchment population) to 28 (9.2/100 000 hospital catchment population) cases per week. Four hundred and thirty-one cases (99%) were tested for SARS-CoV-2 RNA and 349 (80%) for influenza/RSV RNA. WGS identified Delta and Omicron SARS-CoV-2 variant dominant periods. Challenges included the resource-intensive nature of manual clinical data collection, specimen management, and laboratory supply shortages for influenza/RSV testing. SARI surveillance was successfully established in Ireland as part of a wider EU network. Expansion of surveillance to include additional sentinel sites is planned following formal evaluation of the existing system. SARI surveillance requires multidisciplinary collaboration, automated data collection where possible, and dedicated personnel resources, including for specimen management.

Role of fellow: Melissa developed the surveillance protocol, developed the data dictionary, wrote the data sharing agreement, assisted with the development of the clinical questionnaire, developed the SARI database, developed rapid data transformation processes, contributed to the validation, analysis and reporting of SARI data, assisted with the development of a weekly SARI epidemiology report, and trained surveillance personnel. She also presented on SARI denominator data at a meeting of the E-SARI-Net, submitted an abstract to the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE) 2022 conference and was the first author of a manuscript which has been submitted to a peer-reviewed journal for consideration [5.4].

2.2 Monitoring community-based HIV testing in Ireland, 2019

Supervisor: Derval Igoe (Specialist in Public Health Medicine), HPSC, Dublin, Ireland

Since 2018, community-based organisations (CBOs) report anonymised voluntary community-based HIV testing (VCBT) data to the Health Protection Surveillance Centre (HPSC) in Ireland. VCBT services focus on key populations at higher risk of acquiring HIV, to support early diagnosis and treatment. We aimed to improve our understanding of HIV key populations in Ireland in order to provide public health guidance and recommendations for VCBT strategies. We carried out descriptive analysis of 2019 VCBT data, focusing on previously undiagnosed people for the first time. Variables analysed were: age, sex, country of birth, first time testing, prior HIV diagnosis, and key population group. CBOs reported 5 607 HIV tests in 2019; 92 people (1.6%) had a reactive test result, similar to the proportion in 2018 (1.7%). By setting, the test reactive rate (seropositivity rate) was the highest in asylum/direct provision settings (0.8%). Among previously undiagnosed people, the test reactive rate was 0.5% (n=24), and was higher in females (0.9%) than in males (0.4%) ($p < 0.001$). Of the 24 new diagnoses, 11 were female and were born in sub-Saharan African (SSA) countries of high HIV prevalence (median age 31 years; range 24–47), and 13 were male and were born in a range of regions including Ireland, Latin America, Europe and East Asia and Pacific. Ten were men who have sex with men (MSM) among whom the median age was 26 years (age range: 19–34 years); four were first-time testers (age range: 19–26 years) and six were repeat testers (age range: 22–34 years). Considering the different demographic profiles by sex among people with undiagnosed HIV in Ireland, a gender-orientated approach to VCBT strategies could be beneficial, including for females. Continued monitoring can help inform future strategies.

Role of fellow: Melissa conducted the data validation and analysis, wrote the surveillance report which was published on the HPSC website, and communicated findings to stakeholders. She also presented the findings at the HPSC Training and Research Forum, and submitted her work to the ESCAIDE 2021 conference where she presented it orally [5.7].

2.3 HIV drug resistance in Ireland, 2018

Supervisors: Derval Igoe and Naomi Petty-Saphon (Specialists in Public Health Medicine), HPSC, Dublin, Ireland

The World Health Organization (WHO) recommends population surveillance of HIV transmitted drug resistance (TDR) to preserve treatment options. HIV diagnoses are notified in Ireland using the national Computerised Infectious Disease Reporting (CIDR) system. The National Virus Reference Laboratory (NVRL) at University College Dublin conducts genotypic antiretroviral resistance testing (GART) but does not report this data to CIDR. In 2019, the Health Protection Surveillance Centre (HPSC) in partnership with NVRL commenced national surveillance of TDR prevalence, starting with 2017 data, requiring linkage of CIDR and GART data. We conducted data linkage and descriptive analysis of the 2018 data. Drug resistance was categorised according to the Stanford 2009 surveillance drug resistance mutation (SDRM) list of nucleoside-analogue reverse transcriptase inhibitors (NRTIs), Non-nucleoside analogue reverse transcriptase inhibitors (NNRTIs) and protease inhibitors (PIs), and the 2019 integrase strand transfer inhibitors (INSTI) surveillance list. Descriptive analysis included calculation of TDR prevalence and 95% confidence intervals (CI). Twenty-one (11%; 95%CI=7.2–16) antiretroviral treatment (ART)-naïve individuals tested for GART in 2018 had at least one SDRM, 18 had resistance to one drug class and three had resistance to two drug classes.

Resistance to NNRTIs (8%; 95%CI=5.1–13) was significantly higher than PIs (1%; 95%CI=0.3–3.7) and INSTIs (0.5%; 95%CI=0.1–2.9), but was not significantly different from NRTIs (3%; 95%CI=1.1–5.9). TDR prevalence was 14% among people born in sub-Saharan African countries, 14% among people born in Latin America, and 9% among people born in Ireland. By probable route of transmission, TDR prevalence was 12% among heterosexual males, and 11% among men who have sex with men (MSM). Early initiation of effective ART is critical for clinical benefits to individuals and to prevent onward transmission of TDR. Continuation of TDR surveillance may help guide development of national treatment guidelines or preferred medicine strategies for the management of HIV.

Role of fellow: Melissa conducted the data linkage, validation and analysis, wrote the surveillance report which was published on the HPSC website, and communicated findings to stakeholders [5.8].

2.4 COVID-19 pandemic in Ireland, 2021

Supervisors: Lois O'Connor and Joan O'Donnell (Specialists in Public Health Medicine), HPSC, Dublin, Ireland

Melissa was a member of the HPSC COVID-19 Epidemiology Team and was involved in work related to the pandemic response in Ireland including validating and analysing daily case numbers and deaths, responding to data requests and queries, and producing the daily COVID-19 epidemiological report and circulating it to stakeholders. Melissa also participated as an observer in the weekly meetings of the national COVID-19 Pandemic Incident Control Team (PICT).

Training modules related to assignment/projects

EPIET/EUPHEM Introductory Course: This course built on Melissa's knowledge of setting up a new surveillance system, evaluating a surveillance system, and analysing surveillance data.

Vaccinology module: The module included an overview of COVID-19 and vaccine effectiveness, was helpful in understanding the format of vaccine data that needed to be included in the SARI surveillance system where data uses included vaccine effectiveness studies.

Outbreak module: This module and other modules provided training in the use of R statistical software which was helpful in developing rapid data transformation tools to improve surveillance efficiencies.

Educational outcome

The surveillance projects added to Melissa's experience in setting up new surveillance systems, writing surveillance reports and communicating findings in writing and verbally. They also provided her with an opportunity to use new programming skills to increase efficiencies in data transformation and analysis. Furthermore, Melissa had the opportunity to develop working relationships with a range of stakeholders, in different settings including healthcare, non-governmental organisations, and members of the European SARI Network.

3. Applied public health research

3.1 SARS-CoV-2 antibody testing in healthcare workers: a comparison of the clinical performance and retained sensitivity of three commercially available antibody assays, Ireland, 2020

Supervisor: Lisa Domegan (Principal Epidemiologist), HPSC, Dublin, Ireland

SARS-CoV-2 immunoassays can be used in seroprevalence studies to guide public health decision-making. The objective of this study was to compare results of three assays used in a healthcare worker (HCW) seroprevalence study in order to learn more about retained sensitivity over time on different assays. Seroprevalence testing was carried out in October 2020 on 5 788 unvaccinated HCWs in two Irish hospitals. The study population were those HCWs who participated in seroprevalence testing and were previously SARS-CoV-2 positive by PCR (n=367, 6.3%). Time since PCR positivity ranged from 2–33 weeks. We analysed positivity on three SARS-CoV-2 immunoassays; one anti-nucleocapsid IgG immunoassay (Abbott) and two total antibody immunoassays (Roche anti-nucleocapsid; Wantai anti-spike). All 367 were tested on Abbott and Roche, and all those who were positive or inconclusive on Abbott (71%) were tested on Wantai. Multivariable logistic regression was carried out on Abbott results, controlling for age, sex, ethnicity/background, type of patient contact, symptom severity, and time since PCR diagnosis. Overall, 95% (95%CI=92–96) tested positive on Roche and 41% (95%CI=35–46) tested positive on Abbott. All of those tested on Wantai had a positive result. Decline in Abbott positivity began at 21 weeks (150 days) after confirmed infection. Factors associated with Abbott seronegativity included sex (male OR=0.30; 95%CI=0.15–0.60), symptom severity (OR=0.19 severe symptoms; 95%CI=0.05–0.61), ethnicity (OR=0.28 Asian ethnicity; 95%CI=0.12–0.60) and time since PCR diagnosis (OR=2.06 for infection six months previously; 95%CI=1.01–4.30), (p<0.05). Longevity of SARS-CoV-2 immunoassay sensitivity differs by assay type. Total antibody assay is more appropriate for longer term SARS-CoV-2 seroprevalence studies.

Anti-spike outperformed the anti-nucleocapsid assay, but further unbiased study is needed. Further research is needed to guide most appropriate use/choice of immunoassays in various settings/scenarios, particularly for vaccinated populations.

Role of fellow: Melissa wrote the analysis plan, conducted the data analysis, and co-authored the technical report which was published on the HPSC website. Furthermore, she was joint first author on a manuscript which was published in a peer-reviewed journal. Melissa also submitted her work to the ESCAIDE 2021 conference where it was presented as a poster [5.1].

3.2 Prevalence of COVID-19 antibodies in Irish healthcare workers (PRECISE Study (Part 2))

Supervisor: Lisa Domegan (Principal Epidemiologist), HPSC, Dublin, Ireland

In October 2020, SARS-CoV-2 seroprevalence among hospital healthcare workers (HCW) of two Irish hospitals was 15% and 4.1% respectively. We compared seroprevalence in the same HCW population six months later, to assess changes in risk factors for seropositivity with progression of the pandemic and serological response to vaccination. All staff of both hospitals (N=9 038) were invited to participate in an online questionnaire and SARS-CoV-2 antibody testing in April 2021. We analysed seropositivity on anti-nucleocapsid and anti-spike assays, and we carried out multivariable regression analysis. In total, 5 085 HCWs participated. Seroprevalence increased to 21% and 13% respectively; 26% of infections were previously undiagnosed. Black ethnicity, lower level of education, living with other HCW, and direct patient contact were significantly associated with seropositivity ($p < .001$). Infection occurred in 23/4111 (0.6%) fully vaccinated participants; all had anti-S antibodies. Out of 360 HCWs who participated in the first phase of the PRECISE study and were anti-nucleocapsid positive at that time, 325 (90%) still had detectable antibodies six months later. Genomic sequencing is needed to apportion risk to the workplace versus the household/community. Concerted efforts are needed to mitigate risk factors due to ethnicity and lower level of education. Undiagnosed infections and infections that occur in fully vaccinated individuals call for ongoing infection prevention and control measures and testing of HCWs in the setting of close contact. Further study is needed to understand reasons for infection among fully vaccinated HCWs. Future study of a longitudinal nature is needed to fully understand retained antibody over time.

Role of fellow: Melissa conducted the data analysis and co-authored the technical report which was published on the HPSC website. She also co-authored a letter to the editor which was published in a peer-reviewed journal, and a manuscript which was also published in a peer-reviewed journal. Lastly, Melissa prepared a reflection document describing challenges in data linkage and analysis in order to assist with the three planned future phases of the PRECISE study [5.2, 5.3, 5.9].

3.3 Investigation of the genomic and epidemiological factors associated with haemolytic uraemic syndrome among confirmed cases of verotoxigenic *E. coli* infection in Ireland, 2017–2020: Joint EPIET and EUPHEM project

Supervisors: Patricia Garvey (Principal Epidemiologist) and Lois O'Connor (Specialist in Public Health Medicine), HPSC, Dublin, Ireland

Verotoxigenic *E. coli* (VTEC) infection can cause potentially fatal haemolytic uraemic syndrome (HUS). Risk factors are previously described but not fully investigated. We investigated the epidemiological and genomic factors associated with HUS among cases of VTEC infection. We selected 108 cases (HUS VTEC) and 416 unmatched controls (non-HUS VTEC) for a case-control study among VTEC notifications in Ireland (2017–2020). A gene presence/absence pan genome-wide association study (GWAS) was conducted to identify novel genes associated with HUS. Routinely collected VTEC epidemiological data were combined with GWAS results. Logistic regression was used to estimate adjusted odds ratios (aOR). GWAS analysis indicated a positive association between HUS and the presence of 26 genes ($OR > 1$; Benjamini-Hochberg and pairwise comparison p -values < 0.05) involved in processes including toxin production, sugar metabolism, stress response, and phage life cycle. Seven genes had unknown functions. In multivariable analyses, younger patients (0–9 years) had a threefold odd of HUS, compared to patients aged 10 and older (aOR=3.3; 95%CI=1.7–6.4). The odds of HUS were higher among patients with *vtx2a* alone (aOR=154.3; 95%CI=27.1–1567.3), both *vtx1a*/*vtx2a* (aOR=36.7; 95%CI=7.3–358.4) or both *vtx1a*/*vtx2c* (aOR=31.3; 95%CI=2.9–447.4), compared to patients with *vtx1a* alone. Odds were higher among patients with both *ygiW*/*mokC* homologs (aOR=5.4; 95%CI=1.8–18.6) compared to those with neither, and among patients with both *pfkA*/*fieF* genes (aOR=1.8; 95%CI=1.0–3.3) compared to those with neither. Our findings reaffirm known risk factors including young age and presence of specific *vtx* genes/gene combinations, and additionally suggest that *ygiW*/*mokC* homologs and *pfkA*/*fieF* genes are associated with developing HUS. Further investigation could improve early diagnosis, surveillance and public health management of VTEC infection.

Role of fellow: Melissa was a principal investigator on this study jointly with the EUPHEM fellow, Diana Espadinha Costa. Melissa and Diana both formulated the study question, wrote the study protocol and reviewed literature. Melissa conducted data linkage, determined the sample size, and produced the sampling frame for cases and controls. Melissa and Diana both conducted the analysis; Diana used whole genome sequencing (WGS) data to conduct a GWAS and Melissa conducted multivariable regression analysis of molecular and epidemiological data. Melissa, together with the EUPHEM fellow, submitted an abstract to the ESCAIDE 2022 conference and is joint-first author on a manuscript which is being drafted for submission to a peer-reviewed journal [5.6].

Training modules related to assignment/projects

EPIET/EUPHEM Introductory Course: This course included an overview of cross-sectional studies, case-control studies and other study designs, matching, stratification and confounding in multivariable regression analyses. It also provided an introduction to measures of association including odds ratios and risk ratios. The operational research component of the module outlined how to write a study protocol and calculate sample size. All of this learning was applied to the research studies described above.

Multivariable Analysis Module: This module strengthened Melissa's analytical and statistical skills needed for multivariable regression analysis and her command of R software. It introduced different regression models which she applied in the research studies.

Educational outcome

Melissa gained experience in leading on research studies, and in developing protocols and analysis plans. The studies gave Melissa the opportunity to improve her skills in developing a sampling frame, conducting multivariable regression analysis, writing scientific reports and manuscripts, and presenting findings. It also gave her an opportunity to collaborate with colleagues in healthcare and laboratory environments, and to participate in a pan genome-wide association study for the first time.

4. Teaching and pedagogy

4.1 Case study: An outbreak of trichinosis in France

Melissa facilitated an online three-hour case study 'An outbreak of trichinosis in France' on two occasions (3 December 2020 and 25 November 2021). An existing case study was used. The students were undergraduate students of the School of Veterinary Medicine, University College Dublin. Melissa contributed to the development of an evaluation form, which was completed by students in 2020 and used to improve training in 2021. She produced a teaching reflection note for both sessions.

4.2 Training: Surveillance of HIV community testing

Melissa conducted training for members of the HPSC HIV/STI Team on surveillance of HIV community testing. She initiated a meeting to establish training needs, developed new training materials (presentations and exercises), and delivered training over three two-hour periods on 1 June 2021, 13 June 2021 and 26 November 2021. She developed an evaluation form which was completed by participants at the end of the training, and she produced a teaching reflection note.

4.3 Lecture: Outbreak investigation

Melissa delivered a one-hour lecture on outbreak investigation. The lecture took place online on 23 February 2022. The students were MSc students in Healthcare Infection Management at Trinity College Dublin. She developed a presentation, adapting existing lecture materials to focus more on outbreaks in the healthcare environment, and she produced a teaching reflection note.

4.4 Training: Surveillance of severe acute respiratory infection

Melissa conducted training for a newly recruited HPSC Surveillance Scientist, on surveillance of severe acute respiratory infection (SARI). The online training took place over several one-hour sessions in May 2021 and January 2022, where she demonstrated how to develop and modify a SARI database, how to modify data transformation scripts, and how to develop a weekly surveillance report.

4.5 Training: HIV drug resistance surveillance

Melissa conducted training for the EUPHEM fellow Diana Espadinha Costa on HIV drug resistance surveillance. The training took place online, during two-hour sessions on 14 December 2021 and 9 February 2022, and during periodic progress meetings and updates. Melissa developed a presentation for the initial training session.

Training modules related to assignment/projects

EPIET/EUPHEM Introductory Course: This course covered the principles for assessing training needs, planning and organising training events, developing training materials, delivering and evaluating training. The practical exercise provided an opportunity to prepare a training plan, which was helpful for training activities described above.

Educational outcome

These teaching activities provided Melissa with a range of experiences in developing new training materials, delivering teaching on various topics aimed at a range of target audience groups. Teaching the same outbreak investigation case study on two occasions provided Melissa an opportunity to evaluate the training, identify areas for improvement and apply these to improve the next online training session. Teaching outbreak investigations in the form of a case study supported a deeper understanding of food-borne outbreaks. The lecture on outbreak investigation provided an opportunity to incorporate learning gained from prior healthcare infection management experience.

5. Communication

Publications related to the EPIET fellowship

- 5.1 **Brady M#** & Allen N#, Carrion Martin AI, Domegan L, Walsh C, Houlihan E, et al. SARS-CoV-2 Antibody Testing in Health Care Workers: A Comparison of the Clinical Performance of Three Commercially Available Antibody Assays. *Microbiology spectrum*. 2021;9(2):e0039121. **#Joint first authors**
- 5.2 Allen N, **Brady M**, Ni Riain U, Conlon N, Domegan L, Carrion Martin AI, et al. Prevalence of Antibodies to SARS-CoV-2 Following Natural Infection and Vaccination in Irish Hospital Healthcare Workers: Changing Epidemiology as the Pandemic Progresses. *Frontiers in Medicine*. 2022;8.
- 5.3 Allen N, **Brady M**, Carrion Martin AI, Domegan L, Walsh C, Doherty L, et al. Serological markers of SARS-CoV-2 infection; anti-nucleocapsid antibody positivity may not be the ideal marker of natural infection in vaccinated individuals. *Journal of Infection*. 2021; 83(4):E9-E10.

Manuscripts submitted to peer reviewed journals (pre-publication)

- 5.4 **Brady M**, Duffy R, Domegan L, Salmon A, Maharjan B, O'Broin C, et al. A pilot study to establish Severe Acute Respiratory Infection (SARI) surveillance in Ireland, 2021

Manuscripts being drafted for submission to peer-reviewed journals

- 5.5 **Brady M**, et al. COVID-19 outbreaks among third-level students: a retrospective analysis of the second wave of the COVID-19 pandemic in Ireland, 2020
- 5.6 **Brady M#** & Espadinha D#, et al. Putative genes associated with development of haemolytic uraemic syndrome among verotoxigenic *Escherichia coli* notifications in Ireland 2017–2020: a case control study. **#Joint first authors**

Reports

- 5.7 HSE Health Protection Surveillance Centre. Monitoring Community HIV Testing in Ireland, 2019. Dublin: HSE HPSC. Surveillance Report, 2020 https://www.hpsc.ie/a-z/hivandaids/hivtesting/Monitoring%20Community%20HIV%20Testing%20in%20Ireland%202019_Final.pdf
- 5.8 HSE-Health protection surveillance centre and UCD-National Virus Reference Laboratory. HIV drug resistance in Ireland, 2018. Dublin: HSE HPSC. Surveillance Report, 2021 https://www.hpsc.ie/a-z/hivandaids/hivdrugresistance/HIV%20Drug%20Resistance%20in%20Ireland%202018_v1.1.pdf
- 5.9 Prevalence of Antibodies to SARS-CoV-2 natural infection and post-vaccination in Irish Hospital Healthcare Workers (PRECISE 2). Final Study Report, 2021 <https://www.hpsc.ie/a-z/respiratory/coronavirus/novelcoronavirus/research/precise/PRECISE%20%20Report%20v2.0%20with%20addendum.pdf>
- 5.10 Prevalence of Antibodies to SARS-CoV-2 natural infection and post-vaccination in Irish Hospital Healthcare Workers (PRECISE 2). Study reflective note, 2021
- 5.11 COVID-19 outbreaks among third-level students in Ireland, 2020. Epidemiological Situation Report, 2020
- 5.12 COVID-19 outbreaks among third-level students in Ireland, 2020. Final Outbreak Report, 2021
- 5.13 A norovirus outbreak in a residential care facility in Ireland in 2021. Final Outbreak Report, 2022
- 5.14 An outbreak of trichinosis in France. Teaching reflective note, 2020 and 2021
- 5.15 Surveillance of HIV community testing. Teaching reflective note, 2021

- 5.16 Outbreak Investigation. Teaching reflective note, 2022
- 5.17 Investigation of the genomic and epidemiological factors associated with haemolytic uraemic syndrome among confirmed cases of verotoxigenic *E. coli* infection in Ireland, 2017–2020: Joint EPIET and EUPHEM project. Study Protocol, 2021
- 5.18 Participant in ECDC COVID-19 vaccine effectiveness hospital study.
https://www.ecdc.europa.eu/sites/default/files/documents/covid-19-vaccine-effectiveness-interim-analysis-second-update_0.pdf

Conference presentations

- 5.19 Brady, M. Improving understanding of HIV key populations through national surveillance in Ireland, 2019. ESCAIDE conference November 2021. Online Oral Scientific Presentation
- 5.20 Brady, M. SARS-CoV-2 Antibody Testing in Healthcare Workers: a comparison of the clinical performance and retained sensitivity of three commercially available antibody assays, Ireland, 2020. ESCAIDE conference November 2021. Online Poster Presentation
- 5.21 Brady, M. A norovirus outbreak in a residential care facility in Ireland, 2021. Faculty of Public Health Medicine in Ireland (FPHMI) Summer Scientific Meeting. Poster Presentation May 2022

Other presentations

- 5.22 HPSC Training and Research Forum. Improving understanding of HIV key populations through national surveillance in Ireland, 2019. Online oral presentation, Dublin, October 2021
- 5.23 HPSC Training and Research Forum. SARS-CoV-2 Antibody Testing in Healthcare Workers: a comparison of the clinical performance and retained sensitivity of three commercially available antibody assays, Ireland, 2020. Online oral presentation, Dublin, October 2021
- 5.24 ECDC EPIET/EUPHEM COVID-19 Think Tank. COVID-19 outbreaks among third-level students: a retrospective analysis of the second wave of the COVID-19 pandemic in Ireland, 2020. Online oral presentation, February 2021
- 5.25 EPIET Project Review Module. Improving understanding of HIV key populations through national surveillance in Ireland, 2019. Online oral presentation, August 2021
- 5.26 ECDC European SARI Network. Denominators for SARI surveillance in Ireland. Online oral presentation, September 2021

6. Other activities

- 1 World Health Organization webinar on HIV drug resistance. 20/11/2020
- 2 ESCAIDE conference 24/11/2020 – 27/11/2020
- 3 World Health Organization webinar on Monitoring uptake and effectiveness of COVID-19 vaccine in the WHO European Region. 25/01/2021
- 4 World Health Organization webinar on COVID-19 variants of concern and transmissibility. 28/01/2021
- 5 ECDC COVID-19 Think Tank - Omicron Variant. 13/12/2021
- 6 World Health Organization Seminar on SARI surveillance. 15/12/2021
- 7 HPSC Training and Research Forum - COVID-19 outbreaks in Irish hospitality, social and recreational settings from the second epidemic wave to October 2021. 06/12/2021
- 8 HPSC Training and Research Forum – Seroepidemiology. 15/02/2022
- 9 HPSC SARS-CoV-2 Whole Genome Sequencing conference. 13/05/2022
- 10 Faculty of Public Health Medicine in Ireland (FPHMI) Summer Scientific conference. 24/05/2022 – 25/05/2022
- 11 Co-author on abstract 'HIV transmitted drug resistance in Ireland, 2019', presented by EUPHEM fellow Diana Espadinha Costa at the ECCMID conference. 25/04/2022

7. EPIET/EUPHEM modules attended

- 1 Introductory Course Part I, (28/09/2020 – 25/09/2022), online
- 2 Introductory Course Part II - Operational Research Training, (9/11/2020 – 10/11/2022), online
- 3 Outbreak Investigation, (07/12/2020 – 11/12/2020), online
- 4 Multivariable analysis Part I, (15/02/2021 – 19/02/2021), online
- 5 Multivariable analysis Part II – Cox Regression, (18/03/2021), online

- 6 Introductory Course Part III, (26/04/2021 – 07/05/2021), online
- 7 Rapid Assessment and Survey Methods, (05/05/2021 – 06/05/2021), online
- 8 Project Review Module 2021, (23/08/2021 – 26/08/2021), online
- 9 Biorisk and Quality Management, (17/01/2022 – 18/01/2022), online
- 10 Vaccinology, (14/02/2022 – 18/02/2022), online
- 11 Time Series Analysis, (04/04/2022 – 08/04/2022), Rome, Italy
- 12 Management, Leadership and Communication in Public Health, (13/06/2022 – 17/06/2022), Stockholm, Sweden

8. Other training

- 1 EPIET Alumni Network geographic information system (GIS) mini module, (09/04/2022 – 10/04/2022), Rome, Italy
- 2 In-house self-paced HPSC training on R tidyverse, 2021 and 2022, Dublin, Ireland

Discussion

Coordinator's conclusions

Melissa started her fellowship with a background in Biomedical Science and some experience in surveillance of sexually transmitted infections. During her fellowship, she was involved in four surveillance projects and two outbreak investigations and was able to work on three applied research projects. Through her dedication, enthusiasm, and commitment, she has achieved all the EPIET objectives and produced high quality outputs. Some highlights of her fellowship include leading two outbreak investigations, one on COVID-19 and another on acute infectious gastroenteritis in a residential care facility, and she has been very active in training and teaching activities during the two years. Though she started with strong statistical skills, she has further developed and consolidated her competencies in this area, particularly during her research project on Verotoxigenic *Escherichia coli*. She has been independent during her fellowship and has been able to organise and complete her work effectively with excellent supervision from her site. The site gave her the opportunity to be involved in a range of projects that enabled her to develop a diverse portfolio. She has worked in a professional manner and has strong competencies to continue a career in epidemiological and public health-related work. I wish her success in her future career.

Supervisor's conclusions

During the past two years of her EPIET programme, Melissa has enthusiastically embraced and conscientiously applied herself to learn and apply new competencies that she obtained during the fellowship programme. She took the opportunity to participate in all the required EPIET modules, as well as optional EPIET modules that she felt would be of benefit to her in her future career in health protection in Ireland, and bring additional skills to her work in HPSC. She implemented and supported COVID-19 surveillance activities set up at the start of the pandemic and was a key member in initiating a new severe acute respiratory infection (SARI) surveillance system in the hospital surveillance system which is planned as an integral system to be expanded in the coming years in Ireland. This had long been identified as needed in Ireland and was only realised with Melissa's input. She trained in-facility staff to carry on the work she had initiated. Melissa also led two outbreak investigations – the first, a national review of SARS-CoV-2 outbreaks in third-level educational settings highlighting the role of living and social interactions outside the university as being key drivers of transmission. The second, an outbreak in a nursing home identified the breakdown in infection-control procedures and the challenge to implement good infection control in settings with dementia patients. Melissa was a co-investigator in the study on VTEC (with a EUPHEM fellow), a disease with high incidence in Ireland.

Melissa was a regular contributor and consolidated her training skills during the past two years in her teaching of under and postgraduate students, training new staff on project implementation, data management and analysis and report writing and communication of results to stakeholders – all of these activities are an integral part of the health protection services provided by the Health Protection Surveillance Centre.

Personal conclusions of fellow

The EPIET fellowship provided me with a unique opportunity to improve my skills and competencies in epidemiology and has provided many valuable experiences. It took place during the COVID-19 pandemic when opportunities to meet people face to face were extremely limited. Despite this, I felt well connected and part of the public health community in Ireland and Europe thanks to supervisors and colleagues. Undertaking the fellowship during the pandemic provided an opportunity to work within new areas including seroepidemiology and to observe public health leaders in action during times of crises. HPSC had an extremely supportive training environment where I gained exposure to a range of disease areas and was afforded the flexibility to explore new opportunities.

Acknowledgements of fellow

I would like to thank my main supervisor, Dr Suzanne Cotter and co-supervisors, Dr Margaret Fitzgerald and Dr Lisa Domegan for their tremendous support, supervision and mentorship during my fellowship. Thanks also to EPIET scientific co-ordinators, Zaida Herrador Ortiz and Katie Palmer for their guidance and technical assistance, and to the module co-ordinators and the faculty office.

I would like to acknowledge former HPSC Director, Dr John Cuddihy, for his support and encouragement, and the current Director, Dr Greg Martin, for continuing to offer that support. Thanks also to Dr Lorraine Doherty, National Clinical Director of Health Protection, for her support and for inviting me to observe the National Health Protection Pandemic Incident Control Team (PICT) in action.

Many thanks to all the project supervisors for giving me the opportunity to work on a diverse set of projects and for providing expert guidance, in particular, Dr Suzanne Cotter, Dr Lisa Domegan, Dr Derval Igoe, Dr Naomi Petty-Saphon, Dr Lois O'Connor, Dr Patricia Garvey and Dr Joan O'Donnell, and to the collaborators including the PRECISE study steering group, the Department of Public Health in North-East Ireland and the National VTEC Reference Laboratory in Ireland. Thanks also to colleagues at HPSC for covering my previous work during a difficult and challenging COVID-19 pandemic, and to the IT department who provided technical assistance throughout.

Last but not least, I'm grateful to have met past and present EPIET and EUPHEM fellows and to be part of cohort 2020 who have provided enormous support to each other.