



## Summary of work activities

Héloïse Lucaccioni  
European Programme for Intervention  
Epidemiology Training (EPIET), 2019 cohort

### Background

ECDC's Fellowship Programme is a two-year competency based training course offering two paths: the field epidemiology path (EPIET) and the public health microbiology path (EUPHEM). After the two-year training course, the graduates will have extensive expertise in applying epidemiological or microbiological methods to guide public health interventions for communicable disease prevention and control.

Both curriculum paths provide training and practical experience through a 'learning by doing' approach at 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' which is why 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 Héloïse Lucaccioni, cohort 2019 of the Intervention Epidemiology path (EPIET) at the Direção-Geral da Saúde (the Directorate-General of Health) (DGS) Lisbon, Portugal.

### Pre-fellowship short biography

Héloïse Lucaccioni holds a PhD in Health Geography from the University of Paris Nanterre and a Postgraduate Diploma in Public Health/Epidemiology from the London School of Hygiene and Tropical Medicine. Prior to the fellowship she worked in academia, scientific cooperation, and the humanitarian sector. Her work focused on emerging zoonotic diseases, health information management, and epidemic response.

## Methods

This report accompanies a portfolio that demonstrates the competencies acquired during the EPIET fellowship by working on various projects, activities, theoretical fellowship training modules, other modules or trainings and from international assignments or exchanges.

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 Manual<sup>1</sup>.

### 1. Epidemiological investigations

#### 1.1. Outbreak investigations

##### *Descriptive analysis of a nationwide laboratory cluster of Salmonella Newport, Portugal, November 2019*

Supervisors: Rita Sá Machado

Between April and August 2019, a laboratory cluster of 32 genetically-related human isolates of *Salmonella* Newport was detected in Portugal through whole-genome sequencing (WGS) or core genome multilocus sequence typing (cgMLST). A total of 24 confirmed cases were notified through the national surveillance system of notifiable diseases (SINAVE).

We used data from SINAVE to conduct a descriptive analysis of these 24 notified confirmed cases in terms of person, time, and place in order to generate hypotheses on the source and likely vehicle of this cluster. The case report form contains information on demographics, place of infection, symptoms, travel history, and possible environmental and food exposure.

This preliminary analysis showed a widespread geographical, temporal, and demographic pattern. No epidemiological link was reported between cases. This suggested that broadly distributed food product(s) could be the source of contamination.

Role: co-investigator (data analysis, report).

##### *Cluster of pneumonia of unknown aetiology in a poultry plant, Torres Vedras, Portugal, April 2020*

Supervisors: Nuno Rodrigues

On 20 April 2020, a cluster of pneumonia of unknown aetiology was detected in a poultry plant of 400 employees in Torres Vedras. An outbreak investigation was conducted by the local public health unit (USP Moinhos, Aces Oeste Sul, ARS LVT) to 1) assess the extent of the outbreak, 2) identify the causative agent and source of exposure, and 3) implement control and prevention measures to limit the spread and reoccurrence of the outbreak.

Seven employees and one household contact met the case definition. All cases sought treatment in hospital and six (75%) were hospitalized, one being admitted to the intensive care unit. Cases presented a similar clinical picture with fever, myalgia, malaise/fatigue and pneumonia.

Cases underwent chest X-rays and submitted blood, urine, and respiratory samples which were tested for an extensive panel of viruses and bacteria. All cases tested negative for Sars-CoV-2. Environmental samples were taken from the five cooling towers at the poultry plant. One cooling tower was positive for *Legionella pneumophila* serotype 2-15. Microbiological investigations on human samples could neither rule out nor confirm the diagnosis. The occupational health services did a medical screening of all the employees, and no further cases were detected.

<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>

The identified cooling tower was immediately closed and disinfected in accordance with the appropriate technical standards. Employees in the meat and poultry processing industry are at high risk of occupational hazards, particularly zoonotic pathogens and person-to-person transmission of diseases, through the processes of plucking, slaughtering, and meat and carcass transformation, and due to the cold, wet environment that favors aerosol transmission. We recommended that adequate use of personal protective equipment and disinfectant products for air cleaning be reinforced and that a new occupational exposure assessment for biological agents be conducted.

Role: co-investigator (field investigation, data collection, analysis, report).

### ***Early steps and planning of an investigation into a gastrointestinal illness outbreak at a nursery, Torres Vedras, Portugal, December 2020***

Supervisor: Nuno Rodrigues

On 11 December 2020, the local public health unit of Moinhos was notified of a cluster of gastrointestinal illnesses at a nursery in Torres Vedras. The investigation aimed to confirm the outbreak, identify the agent and vehicle, and implement control measures.

In total, 61 children (aged between five months and three years) and 14 staff (19–53 years old) attended the nursery. Preliminary information obtained from the nursery, children's caregivers, and clinical records showed that one child tested positive for SARS-CoV-2. One member of staff and a dozen other infants experienced gastrointestinal illness, with one testing positive for *Campylobacter jejuni* on 14 December 2020. A preliminary hypothesis was that of a foodborne outbreak from meals served at the nursery, although COVID-19 was still suspected because of its non-specific and gastro-intestinal symptoms in children.

We wrote an investigation protocol including environmental and microbiological investigations and an epidemiological investigation through a retrospective cohort study.

All children and staff were invited to take a COVID-19 RT-PCR test and to provide a stool sample. Only 10 children and one member of staff (symptomatic) submitted stool samples and of these three tested positive for *Campylobacter coli*. The environmental investigation found one surface sample (meat board) positive for *Campylobacter coli*. No further epidemiological investigation was conducted due to the holidays and the limited number of questionnaire replies and laboratory samples.

The presence of *Campylobacter coli* on a surface where poultry had been prepared supported the foodborne hypothesis. However, the presence of two species of *Campylobacter* led us to hypothesize that there might have been either two concomitant but distinct outbreaks, or poultry as a common source (poultry being commonly colonized by concurrent species). Undercooked meat or transmission through fomites, cross-contamination, or person-to-person (e.g. via diapers) could explain the spread of such an agent. However, it was not possible to rule out a COVID-19 outbreak.

The nursery was immediately closed and re-opened three weeks later, after the holidays. Ultimately, this preliminary investigation showed the importance of sensitive and specific surveillance system for the early detection of outbreaks.

Role: co-investigator (study design, questionnaire, report)

### ***Large foodborne illness outbreak in a network of catered institutions, Beja, Portugal, May 2021***

Supervisors: Mário Jorge Santos

On 18 May 2021, an outbreak of gastrointestinal illness occurred among 211 individuals who had had lunch in schools and institutions whose catering was provided by a community centre in Beja,. We investigated the outbreak to assess its extent, identify potential sources and vehicle of transmission, and implement relevant public health measures to stop the outbreak and prevent reoccurrence. The institutions provided information on the list of individuals who were served the lunch catered by the community centre on 18 May 2021, their illness status and symptoms, the time of onset, the dishes served, the delivery time and groups, and the time of lunch. We conducted a descriptive analysis of the cases and a retrospective cohort study.

A total of 82 (38.9%) individuals met the case definition (vomiting or abdominal pain or reported ill by school from 12:30 onwards after having lunch at one of the institutions). In total, 44 children and three adults were admitted to hospital the same day. Three children submitted stool samples, which were negative for *Salmonella*, *Shigella* and *E. coli*, and culture negative.

The main dish (fish done in 'à Bràs' style, containing eggs and vegetables, with salad) was identified as the most likely vehicle of this outbreak (RR= 5.1 95% CI 1.4–48.6). The attack rate among those who consumed the main dish was 41.8%. It was notable that 98.8% of cases were served this main dish. There was also an increased risk of illness in delivery groups 2 and 3 located further away (2.5 to 15 km) from the catering facilities, where a longer period of time had elapsed between delivery to lunch. Six food handlers submitted nasal swabs, four of whom were positive for *Staphylococcus aureus*. Environmental investigations (food samples) at the catering facilities were sealed under judicial confidentiality following the initiation of a legal procedure by the Food and Economic Security Authority.

The food handlers carrying *S. aureus* were decolonized. We recommended that standard precautions in hygienic food handling, preparation, storage, packaging, transport and delivery should be reinforced.

Role: co-investigator (study design, data collection, analysis, report).

### ***11<sup>th</sup> Ebola Virus Disease outbreak in the Democratic Republic of Congo, Mbandaka, Equateur Province, 2020***

Supervisors: Mory Keita

The 11th Ebola Virus Disease (EVD) outbreak in the Democratic Republic of Congo (DRC) was declared on 1 June 2020 in Equateur Province. In August 2020, the Global Outbreak and Alert and Response Network (GOARN) sent a request for assistance to deploy epidemiologists in Mbandaka (Equateur) in support of the EVD outbreak response.

The outbreak occurred in both scattered communities across remote forest areas and densely populated urban areas. This led to many logistical challenges (accessibility, communication networks), particularly as the COVID-19 pandemic was also ongoing at the same time.

The team contributed to surveillance, alert and response through various activities: 1) the multi-partners 'analytical cell' that conducts multidisciplinary thematic analyses to inform operations and draw lessons learned with the different response pillars, 2) the coordination of epidemiological field investigations to consolidate the identification and understanding of transmission chains, 3) the training and mentoring of investigators, supervisors and data managers, 4) the development of surveillance tools and 5) participation in internal/external meetings (incident management team, surveillance commission, etc.).

On 18 November 2020, the Minister of Health declared the 11th outbreak of Ebola in the DRC to be over. A total of 130 cases (119 confirmed and 11 probable) with 55 deaths and 75 survivors were reported from 13 health zones.

Role: co-investigator (study design, data collection, analysis, report).

### ***COVID-19 readiness and response in Portugal, 2020–2021***

Supervisors: Rita Sá Machado

In late 2019, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes COVID-19, emerged. The virus was first detected in Wuhan, China, and rapidly spread worldwide. On 11 March 2020, the World Health Organization declared COVID-19 a pandemic. In Portugal, the first confirmed case was diagnosed on 1 March 2020. The fellow was included in the early Task Force and participated in the COVID-19 readiness and response activities at the Directorate-General of Health, Portugal (DGS). This included contributions to 1) the horizon scanning of the emerging scientific literature on this new virus, 2) the cartography of healthcare capacities for isolation of suspected patients, 3) the National Plan for Preparedness and Response to the new coronavirus disease (COVID-19) - 2020, specifically on the alert and response levels, 4) the school guidelines for the control of the transmission of COVID-19 in school contexts, specifically testing criteria and management of outbreaks, 5) expert groups and Task Force meetings.

Role: team member (literature scanning, data analysis, guidelines, reporting).

### ***A SARS-CoV-2 Delta variant (B.1.617.2) outbreak in a long-term care facility with high COVID-19 vaccination coverage, Mafra, Portugal, June 2021***

Supervisor: Nuno Rodrigues

In June 2021, an outbreak of SARS-CoV-2 Delta variant (B.1.617.2) occurred in a long-term care facility (LTCF) with high vaccine coverage in Mafra, Portugal.

The LTCF had 12 health workers (HW) and 22 residents (median: 83 years old). In total, 24 (71%) were fully vaccinated, four (12%) partially vaccinated within the recommended interval between doses, three (9%) unvaccinated with previous infection five months before, and three (9%) unvaccinated without previous infection. All vaccinated individuals received Comirnaty, except one (one dose of Vaxzevria). The median time since the last dose of fully vaccinated individuals was 95 days (50–103 days).

On 11 June 2021, a resident was admitted to hospital with low-grade fever (37.5°C), dyspnoea and knee oedema and tested positive for SARS-CoV-2 (RT-PCR). On 14 June 2021, all individuals were tested using rapid antigen detection tests followed the next day by RT-PCR. A questionnaire was administered to collect data on demographics, symptoms, previous infection, and vaccination status.

The retrospective investigation, supported by whole-genome sequencing (WGS), identified the most likely index case as an unvaccinated healthcare worker who experienced symptoms on 9 June 2021 while at work, and tested positive on 14 June 2021. In total, 22 cases (six healthcare workers and 16 residents) were detected. The overall attack rate was 65%, 75% among those who were fully vaccinated. Four deaths occurred in fully vaccinated residents with known risk factors for severe COVID-19. All other cases experienced mild symptoms.

In total, 17 RNA-positive samples were analysed using WGS, identifying the variant and confirming the outbreak (up to two SNPs between genome sequences). No cold chain failure was identified. Serological analyses from two cases showed a vaccine-induced antibody response.

Waning immunity and/or reduced vaccine effectiveness against Delta variant could explain the high attack rate. Recommendation was made to review policy on masks, testing, and healthcare worker vaccination accordingly.

Role: co-investigator (data analysis, report, manuscript, submission to journal/conferences).

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

#### **EPIET/EUPHEM Introductory Course**

The course offered an introduction to key principles of outbreak investigations, study designs, and analysis, including the field epidemiology approach, the steps of outbreak investigations, the design of data collection instruments and data collection process, and data analysis.

#### **Outbreak Investigation Module**

This module built on the introductory course to provide a deeper understanding and practice of all aspects of outbreak investigations through real-life case-studies (detection, data analysis and interpretation, microbiological and environmental investigations, report writing, communication, etc.).

#### **Multivariable Analysis Module (MVA)**

The MVA module strengthens the hands-on understanding of statistical analyses that can also be applied to analytical studies conducting in the framework of outbreak investigations.

#### **Rapid Assessment and Survey Methods (RAS) module**

The RAS module covered important aspects of field survey (spatial) sampling for complex public health emergencies, risk assessment, monitoring of interventions in outbreak response, and risk communications.

### *Educational outcome*

Héloïse had the opportunity to be involved in a range of outbreaks of different scales and types in a variety of contexts, including gastrointestinal and respiratory infections, Ebola, and COVID-19 at the local, regional, national, and international level. She was involved in all aspects of the outbreak investigation from the planning to the operational conduct and communication. In each case, she was a part of a multidisciplinary team, participating in environmental and laboratory investigations and involved in coordination structures and multi-agency collaborations.

## **1.2. Surveillance**

### *Epidemic intelligence – horizon scanning and weekly epidemic intelligence roundtable of the Public Health Emergency Center (CESP)*

Supervisors: Public Health Emergencies Center team.

The Public Health Emergencies Center (CESP - Centro de Emergências em Saúde Pública) aims to strengthen systems of early detection for cross-border health threats, increase capacity for the monitoring of indicators and warning signals, promote communication and enhance the respective coordination capacities for responding to public health emergencies in Portugal. In November 2019, the fellow did a one-week placement at the CESP to gain insights and participate in the day-to-day activities of the center, with a focus on event-based surveillance and epidemic intelligence. She contributed to the horizon scanning (screening, filtering, and validation of alerts) for the purpose of the weekly "Meeting on Observations, News, Data and Alerts" - RONDA (Reunião sobre Observações, Notícias, Dados e Alertas) and for the national weekly threats bulletin. In addition, the fellow participated regularly in the epidemic intelligence round table meetings throughout the fellowship.

Role: screening, filtering, and validation of alerts; brief report and presentation.

### *Evaluation of the national surveillance system for notifiable sexually-transmitted infections (2015-2018), Portugal*

Supervisor: Rita Sá Machado

In the early 2000s, Portugal formulated a strategy for tackling sexually-transmitted infections (STIs), including the improvement of mandatory notification. The national epidemiological surveillance system (SINAVE) shifted to a web-based platform in June 2014 and, although its implementation was monitored during 2016–2017, its performance was not evaluated. We designed and conducted an evaluation of the national surveillance system for mandatory notifiable STIs (gonorrhoea, *Chlamydia trachomatis* infections, *Lymphogranuloma venereum* and syphilis) to assess whether the system meets its main objective of monitoring the health status of the population.

We used medical and laboratory notifications reported through SINAVE between 2015 and 2018 to assess the positive predictive value (PPV), data quality, timeliness, and representativeness. PPV was defined as the proportion of validated cases. Data quality was assessed by completeness (proportion of 'Unknown'/blank fields), internal validity (proportion of inconsistent values), and record linkages between medical/laboratory notifications. Timeliness was calculated as median time length from symptoms onset through diagnosis and laboratory result to notification.



Representativeness was evaluated by comparing demographics, geographical distribution, and transmission types to the literature in Europe and Portugal.

The performance of the surveillance system varied according to attributes and diseases. Completeness was low (<90%), less than a quarter of notifications could be matched between medical and laboratory notifications, and 6.8% to 26.0% notifications had inconsistent values. Data quality attributes performed systematically higher for Chlamydia. PPV was high (70%-92%) in all four diseases. Timeliness varied from 5–17 days between the date of symptom onset and diagnosis, although 13.7–38.6% notifications were not notified within the legal delay of 24 hours from diagnosis. All four diseases appeared consistent with the literature, which suggests representativeness.

The evaluation revealed unsatisfactory data quality, and timeliness. The recommendations were to review the case-report forms to include only the most essential variables as a way to increase completeness, to introduce validation rules in the information system to improve data quality, and to strengthen training, guidelines, and feedback for clinicians and laboratory professionals.

Role: wrote the protocol, conducted the evaluation including data extraction and analysis, wrote the report, submitted a conference abstract, presented results to stakeholders.

### ***A non-systematic literature review on the sources of Salmonella Newport outbreaks and implications for surveillance and investigations***

Supervisors: Rita Sá Machado

Salmonellosis is one of the most common zoonosis in humans. Particularly, *Salmonella* Newport is a common and increasingly occurring serotype of clinical and epidemiological importance due to multiple antimicrobial resistant strains. We conducted a rapid and non-systematic literature review on the sources of outbreaks due to *S. Newport* in North America and Europe over the past few years and their implications for surveillance and outbreak investigation.

We identified 28 publications reporting outbreaks or clusters of human *S. Newport* infections that occurred between 1995 and 2019 in the USA, Canada, Finland, France, Ireland, UK, Germany, and the Netherlands. Outbreaks were associated with a wide range of food commodities such as fruits, vegetables and seeds, meat, poultry, dairy, and fish. A study found that *S. Newport* serovar is associated with the highest diversity of food items, which might be related to intra-serotype genetic variation.

Most investigations were able to trace back the supplier/producer, but not to identify the exact point of contamination. Among the main challenges reported by the authors were: recall bias, lack of purchase information for trace back, lack of systematic tracing of products to the original production site and delays associated with pathogen identification (e.g. real-time sequencing).

Role: conducted literature review, extracted data, wrote the report.

### ***National surveillance of COVID-19 in Portugal***

Supervisors: Rita Sá Machado

In late 2019, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), causing COVID-19, emerged. The virus was first detected in Wuhan, China, and rapidly spread worldwide. On 11 March 2020, the World Health Organization declared COVID-19 a pandemic. In Portugal, the first confirmed case was diagnosed on 1 March 2020. The fellow was a member of the surveillance team where she contributed to the national surveillance activities. The surveillance activities included 1) setting-up the surveillance system for COVID-19 (case definition and case-report forms, definitions of indicators), 2) supporting routine operations for the information system, 3) automating of data analyses and reporting with R, including case-based reporting at the European level (TESSy), 4) regularly analysing surveillance data and producing health information products for diverse audiences (general public, experts, decision makers) such as daily and weekly situation reports, monitoring of mortality, monitoring of epidemiological situation, presentations, and 5) sharing information and collaborating with other agencies and stakeholders (e.g. academic community, national reference laboratory, etc.).

Role: surveillance officer (data gathering, analysis, reporting)

### ***Evaluation of the performance of an Early Warning, Alert and Response System (EWARS) in the control of the Ebola Virus Disease epidemic in Beni, Eastern Democratic Republic of Congo, 2018–2020***

Supervisors: Mory Keita

The 10th Ebola Virus Disease (EVD) epidemic in the Democratic Republic of Congo (DRC) occurred in the North Kivu Province in August 2018, lasting until June 2020. We described and evaluated an Early Warning Alert and Response System (EWARS) implemented in Beni health zone between 5 August 2018 and 30 June 2020. The EWARS aimed to report, collect, investigate, validate, and take early action (isolation, safe burial or referral) on alerts that met the suspected case definition of EVD. We described and evaluated the performance of the EWARS using existing guidelines (WHO Guide to Monitoring and Evaluating Communicable Disease Surveillance and Response Systems, US CDC Framework for Evaluating Public Health Surveillance Systems for Early Detection of Outbreaks). We used a

quantitative and qualitative approach to assess a set of attributes (sensitivity, specificity, positive predictive value, negative predictive value, timeliness, usefulness and cost, and stability). The system was a cost-effective component of surveillance in this setting, underscoring its importance, alongside the necessity to ensure efficiency and sustainability beyond the duration of the emergency response phase.

Role: co-author (methodology, software & data analysis, drafted manuscript).

### ***Spatial patterns of invasive pneumococcal disease and socio-environmental determinants in continental Portugal (2015–2019): potential and limitations of spatial analysis for epidemiological surveillance.***

Understanding community-level factors that explain the spatial variation in invasive pneumococcal disease (IPD) in high vaccine uptake settings can contribute to targeted public health interventions. We investigated spatial patterns of IPD and their association with socio-environmental determinants in continental Portugal.

We used laboratory-confirmed cases from the national epidemiological surveillance system between 2015 and 2019 and resident population estimates to calculate the incidence rate by municipality ( $m=278$ ). We assessed spatial dependency using Moran's I index and local indicator of spatial association (LISA) maps. We used Kulldorf's spatial scan statistics to detect significant higher rate clusters. We conducted bivariate analyses using a negative binomial regression model to measure the association between incidence rates and socio-environmental determinants (e.g. deprivation index, population density, gini coefficient, urban typologies, temperature).

In total, 1 460 cases were reported, 48% of which were in the age group  $\geq 65$  years. The incidence increased from 1.42 in 2015 to 4.76/100 000 inhabitants in 2019. Only 5% of municipalities, which included 30% of the resident population, accounted for half of the cases. We found a significant moderate spatial dependence ( $I=0.31$ ), and four significant high risk clusters comprising 111 municipalities. The median temperature was significantly associated with the incidence ( $IRR=0.83$ ,  $95CI$  0.76-0.91).

Our analysis suggests the existence of spatial patterns of IPD and a relationship with air temperature, but no further socio-environmental factors associated with the spatial variation in incidence were identified. Spatial analysis has the potential to strengthen epidemiological surveillance and contribute to targeted public health intervention by shedding light on the underlying determinants of diseases at the community level. We recommended improving the availability of health determinant datasets at sufficient spatiotemporal resolutions, and integrating spatial tools and methodology into the surveillance system.

Role: wrote the protocol, analysed data, submitted abstract to conference, wrote the report.

### ***National surveillance and reporting of notifiable infectious diseases***

Supervisors: Rita Sá Machado

As part of the systematic and ongoing collection, analysis, interpretation, and dissemination of epidemiological data, we contributed to the routine surveillance activities of mandatory notifiable infectious diseases reported through the National Epidemiological Surveillance (SINAVE) (rickettsia, giardia, COVID-19), reporting to the European surveillance system (TESSy) (COVID-19, invasive pneumococcal disease, *Haemophilus influenzae*, meningococcal disease), and the elaboration of a public interactive web-based dashboard of congenital infectious diseases (Zika, rubella, toxoplasmosis, syphilis) through the selection of epidemiological indicators.

Role: systematic collection, analysis and interpretation and dissemination of surveillance data, automatization of TESSy reporting (R code), selection of surveillance indicators.

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

#### **EPIET/EUPHEM introductory course**

The introductory course familiarised fellows with the core concepts in surveillance, such as the needs for surveillance, the key components and types of surveillance systems, the analysis and interpretation of surveillance data, and the development and evaluation of a surveillance systems.

#### **Rapid Assessment and Survey Methods module**

The RAS module provided insights in how to set up an alert and response system and interpret surveillance data in complex emergency situations, and to monitor interventions.

#### **Multivariable Analysis (MVA) Module**

The MVA module introduced a variety of statistical methods that can be applied for the analysis of surveillance data.

#### **Time Series Analysis module**

The Time Series Analysis module built on previous modules to further equip fellows with specific tools for the understanding and analysis of time-series surveillance data.

## *Educational outcome*

Héloïse developed competencies in epidemiological surveillance by being involved in various projects such as indicators and event-based routine surveillance and evaluation of surveillance systems. She regularly gathered, analyzed, interpreted, and reported surveillance data and, more specifically, contributed to different outputs including surveillance protocols, situation reports, and the automatization of reporting and information sharing at European level (TESSy).

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

### *National estimates of severe rotavirus infections and all-cause acute gastroenteritis hospital episodes in children under five years old in mainland Portugal.*

Supervisor: Rita Sá Machado

Rotavirus infections are a leading cause of severe acute gastroenteritis in children under five years old. In December 2019, Portugal announced the inclusion of the rotavirus vaccine, already available for private purchase, in the National Immunization Program (NIP). We estimated and described the first nationwide analysis of the burden and trends of rotavirus and acute gastroenteritis (AGE) hospital episodes in children under five years in mainland Portugal (2014–2017).

The hospital morbidity database (BIMH) and the Death Certificate Information System (SICO) was used to identify hospital episodes and deaths of rotavirus and acute gastroenteritis based on the codes of the International Classification of Diseases (ICD-9-CM/ICD-10-CM). We described the number and rates of hospital episodes disaggregated by age group, sex, geographical units (districts), seasonality and trends during the study period.

On average, during the study period, there were 1 985 annual hospital episodes among children under five years. The annual rate was 48.0/10 000 children (95% CI 46.9 - 49.0), meaning that one in 208 children were likely to be hospitalized for all-cause AGE by the age of five. Rates were consistently higher in younger children, and 67.8% episodes occurred in children under 24 months. We found a seasonal pattern, with a major peak in the early spring.

Our results were consistent with the current knowledge on rotavirus and acute gastroenteritis hospital episodes in Europe. Additional studies are needed to identify the risk factors and high-risk groups for hospital attendance.

Rotavirus and acute gastroenteritis hospital episodes in children under five years in mainland Portugal represent an important health and economic burden. In the future, monitoring this burden and trends in relation to rotavirus vaccine coverage could be useful in order to assess the impact of the vaccination programme on changes in hospital episodes.

Role: wrote the protocol, data extraction, data analysis, wrote the manuscript, published manuscript in a peer-reviewed journal.

### *A test-negative case-control study to measure the risk of COVID-19 in health professionals, January–May 2020, Portugal.*

Supervisors: Rita Sá Machado

Health professionals are known to be disproportionately affected during public health emergencies, and they represent a non-negligible proportion of COVID-19 cases. However, few studies have measured the risk of COVID-19 in health professionals. We conducted a test-negative case-control study using national surveillance data (January – May 2020) to estimate the risk of COVID-19 in health professionals compared to non-health professionals during the early months of the COVID-19 epidemic in Portugal.

Cases were suspected cases who tested positive for SARS-CoV-2, controls were suspected cases who tested negative. We used multivariable logistic regression modelling to estimate the odds ratio of a positive COVID-19 test (RT-PCR), our primary outcome. We did this by comparing health professionals and non-health professionals (exposure), and adjusting for the confounding effect of demographic (age, sex, region), clinical (symptoms), and epidemiological characteristics (international travel history), and the modification effect of a self-reported epidemiological link (self-reported contact with a COVID-19 case or person with COVID-19-like symptoms).

The proportion of cases was almost double in health professionals compared to non-health professionals (20.04% versus 12.62%,  $p < 0.001$ ). In the crude analysis, health professionals were found to be significantly more likely to test positive for COVID-19 (OR=1.74, 95% CI 1.62-1.86). This association persisted after adjustments (aOR=1.89, 95% CI 1.69-2.11), but was strongly modified by the reporting of an epidemiological link. Indeed, among cases who did report an epidemiological link, being a health professional was a protective factor (aOR=0.90, 95% CI 0.82-0.98).

Our findings suggest that in Portugal, health professionals face a greater risk of testing positive for COVID-19 in relation to the self-reporting of an epidemiological link. Our hypothesis is that different types of exposure and variability in awareness and risk perception of COVID-19 and associated preventive behaviour might play a role in modulating the risk of COVID-19 in health professionals. Ultimately, these findings highlight the need to pursue efforts



to increase awareness and better protect health professionals who work on the frontline of COVID-19 epidemic response.

Role: wrote the protocol, data cleaning, data analysis, wrote manuscript, submitted manuscript to peer-review journal.

### ***Occurrence and risk factors associated with Giardia duodenalis in indigenous People from the Tapirapé tribe, Brazilian Amazon***

Supervisor: Sooria Balasegaram

*G. duodenalis* is an enteric protozoan parasite causing both symptomatic (diarrhoea) and asymptomatic infections. Giardiasis has been poorly studied in Brazilian indigenous people, partially due to the geographical isolation and difficulty in accessing these fragile communities. Specifically, no information is currently available on the *G. duodenalis* assemblages and sub-assemblages circulating in native Brazilian people. This molecular-based epidemiological survey (Spanish National Centre for Microbiology, University of State of Mato Grosso, São Paulo University, Complutense University of Madrid) aimed to investigate the genetic diversity of *G. duodenalis* and assess potential risk/protective factors associated with the infection in indigenous communities in Brazil (Tapirapé people, Brazilian Amazon).

Data collected during four cross-sectional sampling campaigns (2008–2009) included laboratory confirmation and sequencing of pathogens from stool samples, and a set of sociodemographic and clinical variables. Microscopy and molecular assays (PCR and Sanger sequencing) were used to further confirm the diagnosis and for genotyping. Associations between *G. duodenalis* and sociodemographic and clinical variables were investigated using Chi-squared test and univariable/multivariable logistic regression models.

Prevalence rates (symptomatic and asymptomatic) varied from 13.5–21.7%. The infection was positively linked to younger age and tribe. Infected children <15 years old reported more frequent gastrointestinal symptoms than adults, which suggests that acquired immunity plays a role in modulating the frequency and virulence of the disease. Assemblage B accounted for three out of four *G. duodenalis* infections and showed a high genetic diversity. No association between genetic assemblages and age or occurrence of diarrhoea was demonstrated. These data indicate that the most likely source of infection was anthropic and that different pathways (e.g. drinking water) may be involved in the transmission of the parasite. Further molecular epidemiological studies targeting animal and environmental samples are needed to understand the transmission dynamics of *G. duodenalis* in this Brazilian geographical region.

Role: data cleaning, data analysis, wrote manuscript (epi part), co-author manuscript published in a peer-reviewed journal.

### ***Support for the planning and field implementation of the COVID-19 vaccine effectiveness study in hospital-based healthcare workers in Georgia, 2021.***

Supervisors: Mark Katz

With the massive rollout of COVID-19 vaccines globally, it is critical to evaluate the real-world effectiveness of the vaccine. The WHO Regional Office for Europe is providing financial and technical assistance to the National Center for Disease Control and Public Health (NCDC) in Georgia for the design and implementation of a multicentre prospective one-year cohort study of hospital-based healthcare workers to evaluate the effectiveness of COVID-19 vaccine in preventing laboratory-confirmed SARS-CoV-2 infection. In Georgia, the study is taking place at six centrally located hospitals (Tbilisi, Batumi). All healthworkers eligible for COVID-19 vaccination can be enrolled in the study, including those who intend to get vaccinated, those who do not plan on getting vaccinated, and those who are unsure. At enrolment, study participants complete a baseline enrolment survey about demographics, clinical comorbidities, and work- and community-related behaviour related to infection risk, along with baseline serology. During the study, participants are actively followed for suspected COVID-19 infection, and tested by RT-PCR where relevant. Quarterly serology is also collected and tested for antibodies to SARS-CoV-2, distinguishing between vaccine-induced antibodies and antibodies that result from natural infection.

Role: process of ethical approval, study registration, support for the design of data collection tool and training of data collectors, sites visits and coordination, preliminary data monitoring.

### ***A time series analysis of the impact of antibiotics consumption on Salmonella spp. resistance, Spain, 2010–2019***

Supervisor: Silvia Herrera Leon

Antimicrobial resistance (AMR) is one of the most serious public health threats. AMR is estimated to be responsible for 33 000 deaths per year in Europe that cost approximately EUR 1.5 billion per year in healthcare and productivity losses. *Salmonella* enterica isolates harbouring fluoroquinolone resistance alongside a number of other resistance genes are being increasingly identified. The threat of AMR has led to a variety of measures to mitigate its future public health burden. Among these are the general reduction of antimicrobial consumption and a number of wide-ranging preventive campaigns.

We developed a protocol to investigate the effect of antibiotic consumption on the trends and resistance profiles of *Salmonella* (human) isolates in Spain between 2011 and 2019, using time series analysis.

Using isolate data from the national microbiological surveillance system and antibiotics data in public hospitals from the national plan against antimicrobial resistance, the protocol aims to:

- describe and model the trends, seasonality, and resistance profiles of *Salmonella* spp. isolates;
- estimate the effect of antibiotic consumption on the previous trends;
- estimate the effect of policy changes (e.g. prevention campaigns) on the previous trends;
- inform public health action in relation to the efficacy of the interventions implemented.

This work will help evaluate the effectiveness of current interventions and formulate improved prudent antibiotic-use campaigns in the future.

Role: joint project with EUPHEM Fellow Andreas Hoeffler (Spain), wrote the protocol.

### *Predictors of previous SARS-CoV-2 infections and early COVID-19 vaccine uptake in health workers, Georgia, 2021*

Supervisors: Mark Katz

In the framework of the COVID-19 vaccine effectiveness study in hospital-based health workers in Georgia conducted by the WHO Regional Office for Europe and the National Center for Disease Control and Public Health (NCDC), we developed an analysis plan to assess baseline data and investigate the predictors of previous SARS-CoV-2 infections and early COVID-19 vaccine uptake in healthworkers participating in the study.

Role: wrote the protocol, data analysis, anticipated manuscript.

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

#### **EPIET/EUPHEM Introductory Course**

The EPIET/EUPHEM introductory course laid the foundations to designing, planning, and conducting applied public health research. Specifically, it covered the development of study protocols relevant to public health, the operational steps including project management and collaborative working, ethical aspects, as well as data analysis and presentation of results.

#### **Multivariable Analysis Module**

The Multivariable Analysis Module equipped fellows with advanced statistical skills (statistical approach in the relation with the study design and objectives, regression methods, confounding and effect modification, interpretation and reporting of results).

#### **Time Series Analysis module**

The Time Series Analysis module prepared fellows for the analysis of time-series to answer various type of research questions relevant to public health.

### *Educational outcome*

Héloïse led and contributed to operational public health research in the field of vaccine-preventable diseases, COVID-19, vaccine effectiveness, and antimicrobial resistance. She was involved in every step of the research projects from the identification of research questions relevant to public health to the study design, field implementation and coordination, data analysis, scientific communication, and recommendations for public health. She also took part in multidisciplinary projects involving collaboration with international organisations and institutes.

## **3. Teaching and pedagogy**

### *Introduction to GIS and mapping for outbreak investigation, Outbreak Investigation Module, December 2019, Nicosia, Cyprus*

This training aimed to provide theoretical and practical foundations to produce and interpret basic maps in the context of outbreak investigation. The target audience were the participants of the fellowship module 'Outbreak investigation'. The training was based on existing material from previous years that was reviewed and adjusted to fit the session format, timing, and objectives. It consisted of a lecture (45 minutes) and a case-study (2 hours).

### *Basic Epidemiology for Surveillance and Outbreak investigation, Portuguese-speaking African Countries (PALOP) and East Timor (TL), MOOC + online, April 2021*

As part of a one-week online training course for public health professionals at the national, regional or local level in Portuguese-speaking African Countries (PALOP), this training aimed to consolidate the participant's epidemiological knowledge (e.g. nature and scope of epidemiology, key measures, confounding, bias, random error, causality). It included a pre-recorded lecture (MOOC), a live practical session (21–23, 28–29 April 2021) and an online test and self-assessment. Participants completed an online evaluation to assess the course quality and provide feedback. All of them were satisfied with the content, structure, methodology, clarity, interactions, and usefulness of the course.

### *Introduction to cartography and GIS for surveillance and outbreak investigation, Portuguese-speaking African Countries (PALOP) and East Timor (TL), MOOC + online, April 2021*

As part of a one-week online training course for public health professionals at the national, regional or local level in Portuguese-speaking African Countries (PALOP), this training aimed to provide a practical introduction to key GIS functionalities for disease mapping. It consisted of a pre-recorded lecture (MOO), an online demonstration and Q&A session (21–23, 28–29 April 2021), and a self-paced practical exercise. Participants completed an online evaluation to assess the course quality and provide feedback. All of them were satisfied with the content, structure, methodology, clarity, interactions, and usefulness of the course.

### *Facilitation of a case-study: 'An outbreak of gastro-enteritis in Kalundborg, Denmark', Masters students in biotechnology at Katholieke Universiteit Leuven, online, March 2021*

This teaching assignment consisted in the facilitation of a two hour case-study entitled 'An outbreak of gastro-enteritis in Kalundborg, Denmark' delivered online to a group of Masters students in biotechnology from the Katholieke Universiteit Leuven (Belgium) in March 2021. The facilitation team included Natalie Fischer (EUPHEM fellow, Belgium), Andreas Hofer (EUPHEM fellow, Spain) and Justine Schaeffer (EUPHEM fellow, Austria). It aimed to provide biotechnology students with an overview and understanding of applied public health work, specifically practical insights into an outbreak investigation. All participants were invited to complete an online evaluation form to assess the quality of the training session.

### *Facilitation of two case-studies ('Sampling points' and 'Spatial analysis') of the Rapid Assessment & Survey Methods module, online, May 2021*

Facilitation of two practical exercises for the fellowship Rapid Assessment & Survey Methods module ('Spatial sampling' and 'Spatial analysis' – May 5, 2021, online). The case-studies were developed by Epicentre for the previous editions of the RAS module. The target audience were the participants of the fellowship module (cohort 2019 and 2020). Exercises were conducted in small groups and aimed to provide an understanding and first-hand experience of conducting spatial random sampling and drawing choropleth maps for the purposes of a rapid assessment.

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

#### **EPIET/EUPHEM Introductory Course**

The Introductory Course introduced theoretical and practical aspects about the preparation and delivery of teaching and trainings, focusing specifically on adults learners. It addresses topics such as facilitation, instructional design, adaptation of the methods to the goals and audience of the teaching, evaluation of training activities, and reflective practice in a learning environment.

#### *Educational outcome*

Héloïse participated in the design, delivery, and evaluation of teaching and training activities in topics such as Geographic Information Systems and cartography, spatial analysis and sampling methods, outbreak investigation, and epidemiology. She developed, taught, and facilitated lectures, case-studies and exercises in English and Portuguese to diverse audiences (fellows, students, public health workforce) and in various settings (face-to-face and online – MOOC).

## **4. Communication**

### **Publications related to the EPIET fellowship**

1. [Lucaccioni H](#), Rodrigues NS, Correia DM, Verdasca N, Melo A, Guiomar R, et al. 2021. A SARS-CoV-2 Delta Variant (B.1.617.2) Outbreak in a Long-Term Care Facility with High COVID-19 Vaccination Coverage, Mafra, Portugal, June 2021, Public Health [submitted].
2. Keita M, [Lucaccioni H](#), Kalongo M, Polonsky J, Nsio J, et al. 2021. Evaluation of the performance of an Early Warning, Alert and Response system in the control of the Ebola Virus Disease epidemic in Beni, Eastern Democratic Republic of Congo, 2018-2020. Emerging Infectious Diseases [accepted].
3. [Lucaccioni H](#), Costa C, Perez Duque M, Balasegaram S, Sá Machado R. 2021. Risk of COVID-19 in health professionals: A test negative case-control study, Portugal. Portuguese Journal of Public Health [accepted].
4. Perez Duque M, Saad NJ, [Lucaccioni H](#), Costa C, McMahon G, Machado F, et al. Geographical disparities of COVID-19 clinical presentation and hospitalisation risk factors. PLOS One [in review].
5. Lucaccioni H, Costa C, Perez Duque M, Sá Machado R. 2021. Descriptive epidemiology of COVID-19 cases in healthcare workers, Portugal, 2020. Revista Portuguesa de Medicina Geral e Familiar; 37:366-72. DOI: <https://doi.org/10.32385/rpmgf.v37i4.12979>.

6. [Lucaccioni H, Sá Machado R. 2021. Burden and Trends of Severe Rotavirus Infections and All cause Acute Gastroenteritis Hospital Episodes in Children Under Five Years Old in Mainland Portugal. Acta Médica Portuguesa, 34\(13\).](#)
7. Perez Duque M, Costa C, [Lucaccioni H](#), Marques R, Antunes D, Hansen L, et al. COVID-19 symptoms: a case-control study, Portugal, March-April 2020. *Epidemiology and Infection*, 149,e54,1–5. <https://doi.org/10.1017/S095026882100042X>
8. Köster PC, Malheiros AF, Shaw JJ, Balasegaram S, Prendergast A, [Lucaccioni H](#), et al. Multilocus Genotyping of *Giardia duodenalis* in Mostly Asymptomatic Indigenous People from the Tapirapé Tribe, Brazilian Amazon. *Pathogens*. 2021. 10(2):206. <https://doi.org/10.3390/pathogens10020206>

## Reports

1. Nationwide laboratory cluster of *Salmonella Newport*, Portugal, November 2019. Outbreak Investigation Report, January 2020.
2. Cluster of pneumonia of unknown aetiology in a poultry plant, April 2020, Torres Vedras, Portugal. Outbreak Investigation Report, July 2020.
3. Early steps and planning of an investigation of a gastrointestinal illness outbreak in a nursery, Torres Vedras, Portugal, December 2020. Outbreak Investigation Report, February 2021.
4. Large foodborne illness outbreak in a network of catered institutions, Beja, Portugal, May 2021. Outbreak Investigation Report, June 2021.
5. Protocol for the Evaluation of the National Surveillance System for Notifiable Sexually Transmitted Infections (2015-2019), Portugal, November 2019.
6. Evaluation of the National Surveillance System for Notifiable Sexually Transmitted Infections (2015-2019), Portugal, August 2020.
7. COVID-19 – Relatório Semanal de Situação, Portugal. Direção-Geral da Saúde, 2020-2021.
8. Relatório Semanal de Mortalidade COVID-19, Portugal. Direção-Geral da Saúde, 2020-2021
9. Monitorização da situação epidemiológica de COVID-19, Portugal. Direção-Geral da Saúde/Instituto Nacional de Saúde Doutor Ricardo Jorge, 2020-2021.
10. INSA Evolução do número de casos de COVID-19 em Portugal: relatório de nowcasting e forecasting
11. GOARN/World Health Organization, End of Mission Report. Outbreak Response to the Ebola Virus Epidemic in Mbandaka, Equateur, Democratic Republic of Congo (DRC), December 2020.
12. GOARN/World Health Organization, End of Mission Report. COVID-19 vaccine effectiveness study in health workers, Georgia, May 2021.

## Conference presentations

1. [Lucaccioni H](#), 2020. Evaluation of the National Surveillance System for Notifiable Sexually Transmitted Infections, Portugal, 2015-2018. European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), 24-27 November 2020, online.
2. Perez Duque M, [Lucaccioni H](#), Albuquerque MJ, Ramos M, Sá Machado R. 2020. Hepatitis C National Epidemiological Surveillance System Evaluation, Portugal - 2017/2018. Poster Presentation, European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), 24-27 November 2020, online.
3. Costa C, [Lucaccioni H](#), Perez Duque M, Marques R, Magalhães J P, Fonseca V R, Nunes J, Sá Machado R. 2020. A Matter of Time: Exploring Time Between Events in the COVID-19 Disease Course: a Descriptive Analysis of National Data from Portugal, 2020. Poster Presentation, ECCVID/ESCMID Conference on Coronavirus.

## Other presentations

1. Reunião sobre Observações, Notícias, Dados e Alertas (RONDA), n°46. Dengue em Espanha. CESP, Lisbon, Portugal, 13 November 2019.
2. Sá Machado, Costa C, Lucaccioni H, Perez Duque M, Marques R, Soares A P, Albuquerque M J, Ramos M. Situação Epidemiológica COVID-19 em Portugal (semanal), Auditório Infarmed, Lisbon, Portugal, 2020-2021.
3. World Health Organization. Présentations hebdomadaires de la cellule d'analyse à la riposte à l'épidémie d'Ebola en Equateur (RDC), EOC Mbandaka, Mbandaka, République Démocratique du Congo, Nov-Dec 2020.

## Other activities

1. Adaptation of WHO SARS-CoV-2 investigation protocols for their implementation in Portugal (household transmission, risk factors of infection among health care workers in a healthcare setting).
2. Protocol for a sero-epidemiological study in the context of a COVID-19 outbreak in a cruise ship, Portugal.
3. Lucaccioni H and Finci I. 2021. Postcard from the field: Responding to the Ebola outbreak in Equateur Province, Democratic Republic of the Congo. Available from: <https://www.ecdc.europa.eu/en/news-events/postcard-field-responding-ebola-outbreak-equateur-province-democratic-republic-congo>

## Other training modules

1. Practical Guide – Epicurve with R, DGS, May 2020.
2. Quick guide – Maps with QGIS, DGS, September 2020.

## 5. Other activities

Attended the European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE) – 2019 (Stockholm) & 2020 (online).

## 6. EPIET/EUPHEM modules attended

1. Introductory Course, 23/09-11/10 2019, Spetses, Greece
2. Outbreak Investigation, 9-13/12/2019, Nicosia, Cyprus
3. Management, Leadership and Communication in Public Health, 10-15/02/2020, online
4. Multivariable Analysis, 20-24/04/2020 & 18/03/2021, online
5. Project Review, 24-28/08/2020, online
6. Time Series Analysis, 25-30/01/2021, online
7. Rapid Assessment & Survey Methods (RAS), 27/04/2021 & 5-6/05/2021, online
8. Vaccinology, 14-19/06/2021, online
9. Project Review, 23-27/08/2021, online.

## 7. Other training

1. Comunicação de crise em saúde pública, 06/03/2020, Escola Nacional de Saúde Pública (ENSP), Lisbon, Portugal.
2. Outbreak analytics using R: tools for emergency outbreak response, 25-26/11/2019, R Epidemics Consortium (RECON)/EPIET Alumni Network (EAN), Stockholm, Sweden.
3. Essentials of Writing and Reviewing Scientific Abstracts: a field epidemiology focus, 21/06/2020, ECDC Virtual Academy, online.
4. Workshop - Design and conduct of an in-action review (IAR) of the ongoing activities in response to the COVID-19 response, 7/10/2020, ECDC, online.
4. GOARN Training Programme Tier 1, 22/03/2021, Global Outbreak Alert and Response Network (GOARN), online.
5. REDCap for Data Collection, 27/05/2021, WHO-IARC, online.
6. Regular participation in fellowship-related webinars (EAN, UK-FETP Masterclass, EPIET COVID619 Think tank), 2019-2021.



# Discussion

## Coordinator's conclusions

One of the main goals of the EPIET programme is for fellows to develop core competencies in field epidemiology, mainly through project or activity work, but also partly by participating in training modules and applying epidemiological methods to provide evidence to guide public health interventions for communicable disease prevention and control. This report summarizes all activities and projects conducted by Héloïse during her two-year EPIET fellowship (cohort 2019) at DGS in Lisbon, Portugal.

It has been a pleasure working with Héloïse during her fellowship. She is an independent, dedicated and excellent public health professional showing a great ability to initiate, a fast working pace, efficiency and flexibility in all her projects. Her professional background as a health geographer is of great additional benefit in the field of infectious disease epidemiology. The combination of both disciplines makes Héloïse's expertise unique, and especially valuable in the context of interdisciplinary settings and teams. During her fellowship, she participated in several international missions and was keen to transfer her expert knowledge in the context of humanitarian and public health emergency settings. She also managed to remain involved in spin-off projects after the actual field mission on COVID-19 vaccine effectiveness was over. She proved to be a trusted professional advisor and reliable team member. She has continuously expressed willingness to work on projects that would help her to reach the fellowship objectives and more. Although she would have wished to be even more productive, her work environment was challenging in a unit that was also overburdened with the response to the COVID-19 pandemic.

Héloïse clearly improved and expanded her knowledge of infectious disease epidemiology, participating in several outbreak investigations of foodborne zoonoses and a COVID-19 outbreak at a long term health facility. She also expanded her analytical skills in both research and surveillance projects on COVID-19, giardiasis, rotavirus and sexual transmissible diseases. During the EPIET modules, the PALOP course and in the role of facilitator she convincingly shared her professional knowledge and experience with others. More importantly, Héloïse foresees a career where her professional capabilities, dedication, excellent interdisciplinary expertise and enthusiasm in the global public health arena will be extremely valued.

## Supervisor's conclusions

Héloïse was a very dedicated fellow with a strong sense of responsibility. She worked hard to acquire the requisite knowledge and technical skills in all areas to fulfil EPIET competency requirements. She is attentive to detail and aims for high standards. Héloïse worked at the national level on the surveillance of numerous diseases and with different objectives in each project. She is capable of working both on data gathering and analysis and on communication, reporting and evaluation. In terms of field work, she was deployed at the local level for outbreak investigations with different diseases in a variety of settings. She is capable of planning, but can also interpret and adapt to developing situations. Héloïse thrives in a team when given clear deadlines, objectives and tasks. Héloïse survived the COVID-19 pandemic workload and through her work she made great contributions to the Directorate-General of Health. I think the output and quality of her work all around speaks for itself and she should be able to continue to succeed in developing and putting into practice her public health skills anywhere.

## Personal conclusions of fellow

The fellowship allowed me to expand and strengthen my skills in applied public health and field epidemiology. In short, I acquired new knowledge and competencies through hands-on experience in a range of projects, settings, organisations, and disease groups. In particular, I consolidated and further developed valuable skills in infectious disease epidemiology, data management and analysis, scientific methodology and communication, but also in project management, and team work. These two years in Portugal have also enabled me to gain a working proficiency in Portuguese. Finally, the fellowship provided me with insights into the broad European and global public health and microbiology community, and I can now confidently count myself as a part of this community.

## Acknowledgements of fellow

I would like to thank my frontline coordinators, Sooria Balasegaram and Barbara Schimmer, for their support and guidance during my fellowship. Thank you to my supervisors, Rita Sá Machado and Nuno Rodrigues, for sharing their experience and knowledge with me during these two years. I extend my appreciation to colleagues from DGS, particularly the DSIA/DEE teams, and all the external project supervisors. Many thanks to the EPIET Office and scientific coordination team for their contribution to the overall programme. Last but not least, thank you to all my fellow fellows from cohort 2019, aka 'the pandemic cohort'. It was a honour and pleasure to have been part of a cohort of such wonderful and brilliant individuals. May we continue as we started: crude and unadjusted, in a COVID-free world.