Summary of work activities
Mariana Perez Duque
Intervention Epidemiology path (EPIET), 2019 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 Mariana Perez Duque, cohort 2019 of the Intervention Epidemiology path (EPIET) at the Portuguese Directorate-General of Health.

Pre-fellowship short biography

Mariana Perez Duque graduated as a medical doctor in 2016 and is a senior resident of the Public Health Medical Specialisation in Portugal. Mariana has been working at both the local and national levels, in the Porto Public Health Unit of the North Region Health Administration and at the Directorate-General of Health (DGS) in Lisbon. She is also a travel medicine expert at the Porto International Vaccination Centre where she does travel medicine consultations. Finally, Mariana was awarded a scholarship in early 2019 to pursue a grade in Clinical Research from Harvard Medical School, USA, which she did concurrently while doing EPIET.

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 Manual[1].

1. Epidemiological investigations

Outbreak investigations

1.1 Mumps outbreak among vaccinated school-aged children and young adults linked to a school and a local football club in Lisbon and Tagus Valley Region, 2019/2020

Supervisors: Rita Sá Machado, Ana San-Bento

On 16 January 2020, four suspected cases of mumps were reported in the National Epidemiological Surveillance System (SINAVE) to the local Public Health Authorities of the Médio Tejo Health Cluster (ACES Médio Tejo). The four suspected cases were male, between four and 14 years old and attended the same local football club in Caxarias, a parish in the Ourém municipality.

Due to the epidemic potential of mumps, an outbreak investigation team was formed on the 21 January 2020 to assess the extent of the outbreak, identify routes of transmission, and initiate appropriate prevention and control measures.

Of the 18 suspected cases followed-up, 14 were further included in our outbreak case definition. Biological samples from five suspected cases were sent to the National Reference Laboratory (INSA) and three had laboratorial findings consistent with diagnosis of mumps acute infection. Thereafter, eleven cases were then classified as probable cases, as they fulfilled both clinical and epidemiological criteria.

The investigation highlighted that although Portugal has high mumps, measles and rubella (MMR) vaccine coverage, mumps outbreaks among children and young adults can occur, especially in crowded settings such as schools and after-school centres. Since the majority of cases had documentation of vaccination for mumps (two doses of MMR vaccine), as described in previous outbreaks, we hypothesised that waning immunity or discordant mumps virus strains (circulating – G and vaccine – A) are likely explanations for this outbreak.

Control measures were implemented. The vaccination status of children in the affected schools was reviewed. Confirmed cases were isolated for at least five days after the appearance of the parotitis.

To prevent and rapidly control future mumps outbreaks we recommended that it should be advisable to exclude mumps disease in salivary glands swelling (including parotitis) among school-age children and young adults in the first contact with healthcare. We also advised to raise clinical suspicion among general practitioners and other physicians that provide acute medical consultations in the region. We also endorsed future analytical studies on similar outbreaks among vaccinated people. This epidemiological investigation contributed further evidence that viral genotypic replacement in a highly vaccinated population can lead to outbreaks of a vaccine-preventable disease with divergent vaccine genotype.

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

Role: Principal Investigator. Mariana led the outbreak investigation together with the local Public Health team, developed analytical investigation - case-control study protocol – and suggested measures for control and prevention. She developed a questionnaire using as baseline existing instruments at international level for mumps outbreaks. This case-control study, including the new questionnaire were not implemented due to the COVID-19 pandemic. She also developed data entry mask, performed data analyses and wrote the final internal report (1). She is the first author of a brief report in a peer-review journal (2).

1.2 COVID-19 outbreak response in Porto-Portugal, 2020/2021
Supervisor: Delfina Antunes

As a compulsory notifiable disease, a COVID-19 confirmed case is followed by an epidemiological investigation by the local Public Health team (PHT), including contact tracing procedures and the implementation of prevention and control measures (i.e. screening). The local PHT is responsible for between 100 000 to 250 000 inhabitants and so the case is followed by the PHT of its residence.

This project involved early detection and control of COVID-19 outbreaks in different settings in Porto as a Public Health officer: schools, restaurants, healthcare institutions, private sector companies, migrant's residences, hostel and travel-associated clusters. Public health measures at schools aimed to reduce interaction between students with a minimum disturbance of school activities (example: reducing class size, increase the space between students, different starting schedules). Regarding public health measures applicable to the work context, the aim is to reduce the risk of transmission in the workplace, considered as a context in which the interaction between people can be close and long lasting. These measures were particularly important since all companies and small local businesses were required to have a contingency plan for COVID-19. The closure of workplaces was considered in cases where the number of cases and high-risk contacts was too high to allow work activities. In workplaces where one or more COVID-19 cases occurred, the adoption of sanitizing measures was crucial, as it decreased the potential of direct contact with the virus through aerosols and indirect contact through contaminated surfaces. Intervention in accommodation facilities such as migrant's shelters and hostels/hotels involved additionally to contact tracing procedures, field visits and intersectional responses with local stakeholders, in order to get beyond cultural and language barriers, as well as to address overcrowded housing issues.

Interventions in special contexts include the strengthening of individual protective measures, contact tracing procedures and mass testing, distribution and communication of public health messages. Event organisers (or those responsible for venues, such as wedding halls and sports centres) must speak with the local health authority for a public health evaluation. The feasibility and adequacy of the venue for the event was evaluated and the implementation of the measures would vary depending on the type of event and the location where it will take place, the number and profile of the target audience, as well as the environmental and logistical characteristics. In certain situations, the final decision could be the rescheduling or cancellation of the event.

Role: Public Health officer and epidemiologist. Mariana was responsible for outbreak management and the implementation of control and prevention measures: identification of contacts, risk assessment, screenings, reports and stakeholders communication during the second and third waves of the pandemic in Portugal.

1.3 COVID-19 emergency response in Amazonas-Brazil, 2020
Supervisor: Francesco Di Donna

Brazil was and still is one of the most affected countries in the world with the COVID-19 pandemic. In November 2020, the second wave started to take hold in Brazil, surpassing six million COVID-19 cases, according to state health secretariats. Mariana did an International Assignment for four weeks with Médecins Sans Frontières (MSF) Operation Center Belgium and MSF Brazil on epidemiological surveillance and outbreak management, providing evidence to control the growing COVID-19 pandemic in two federal states, São Paulo and Amazonas.

Role: Epidemiology Activity Manager. Her responsibilities included: detachment from coordination in São Paulo to the project in Tefé, to conduct epidemiological analyses in order to inform strategic decision making for project extension/future (R software); conduct risk assessments for different provinces in Brazil to provide recommendations for strategy and operational decision-making at the national level; produce routine weekly situation reports and projection analysis for the different projects and the national level (R software); supervise two data entry managers; operational research on antigen test implementation: development of proposal and support for future implementation.

Training modules related to assignment/projects

EPIET/EUPHEM Introductory Course - Main concepts of outbreak investigation, study designs and data analysis. Case studies on practical sessions based on previous EU infectious diseases outbreaks.

Outbreak Investigation Module - Comprehensive training for outbreak management and control. Detection, Elaborate hypothesis and test them through most common study designs for outbreaks. Detailed case study in different phases

Multivariable Analysis Module - Intermediate and advanced statistical skills training for applied research and outbreak investigation.

Vaccinology – Apply immunology concepts in vaccine preventable-diseases cases: genomic replacement, waning immunity, herd immunity.

Educational outcome

Mariana improved the skills and competences for outbreak investigations, from the detection of alerts to study design, questionnaire development and validation and communication of results. The most important aspects which Mariana further developed were data analysis and the formulation of evidence-based recommendations for targeted public health action. Moreover, she learnt how to be flexible, adapt to different contexts and how to work with different stakeholders in the field in emergency situations.

2. Surveillance

2.1 Evaluation of National Epidemiological Surveillance System Hepatitis C, 2017/2018

Supervisors: Rita Sá Machado, Ana Maria Correia

The Hepatitis C National Epidemiological Surveillance System sets as objectives the monitoring of ongoing virus transmission, understanding characteristics of cases and risk factors, early detection of cases to implement control and prevention measures and provides linkage to care. This strategy supports the Hepatitis C global elimination goals. The aim was to evaluate performance of the surveillance system using a set of key attributes, in order to identify gaps in for improvement or strengthening to guide prevention and control efforts.

SINAVE electronic data on all notified Hepatitis C cases were extracted from 2017 to 2018. Of the different key attributes, completeness was assessed using the proportion of compulsory fields filled. Positive predictive value was evaluated by the proportion of confirmed cases validated for surveillance purposes. Representativeness was discussed by comparing key characteristics with other systems using published findings in the literature. Timeliness was appraised by the proportion of notified cases in the first 24 hours after diagnosis.

Overall, there were 804 reported Hepatitis C cases. Data completeness of compulsory fields was 78.44% among notifications and 74.27% after epidemiological inquiry. The surveillance system had a positive predictive value of 51.3% (410/804). The main cause for non-confirmed cases was year of diagnosis before 2017. The majority of cases were male (75.8%), within the age group of 45-54 years old. Regional incidence was highly asymmetrical, ranging from 0 to 10.3 cases per 100 000 inhabitants. More than half of cases (50.7%) had chronic disease. Disease transmission through non-occupational lesion (needles, tattoo, piercing, bites and injuries) represented 26.8% of cases. Co-infection with HIV was 5.6%. Timeliness for notified cases within the first 24 hours of diagnosis was 24.2%.

The Hepatitis C epidemiological surveillance system, even though comprehensive, provides a sub-optimal picture of strategic disease indicators. It was recommended to improve the data quality on completeness by making the notification form shorter; focussing on key variables, and by making all fields for entry compulsory. It was endorsed an enhanced routine hepatitis C screening to ensure representativeness among high-risk groups. Timeliness can be enhanced by an automatic linkage between laboratorial and clinical software's.

Role: Principal Investigator. Mariana led the evaluation and worked with the national surveillance team, planning the evaluation framework and attributes. She extracted and performed the data analyses and wrote both the protocol and the final report (3). She presented the preliminary results of this project at ESCAIDE 2020 as a poster presentation (4) and is currently preparing a manuscript for submission to a peer-review journal (5).

2.2 COVID-19 National Task-force Portugal, 2020

Supervisor: Rita Sá Machado

The first case of COVID-19 was reported in Portugal on the 1 March 2020. Due to the novel and emerging nature of the disease, there was no reporting system in place. The national epidemiological surveillance system was used and a SARS-CoV-2 notification case report was created by the national team, to which both clinicians and laboratories report cases. A high sensitivity of the system was prioritised in the early phases of the pandemic, with daily processing and analysis of the data needed, in order to inform fast decision making (Ministry of Health), and to regularly communicate on the most up-to-date situation to the public. Weekly analyses in form of internal reports were made for different purposes: internal updates and discussion, and press conferences. With the purpose to address all areas of the National Preparedness and Response Plan for COVID-19, a Task Force with national experts was set up and coordinated by the Director-General for Health, for operationalisation and implementation of prevention and control measures issued in the in the contingency plan. The Task Force's mission was to centralise all epidemiological information and relevant evidence to perform risk assessment and management in order to issue guidelines and recommendations at the national level, as it was responsible for risk communication strategy.

Role: Epidemiologist and Public Health officer. Mariana started the draft and is a co-author of the National Preparedness and Response Plan for COVID-19 (6), she was involved in the selection of surveillance indicators, conducted weekly literature review and draft research protocols (WHO first few cases studies). She was one the data collectors of the WHO study for repatriating citizens during the first wave of COVID-19, she supported data/information system management and reported weekly case-based data to TESSy. She also analysed disease transmission, by calculating basic epidemiological parameters, including forecasting. Mariana contributed to situation reports, daily and weekly epidemiological situations, as well as weekly mortality report (7).

2.3 Listeria *molecular clusters detected by whole genome sequencing in Portugal, 2010-2021*

Listeriosis is a notifiable disease in Portugal. Laboratory confirmed cases have to be reported to the regional public health service, who contacts the case to perform the epidemiological investigation, including exposure to possible risk factors in the four weeks before onset of disease. Pregnant or mothers of a newborn children are included in this report form but have a specific risk group. When the diagnosis of *Listeria* is suspected, biological samples are sent to the National Reference Laboratory (INSA) which perform the analysis for *Listeria* isolates and further typing for national surveillance purposes based on Whole Genome Sequencing (WGS) typing. After several *Listeria* isolates were detected on microbiological samples and typed by WGS in the last decade, DGS and INSA met to investigate these molecular clusters and improve surveillance at the national level. A new working group in DGS was formed to start this project this summer (July 2021).

Role: Epidemiologist. Mariana will be responsible for exploratory data analyses on the epidemiological characteristics of Listeriosis cases detected during 2011-2021 by WGS. These results will be translated in an improved clinical and laboratorial surveillance framework for Listeriosis cases at the national level.

Training modules related to assignment/projects

EPIET/EUPHEM introductory course – Surveillance concepts and definitions, setup, run and evaluation of a surveillance system, types of surveillance systems, how to use and analyse of surveillance data for action and inform the decision-making process.

Multivariable Analysis Module – Intermediate and advanced statistical skills training with deeper understanding of regression methods and basic modelling.

Time Series Analysis module – Intermediate and advanced analysis of surveillance data. The module was particularly useful in the context of the international assignment and modelling COVID-19 data.

Educational outcome

Mariana had the opportunity to be involved in different phases of epidemiological surveillance at different levels, from running a surveillance system, to an evaluation through an attributes-based approach. Deep understanding of surveillance data quality for analysis and support action; importance of using surveillance systems to prioritise interventions (based on health needs) and guide the decision-making process.

3. Applied public health research

3.1 Tuberculosis underreporting in Portugal: a capture-recapture study, 2018

Supervisors: Rita Sá Machado, Ana Maria Correia

Tuberculosis (TB) is a communicable disease and the leading cause of death from a single infectious agent, above human immunodeficiency virus infection and disease (HIV/AIDS). In Portugal, TB has been a notifiable infectious disease since 1902, but a public health concern by law since 1949. Therefore, it is legally mandatory that every TB case must be reported. TB surveillance in Portugal relies on two systems, national epidemiological surveillance system of all notifiable diseases (SINAVE) and the tuberculosis surveillance system (SVIG-TB), a clinical system which is intrinsic to the National TB Program (NTP). In order to achieve 2020 milestones of the *End TB Strategy*, periodic review of methods and strengthening national TB surveillance systems are reliable ways to ensure robust estimates of TB incidence, prevalence and mortality. Inventory studies are needed to provide clear evidence on how national surveillance systems capture all (or virtually all) cases.

As Portugal becomes a TB low-incidence country, evaluation of TB surveillance systems becomes a high value resource to maintain, and even improve this status. Our study addressed TB being under-reported in Portugal and its aim was to evaluate performance of SINAVE for TB surveillance. The primary objective was to evaluate sensitivity of the national epidemiological surveillance system for TB in mainland Portugal in 2018. The secondary objective was to estimate TB incidence in 2018 using capture–recapture methods at the national level and to assess completeness of reporting and to test and propose a record-linkage algorithm to match cases. An inventory study using a capture-recapture analysis was carried out, comprising all incident TB cases diagnosed in mainland Portugal in 2018.

Role: Principal Investigator. Mariana conceived the study question, wrote the protocol, performed data extraction, developed data entry mask, performed data entry, data analysis in R. She wrote the final report (8), presented results in an international conference (9) and is drafting a manuscript to be submitted in a peer-review journal (10).

3.2 Case-control study on non-respiratory symptoms during the first wave of the COVID-19 pandemic in Portugal, March-April 2020
Supervisors: Rita Sá Machado

COVID-19, although a respiratory illness, has been clinically associated with non-respiratory symptoms. A negative case–control study was conducted to identify the symptoms associated with SARS-CoV-2-positive results in Portugal. For descriptive statistics χ2 tests were used to compare notified cases by sex, age group, health region and presence of comorbidities. For the regression analysis we used unconditional logistic regression. Twelve symptoms and signs included in the clinical notification of COVID-19 were selected as predictors, and the dependent variable was the RT-PCR test result. The best-fit prediction model was selected using a backward stepwise method. General and gastrointestinal symptoms were strongly associated with a positive test ($P < 0.001$). In this sense, the inclusion of general symptoms such as myalgia, headache and fatigue, as well as diarrhoea, together with actual clinical criteria for suspected cases, already updated and included in the current COVID-19 case definition, can lead to increased identification of cases and improve control of disease transmission.

Role: Principal Investigator. Mariana formulated the study hypothesis, planned the study design, wrote the protocol, performed data extraction, developed data entry mask, performed data entry and data analysis in both R and STATA, and wrote the final report. One publication and one manuscript were developed from this project (11).

3.3 COVID-19 hospitalisation risk factors and geographical cluster of symptoms during first wave of the COVID-19 pandemic in Portugal, March-April 2020
Supervisors: Rita Sá Machado, Gearoid McMahon

COVID-19 mainly presents as a respiratory disease with flu-like symptoms, however, recent findings suggest that non-respiratory symptoms can occur early in the infection and cluster together in different groups in different regions. Surveillance data on COVID-19 suspected cases tested in mainland Portugal were extracted. A multivariable logistic-regression analysis was performed to ascertain the effects of age, sex, prior medical condition and symptoms on the likelihood of testing positive and hospitalisation. Of 25 926 COVID-19 suspected cases included in this study, 5 298 (20%) tested positive. Symptoms were grouped into ten clusters, of which two main ones: one with cough and fever and another with the remainder. There were higher odds of a positive test with increasing age, myalgia and headache. The odds of being hospitalised increased with age, presence of fever, dyspnoea, or having a prior medical condition although these results varied by region. Presence of cough and other respiratory symptoms did not predict COVID-19 compared to non-COVID respiratory disease patients in any region. Dyspnoea was a strong determinant of hospitalisation, as well as fever and the presence of a prior medical condition, whereas these results varied by region.

Role: Principal Investigator. Mariana formulated the study hypothesis, planned the study design, wrote the protocol, performed data extraction, developed data entry mask, performed data entry and data analysis in both R and STATA, and wrote the final report. One publication and one manuscript were developed from this project (12).

Training modules related to assignment/projects

EPIET/EUPHEM Introductory Course - Main concepts of operational research. Develop research questions based on surveillance and health needs assessments, write study protocols, data analysis, project management and information dissemination and communications of results to different audiences.

Multivariable Analysis Module - Intermediate and advanced statistical skills training with deeper understanding of regression methods and basic modelling.

Educational outcome:
Mariana built up and developed new skills by conducting both hybrid public health/clinical research and field epidemiological studies. The role of a principal investigator was rewarding in terms of her being in charge in handling the study's priorities and needs due the pandemic, prioritise activities and adapt the timeline. Mariana also developed further insight into the importance of selecting the appropriate study design to adequately answer specific research questions. Moreover, she learnt about various data analysis methods and how to select the ideal method to analyse the data at hand. Finally, she furthered her understanding of the importance of communication, both internally and to the scientific community, in order to guide public health decision-making and increase the evidence base regarding the virus and disease in the midst of a pandemic.

4. Teaching and pedagogy

4.1 Epidemiology training course, Public Health Professionals in African Portuguese Speaking Countries (PALOP network)

Organiser and lecturer of an Epidemiology training course for Public Health teams of African Portuguese Speaking countries (PALOP network). She recorded two lectures in a studio (45 minutes each), one on *Outbreak Investigation* and one on *Rapid Risk Assessment* for an online learning platform. For this she developed the training material, the presentation, and the teleprompter guide. She was also a moderator of two online practical sessions (90 minutes each) on the previously mentioned topics. For the last one, an established and adapted botulism case-study was translated and adapted for one of the practical sessions (CDC Botulism Case Study).

4.2 Travel Medicine, Faculty of Medicine of University of Porto

Mariana was an invited lecturer in Travel Medicine (1 hour) for the Public Health module of the sixth year of the Masters in Medicine from Faculty of Medicine of University of Porto. Mariana gavethis lecture twice during the fellowship. She was also a facilitator at the Porto Public Health Unit and at the Porto International Vaccination Centre for pre and postgraduate students' internships.

4.3 Global Health, Public Health Institute of University of Porto

Mariana as an invited lecturer for the Global Health module for the Public Health PhD and for the Master in Public Health degrees. She gave three lectures; one lecture on Public Health Emergencies (three hours), one on Humanitarian crises and international programs and cooperation (three hours), and one on Bioterrorism (three hours). All lectures were online for which Mariana developed the lecturing material (presentation and group dynamics). Finally, she was also a co-evaluator together with the Head of the Global Health module of 18 PhD and master students for their final oral presentation (face-to-face).

Training modules related to assignment/projects

EPIET/EUPHEM Introductory Course – General concepts of teaching and training an adult audience. Main methods, group dynamics and development of teaching material.

Educational outcome:

Mariana improved her competences in the development, preparation, execution and evaluation of teaching and training activities. She strengthened her ability to work independently and adapt established material and topics for specific audience.

5. Communication

Publications related to the EPIET fellowship

Two manuscripts published in peer-review journals (2, 11).
One manuscript submitted and accepted in a peer-review journal after review process (13).
Two manuscripts submitted and under review in peer-review journals (12, 14).
Two manuscripts in draft (5, 10).

Reports

One outbreak report, one surveillance report (1, 3).
Ninety daily COVID-19 reports, eight weekly epidemiological reports and eight weekly mortality reports (7).

Conference presentations

One oral presentation at World Congress on Public Health 2020, online (9).

Other presentations

One ePoster at ESCAIDE 2020 (4) and one at ECCMID 2020 (15).

6. Other activities

Epidemic intelligence activities

Sporadic participant of the RONDA (Reunião sobre Observações, Notícias, Dados e Alertas), weekly meeting organised by the Public Health Emergencies Centre (CESP) of DGS on news, alarms and information on new and current outbreaks and public health threats. Although with the pandemic, Mariana was allocated exclusively to COVID-19, she gained some autonomy in handling tasks in the epidemic intelligence filter and validation of information. This work involved following events at national and international level and assess and communicate its risk (probability and impact) at the national level, as well as evaluate the cross-border potential. Examples include: Ebola in Democratic Republic of Congo, seasonal influenza in Portugal and Europe and vaping-related lipoid pneumonia (USA, Canada, Belgim, Phillipines, Brazil, Israel and Sweden).

Surveillance new report forms

Mariana developed the SINAVE National Epidemiological Surveillance System new surveillance report forms for vector-borne diseases added in the updated 2018 EU Case Definitions, EU Decision 2018/945 from the European Comission and updated nationally by Dispatch n.º 12513-B/201, Directorate-General of Health, Portugal.

Surveillance dashboard

Mariana worked on the SINAVE National Epidemiological Surveillance System dashboard, mainly developing indicators for the dashboard and writing metadata.

Legionnaire's disease outbreak in the North region in Portugal, October-November 2020

Mariana started to work on the North Region huge outbreak of Legionnaire's disease on mid-November 2020, when she was accepted for an international assignment on COVID-19 emergency response in Brazil. Mariana was included in a later stage of the investigation on the outbreak control team, but managed to start an internal report and did a descriptive analysis (R and QGIS) on cases before her deployment.

7. EPIET/EUPHEM modules attended

1. Introductory Course, 23 September - 11 October 2019, Spetses, Greece
2. Outbreak Investigation, 09-13 December 2019, Nicosia, Cyprus
3. Multivariable Analysis, 20-24 April 2020, online
4. Project Review 2020, 24-28 August 2020, online
5. Time Series Analysis, 25-29 January 2021, online
6. Rapid Assessment and Survey Methods, 4-6 May 2021, online
7. Vaccinology Module, 14-18 June 2021, online
8. Project Review 2021, 23-27 August 2021, online

8. Other training

1. Harvard Medical School Postgraduate Medical Education, Portugal Clinical Scholars Research Training Program, 2-year Certificate Program (2019-2021). *Fundação para a Ciência e a Tecnologia* awarded scholarship. Blended learning: face-to-face and online training. Weekly lectures and assignments, mid-term and final exam. Research outputs: one protocol and one publication in a peer-review journal.

2. Introduction to Mathematical models of the Epidemiology and Control of Infectious Diseases, 6-15 September 2021, Imperial College London, online. Miguel Cabral awarded scholarship – Independent Union of Physicians.

Discussion

Coordinator's conclusions

It has been a pleasure working with Mariana during her fellowship. She is a dedicated and ambitious public health doctor with clear professional interest in vaccine-preventable diseases and analytical epidemiology, and is keen to transfer this expert knowledge in the context of humanitarian and public health emergency settings. During her fellowship, she had to balance conflicting demands in an often challenging work environment during the COVID-19 pandemic, both on the national and local level. She managed to be productive by securing dedicated time for her own learning experience. She efficiently combined projects for another training program she was enrolled in and ensured all outputs were achieved. She clearly improved and expand her analytical and technical skills during the national surveillance system evaluation of Hepatitis C, the tuberculosis capture-recapture study and several COVID-19 research projects related to clinical presentation and risk factors for hospitalisation. Moreover, besides her analytical skills, she is a clear communicator and demonstrated excellent teaching skills during the PALOP training. During the EPIET modules she convincingly shared her professional knowledge and experience with others. More importantly, Mariana foresees a public health career, which will involve continuous learning on infectious disease epidemiology on a more academic level, and being active and apply her newly-acquired skills, expertise and enthusiasm in the global public health arena.

(Barbara Schimmer)

Supervisor's conclusions

Mariana developed most of her fellowship during the COVID-19 pandemic. This circumstance brought both a positive and negative impact to her training process. She had the opportunity to improve her field epidemiology knowledge and skills in a public health emergency, but as human resources in healthcare services are scarce in Portugal, all healthcare professionals were involved in COVID-19 response. Being at the General-Directorate of Health, she participated in the preparedness phase, integrating the national team and designing the skeleton of the national contingency plan in all their components, from surveillance to communication. On the other hand, at the local level Mariana was involved in COVID-19 surveillance and response, implying all the domains of applied epidemiology EPIET competencies.

Surveillance systems evaluation was a strong component of the work Mariana developed and I am sure that the results of the projects about Hepatitis C and Tuberculosis will be very useful for the Directorate-General of Health.

So, even in an environment and circumstances where the variety of opportunity of projects was somehow limited, Mariana's energy and enthusiasm allowed her to find the way to diverse her learning gains.

I am sure that Mariana will be an excellent public health doctor and field epidemiologist wherever she will be working in the future.

(Ana Maria Correia)

Personal conclusions of fellow

I enrolled in the fellowship to improve my methodological skills and competences and gain field expertise in infectious diseases epidemiology. I am very passionate about communicable diseases epidemiology and EPIET was a great opportunity to gain competencies to develop outbreak investigation skills, applied research, surveillance and teaching activities applying high standards of quality.

The fellowship was a challenging period of my career, especially due to the COVID-19 pandemic, but a rewarding experience for my professional growth.

I am very happy to belong to a field epidemiologists' network and looking forward to pursuing both a field humanitarian and epidemiology academic career.

Acknowledgements of fellow

I would like to acknowledge all my supervisors and frontline coordinators that guided me during the fellowship with knowledge and expertise in these unusual times. I am also grateful to the DGS national surveillance team for their support, guidance and availability during my fellowship.

Finally, I would like to thank all professionals that helped me during these two years and fellows of the Cohort 2019 for the great companionship and friendships for life.