Emiel Andreas A. Vanhulle

The European Public Health Microbiology Training Programme (EUPHEM), Cohort 2023

National Institute for Public Health and the Environment (RIVM), the Netherlands

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. The Administrative Decisions ECDC/AD/2022/16 Rev.01 and ECDC/AD/2023/06 govern the European Union (EU)-track and Member State (MS)-track, respectively, of the ECDC Fellowship Programme, field epidemiology path (EPIET) and public health microbiology path (EUPHEM), Cohort 2023.

Both curriculum paths provide training and practical experience using the 'learning-by-doing' approach at acknowledged training sites across the European Union/European Economic Area (EU/EEA). This final report describes the experiences and competencies the fellow acquired by working on various projects, activities, theoretical fellowship training modules, other modules or trainings, and international assignments or exchanges during the fellowship.

Pre-fellowship short biography

Emiel Vanhulle is a virologist with a PhD in Biomedical Sciences from the University of Leuven (Belgium) and has over eight years of experience in molecular microbiology and diagnostic development. Trained in high-containment laboratory settings, he has a strong foundation in both academic and public health, combining diagnostic expertise with applied infectious disease surveillance. Before joining the EUPHEM fellowship, his research at the Rega Institute for Medical Research (Leuven, Belgium) focused on respiratory viruses, including severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and respiratory syncytial virus (RSV). His expertise spans molecular diagnostics, genomic surveillance, and viral pathogenesis, with a particular interest in emerging viruses, zoonotic diseases, and capacity-building. He thrives in interdisciplinary and collaborative environments and is motivated by translating laboratory findings into actionable public health evidence.

Encouraged by continuous learning and to broaden his expertise in intervention epidemiology, Emiel joined the EUPHEM programme. He also sought to improve his ability to bridge laboratory diagnostics and epidemiology to support evidence-based infectious disease control at national and European levels.

Stockholm, 2025

Results

The objectives of the core competency domains were achieved partly through project and activity work, and partly by participating in the training modules. Results are presented in accordance with the EPIET/EUPHEM core competencies, as set out in the ECDC Fellowship Manual[1].

1. Epidemiological investigations

1.1. Outbreak investigations

1.1.1. Outbreak of measles in Rotterdam, the Netherlands, 2025

Supervisors: Dr GJ Sips, Dr A Tjon-A-Tsien, M-C Trompenaars (GGD Rotterdam-Rijnmond)

Category: Vaccine-preventable diseases

Aim: To investigate and respond to a measles outbreak linked to two elementary schools with low vaccination coverage in the Rotterdam-Rijnmond region of the Netherlands.

Methods: In February 2025, a measles outbreak was detected in the Rotterdam-Rijnmond region of the Netherlands, initially linked to an elementary school with low vaccination coverage. The outbreak occurred in the context of declining national measles, mumps, and rubella (MMR) vaccine uptake, and after years of minimal measles circulation during the coronavirus 2019 (COVID-19) pandemic. Case finding was based on clinical criteria and epidemiological links, with laboratory confirmation through polymerase chain reaction (PCR) and/or serology. Probable and possible case definitions were adapted during the outbreak based on observed transmission patterns, including a subsequent cluster at a second elementary school with similarly low vaccine coverage.

Results: As of 2 July 2025 (week 19 of the outbreak), a total of 165 confirmed and probable measles cases were reported, with 86% residing in the municipality of Rotterdam. Most cases (n=143) were unvaccinated, and 27 individuals required hospitalisation, mostly for dehydration, pneumonia, or high fever.

Public health implications: The outbreak response focused on surveillance, case management, public communication, and coordination with schools and local health partners. The ongoing transmission at one of the elementary schools demonstrates the challenges of outbreak control in under-vaccinated communities. This outbreak underlines the importance of maintaining high MMR vaccination coverage and tailored communication strategies to reach vaccine-hesitant populations.

Role: As a fellow placed at RIVM, Emiel had the opportunity to go for a secondment at the Dutch municipal public health service (gemeentelijke gezondheidsdienst – GGD), Rotterdam-Rijnmond during this outbreak to support and learn from the local response. He was involved across multiple domains of the investigation and response, contributing both technically and operationally.

1.1.2. Outbreak of **Streptococcus pyogenes** *(invasive group A* **Streptococcus***) in a long-term care facility, Rotterdam, 2025*

Supervisors: Dr N van Eeden, Dr A Tjon-A-Tsien (GGD Rotterdam-Rijnmond)

Category: Healthcare-associated infections and antibiotic resistance

Aim: To investigate a suspected cluster of invasive group A streptococcal (iGAS) infection among residents of a long-term care facility for people with dementia, and to identify potential transmission routes to guide infection-control measures.

Methods: Between January and April 2025, three residents developed iGAS infections, two of which were fatal. One staff member had a GAS-positive wound culture. Case reviews, facility mapping, and screening of staff for throat carriage were undertaken. Whole-genome sequencing (WGS) of patient isolates was performed at the RIVM to assess genetic relatedness. Outbreak coordination meetings were held between the GGD, infection-prevention specialists, and the facility management.

Results: All three patient isolates were identified as *emm* type 49.3, cluster E3, a rare lineage in the Netherlands. WGS confirmed high genetic similarity, indicating a single institutional cluster. No GAS carriage was detected among approximately 20 screened healthcare workers, and no environmental or cross-departmental transmission source was confirmed.

[1] European Centre for Disease Prevention and Control (ECDC). Manual for the ECDC Fellowship Programme EPIET and EUPHEM paths. Stockholm: ECDC; 2025. Available at: https://www.ecdc.europa.eu/en/publications-data/ecdc-fellowship-programme-manual

Public health implications/Conclusions: The investigation showed the vulnerability of long-term care residents to infection and the importance of rapid microbiological typing and inter-sectoral coordination for outbreak control. Early verification of infection-prevention measures, clear communication, and proportional response actions prevented further transmission. Continuous awareness and timely reporting of iGAS cases remain essential for early detection and containment of future clusters.

Role: Emiel actively contributed to the outbreak investigation by gathering case data, reviewing the facility structure to explore potential epidemiological links, and participating in coordination meetings with infection-prevention specialists and clinicians. He consulted international and national guidelines to support the assessment of control measures and transmission hypotheses.

1.1.3. EpiPulse alert on Panton–Valentine leukocidin (PVL)-positive livestock-associated methicillin-resistant **Staphylococcus aureus** *(MRSA) outbreak, Central Netherlands, 2024*

Supervisor: Dr Daan Notermans (RIVM)

Category: Healthcare-associated infections and antibiotic resistance

Aim: To report and disseminate information on a community outbreak of Panton–Valentine leukocidin (PVL)-positive livestock-associated (LA)-MRSA without livestock contact in Central Netherlands, and to alert European partners through the ECDC European surveillance portal for infectious diseases (EpiPulse) platform.

Methods: National MRSA surveillance data were reviewed following identification of an unusual cluster of PVL-positive LA-MRSA cases. Epidemiological and laboratory information were collated in collaboration with RIVM experts and the National MRSA Surveillance Coordinator. Relevant literature and previous national data were analysed to contextualise the event. The resulting summary was drafted as an EpiPulse alert and reviewed prior to publication.

Results: As of 22 February 2024, 22 confirmed cases were identified. The implicated multiple-locus variable-number tandem-repeat analysis (MLVA) type had been detected only four times since 2010. All previously typed strains were PVL-negative, indicating an emerging clone with potential public health relevance. The alert enabled rapid information exchange with EU/EEA countries and assessment of possible international links.

Public health implications/Conclusions: This early signal demonstrated the importance of routine cross-country early warning systems in rapidly detecting emerging antimicrobial-resistance threats. Timely data sharing and coordinated risk assessment across Member States is essential to support early detection and targeted control measures.

Role: Emiel led, drafted, and coordinated the EpiPulse international alert.

1.1.4. Early warning message on **Taenia solium** *cluster in schoolchildren, Belgium, 2024*

Supervisor: Dr T Kortbeek (RIVM)

Category: Food- and waterborne diseases

Aim: To prepare and disseminate an early warning message following notification of *Taenia solium* (*T. solium*) cysticercosis cases among schoolchildren in Belgium, and to assess its public health relevance for the Netherlands and potential cross-border implications.

Methods: In January 2024, Belgian health authorities reported five paediatric cases of cysticercosis linked to a school in Flanders. Emiel collaborated with RIVM experts to review available information from the Belgian *Nieuwsflash Infectieziekte Bulletin*, collect additional epidemiological data, and explore possible additional cases. The information was evaluated during the weekly Early Warning Meeting (EWM) at RIVM and disseminated through the weekly signal report to professionals in infectious disease control.

Results: The cases were likely linked to exposure from a human *T. solium* carrier, although the source remained unidentified. The situation was closely monitored for cross-border relevance, and no related infections were detected in the Netherlands.

Public health implications/Conclusions: The investigation identified communication and preparedness gaps, including limited public access to updated information on *T. solium* diagnostics and control guidance.

Role: Emiel contributed to gathering data, analysing potential links, and participated in drafting the early warning signal.

1.2. Surveillance

1.2.1. Epidemiological and clinical insights into enterovirus circulation in Europe: A multicentre retrospective surveillance study, part of the ENPEN and ECDC study protocol, 2018–2023

Supervisors: Kim SM Benschop (RIVM), Eeva K Broberg (ECDC), Heli Harvala (University of Turku), Thea K Fischer (Nordsjællands Hospital and University of Copenhagen)

Type of project: Analysing and interpreting data from a surveillance system to generate information for action.

Aim: To describe the epidemiological and molecular trends of non-polio enteroviruses (EVs) detected across Europe through the European non-polio enterovirus network (ENPEN) and to assess temporal, geographical, and type-specific changes in circulation from 2018 to 2023.

Methods: ENPEN is a collaborative network of over 30 public health laboratories collecting routine national enterovirus typing data using real-time polymerase chain reaction (RT-PCR), sequencing, and genotyping. Participating laboratories submit annual aggregated and strain-level data to a central database hosted by RIVM. Data were cleaned, harmonised, and analysed to identify dominant EV types, seasonal patterns, and associations with clinical syndromes such as meningitis, hand-foot-and-mouth disease, and respiratory illness.

Results: Twenty-eight institutions (across 16 countries) reported 563 654 EV tests during the study period with 33 265 (5.9%) of the tests EV-positive. Forty-two types were identified (n=11 605 cases). Echoviruses (E30, E11) and EV-A71 dominated, with notable genotype shifts and outbreaks linked to neurological manifestations. Paralysis was reported among 22 infections, associated with 10 non-polio types. A sharp decline in detections was observed during the COVID-19 pandemic, followed by a rebound and altered seasonality in 2021–2023. The findings highlighted differences in surveillance intensity and laboratory methods across Europe and emphasised the value of coordinated data sharing.

Public health implications/Conclusions: This surveillance demonstrated the value of cross-border collaboration and standardised data sharing for tracking enterovirus dynamics in Europe. By integrating national datasets, ENPEN enhances situational awareness, facilitates early warning for emerging types, and contributes to coordinated regional responses, strengthening Europe's collective capacity for enterovirus control.

Role: Emiel contributed to data validation, data analysis, interpreting results, planning, and leading meetings with stakeholders. He presented the proposal and findings to various audiences, incorporated feedback, drafting, writing, and revising the multi-country authored manuscript 'Changing epidemiological landscape of enteroviruses in Europe, 2018–2023' which was published in *The Journal of Infectious Diseases* (see section 7.1).

1.2.2. Enterovirus D68 epidemic trends in the Netherlands during the early respiratory virus season, 2023

Supervisors: Kim SM Benschop, Adam Meijer, Dirk Eggink (RIVM)

Type of project: Analysing and interpreting data from a surveillance system to generate information for action.

Aim: To investigate the molecular characteristics and genotype distribution of enterovirus D68 (EV-D68) detected through national enterovirus surveillance during the early respiratory virus season of 2023 in the Netherlands, and to compare findings across hospital-, community-, and general-practice-based surveillance systems.

Methods: EV-D68 detections from three national surveillance systems (hospital-, community-, and general practice-based) between July and December 2023 were analysed. Viral Protein 1 (VP1) sequencing was performed for subclade determination, and demographic and temporal trends were compared across systems.

Results: A total of 219 samples were EV-D68 positive. Sequencing identified subclades A2 (36%) and B3 (28%), while 36% (n=78) could not be classified due to limited sequence data. The detection peak occurred during week 40 (8 October 2023). Age distribution differed between systems. Most detections in hospital-based surveillance were among children aged 1–5 years, while community surveillance cases were primarily adults aged 50–60 years. Among hospital cases (n=59), B3 predominated (69%, n=41). In community surveillance (n=138), A2 was most frequent (38%). In general-practice surveillance (n=22), 14 samples (64%) belonged to A2 and eight (36%) to B3. No difference in subclade distribution was observed by sex.

Conclusions: The co-circulation of A2 and B3 subclades and the early detection peak mirror patterns observed across Europe. Based on these results, it remains uncertain whether community surveillance data can reliably serve as a proxy for hospital-based trends. Continuous molecular surveillance is essential to detect shifts in EV-D68 activity, seasonality, and associated disease burden.

Role: Emiel contributed to data validation, data analysis, interpreting results, planning, and leading meetings with stakeholders. He presented the proposal and findings to various audiences, incorporated feedback, and drafted a report.

2. Applied public health microbiology research and laboratory investigations

2.1. Comparative overview of **Haemophilus influenzae** *serotyping methodologies used in Europe and their sensitivity and specificity within a surveillance context in the Netherlands, 2025*

Supervisors: Anneke Steens, Rob Mariman, Gerlinde Pluister (RIVM)

Aim: To investigate whether methodological differences in *Haemophilus influenzae* (Hi) serotyping contribute to observed inter-country variation in reported *Haemophilus influenzae* type b (Hib) incidence rates in Europe, and to assess the diagnostic performance of the Dutch in-house agglutination assay compared with PCR-based reference testing.

Methods: A two-phase study was designed. First, a European online survey was distributed to 20 national reference laboratories to map current Hi serotyping methods and assays. Second, a comparative evaluation of the Dutch in-house serotyping method was performed using all invasive Hi isolates from 2021. Results from the in-house agglutination assay were compared with a two-step PCR-based reference method to determine assay sensitivity, specificity, and concordance.

Results: The study revealed variability in serotyping approaches across Europe. Fourteen laboratories responded (70% response rate), reporting diverse practices including PCR-based typing and the use of commercial agglutination kits (BD Difco™, Remel™). The Dutch in-house assay demonstrated excellent specificity (100%) and high sensitivity (98.6%) for Hib detection, with only one false-negative result among 164 isolates evaluated. These findings strongly suggest that the observed high Hib incidence in the Netherlands reflects a true epidemiological trend rather than diagnostic artefacts.

Conclusions: The results confirm the reliability of the Dutch serotyping method and exclude methodological bias as a cause of the higher Hib incidence observed in the Netherlands. These findings reinforce confidence in national surveillance data and highlight the importance of harmonising *Haemophilus influenzae* serotyping across Europe to ensure consistent monitoring and informed public health action.

Role: Emiel coordinated the design and implementation of the *Haemophilus influenzae* serotyping evaluation project together with Anneke Steens. He wrote the project proposal, designed the European survey, analysed the collected responses, and interpreted the findings. He was responsible for coordinating sample selection (together with Gerlinde Pluister), setting up the quantitative PCR (qPCR) workflow, performing the molecular assays, and analysing the resulting quantification cycle data (together with Gerlinde Pluister). He performed the sensitivity and specificity analysis comparing PCR and phenotypic serotyping results, and drafted the full technical report outlining the methods, findings, limitations, and follow-up activities. In the final phase of the project, Emiel supported the handover of ongoing work to continue the comparative testing of commercial kits.

2.2. Verification of a manual **Francisella tularensis** *ELISA assay, the Netherlands, 2025*

Supervisors: Karen Kerkhof, Mark Jonker (RIVM)

Aim: To verify the diagnostic performance of the manual *Francisella tularensis* immunoglobulin G/M (IgG/IgM) ELISA assay compared with the automated SERION Immunomat™ system (both from Institut Virion\Serion GmbH Würzburg, Germany), ensuring continued serological capacity for tularaemia diagnostics at RIVM after relocation of the laboratory facilities. The Immunomat system will not be transferred to the new location, making a validated manual procedure essential for future diagnostic testing.

Methods: The same SERION ELISA classic *Francisella tularensis* IgG/IgM kits were used for both methods. The manual assay was performed according to the manufacturer's instructions, with all pipetting, incubation, and washing steps carried out manually. Plates were read at 405 nm (reference 620 nm) on a Multiskan™ FC reader, and optical density (OD) values were converted to U/mL using a four-parameter logistic (4-PL) model and lot-specific quality control data. Fifty-six archived sera, including confirmed tularaemia cases and negative controls, were tested in parallel with the manual and automated methods.

Results: Results were compared both for the quantitative antibody concentrations (U/mL) and the categorical diagnostic interpretations (negative, borderline, positive). For IgG, 51 of 56 samples (91%) showed concordant diagnostic classification for both methods, with a strong quantitative correlation (R^2=0.94). For IgM, 55 of 56 results (98 %) were concordant, but quantitative correlation was moderate (R ≈ 0.65–0.70), mainly due to variability around low titres near the cut-off.

Conclusions: The manual ELISA produced results comparable to the automated Immunomat method and meets diagnostic quality standards. It provides a validated and sustainable alternative for *Francisella tularensis* serology at RIVM following the phase-out of the Immunomat system.

Role: The fellow coordinated the verification, wrote the study protocol, performed the ELISA experiments, documented procedures in a laboratory standard operating procedure (SOP), analysed the data, and wrote the internal verification report for inclusion in RIVM's Zenya quality management system.

3. Biorisk management

3.1. Previous biosafety level-3/3+ (BSL-3/3+) training and experience, Rega Institute for Medical Research, Belgium, 2020

Before the fellowship, Emiel received extensive BSL-3 training and experience at the Rega Institute for Medical Research (KU Leuven, Belgium), where he completed the 3CAPS general orientation training, as well as the on-site and hands-on containment training (31 contact hours, 2020). This included practical supervised work in BSL-3 and 3+ areas, use of powered air-purifying respirators (PAPR), biosafety incident response, and basic life support training. This foundation provided a strong practical understanding of the principles of high containment.

3.2. Activities related to Biorisk management during the EUPHEM fellowship, 2023–2024

During the fellowship, Emiel strengthened his competencies in biosafety and biosecurity through the Biosecurity Kennisdag (the Netherlands, November 2023), the EUPHEM module on Bio-risk and Quality Management (May 2024), the ECDC AURORAE online seminar on Biosafety and Quality Assurance (December 2024), and the European Mobile Laboratory Core training (Germany, March 2024).

These activities improved his understanding of dual-use research, biosecurity legislation, containment principles, and structured risk assessment. He gained practical skills in performing bio-risk analyses, applying the World Health Organization (WHO) Biosafety Risk Assessment Tool, and aligning laboratory procedures with international standards to ensure safe and sustainable public health laboratory operations.

3.3. European Mobile Laboratory (EMLab) core training at the Bernhard Nocht Institute for Tropical Medicine (BNITM): simulated outbreak of Ebola virus disease, Hamburg, Germany, 2024

Supervisor: Dr Emily Nelson, Lab group Duraffour-Pahlmann, BNITM

Aim: To strengthen practical and theoretical skills in mobile laboratory operations for outbreak response and preparedness, focusing on biosafety, diagnostics, and intersectoral coordination during high-consequence pathogen outbreaks.

Methods: The EMLab Core Training was organised by the European Mobile Laboratory team at the BNITM in Hamburg from 18–22 March 2024. Twelve selected participants from European institutions underwent intensive theoretical and hands-on training based on a simulated Ebola virus disease outbreak scenario. The programme included lectures, group exercises, and practical modules on molecular diagnostics (RT-PCR), field sequencing, logistics, power planning, biosafety, and decontamination procedures.

Results: Participants gained first-hand experience in setting up and operating modular mobile laboratory units, sample inactivation, and data management under field conditions. The training provided a comprehensive understanding of the Rapid Response Mobile Laboratory (RRML) and European Civil Protection Pool (ECPP) mechanisms, and how mobile laboratories integrate within WHO's Global Outbreak Alert and Response Network (GOARN).

Public health implications: The training directly supports global health security by strengthening the pool of experts capable of deploying mobile laboratories during outbreaks. It enhances rapid diagnostic capacity, ensures biosafe handling of high-risk pathogens, and contributes to timely outbreak detection and response, particularly in resource-limited settings.

Role: Emiel completed the full EMLab core training and became part of the global EMLab expert network. The training enhanced his practical competencies in outbreak diagnostics, biosafety, and quality management, and strengthened his readiness to contribute to future international outbreak deployments. It also provided valuable experience in teamwork, communication, and cross-institutional collaboration under simulated emergency conditions.

4. Quality management

4.1. Diagnostic evaluation of the serological detection performance on HBV surface antigens in the Netherlands, 2023–2024

Supervisors: Kim Benschop, Margarida Simões (RIVM)

Aim: To evaluate the diagnostic performance of serological assays used in Dutch clinical laboratories for the detection of hepatitis B virus (HBV) surface antigen (HBsAg) across different HBV genotypes, and to assess inter-assay and inter-laboratory variability.

Methods: An external quality assessment (EQA) panel containing 16 well-characterised serum samples representing HBV genotypes A–H and one negative control was prepared and distributed to 27 Dutch laboratories. Participants tested the samples using their routine diagnostic assays and reported quantitative and qualitative results. Data were compared across platforms and genotypes to identify differences in detection sensitivity and reproducibility.

Results: Eleven diagnostic systems (three quantitative and eight qualitative) were evaluated. All assays consistently detected HBsAg from the included genotypes, demonstrating overall good performance. Quantitative assays, however, showed variability in antigen detection levels both between genotypes and across laboratories using the same system. Lower HBsAg signal values were observed for genotypes A2, B2, D1–D3, and F2.

Public health implications/Conclusions: The study confirmed reliable HBsAg detection across genotypes in Dutch laboratories but highlighted measurable variability in quantitative results. These findings emphasise the importance of continued EQAs, assay standardisation, and cautious interpretation of HBsAg levels for clinical and surveillance purposes.

Role: Emiel developed the data analyses design, coordinated data collection, analysed results, and authored the final report and conference abstract.

4.2. External audit of the Centre for Infectious Diseases Research, Diagnostics and Laboratory Surveillance (IDS), RIVM, by the Dutch Accreditation Council (Raad voor Accreditatie – RvA): Assessment against ISO 15189:2012, 2023

The annual external accreditation audit of the IDS at RIVM was conducted by the Dutch Accreditation Council (RvA) on 6 December 2023 to evaluate compliance with ISO 15189:2012. The audit included document review, staff interviews, and on-site inspections across multiple diagnostic laboratories. Emiel observed the process and participated in follow-up meetings to discuss the audit outcomes and review non-conformity reports (NCBs). He gained insight into the identification of non-conformities, formulation of corrective and preventive actions, and the implementation of root-cause analyses at the IDS using the '3xO' method.

The audit resulted in six minor non-conformities, all of which were addressed and resolved by April 2024. Through active observation and discussion with quality coordinators and auditors, Emiel gained a comprehensive understanding of how external audits contribute to continuous improvement, transparency, and institutional accountability. Participation in the RvA audit strengthened his practical understanding of accreditation processes, ISO-15189 requirements, and the central role of quality management systems in ensuring diagnostic accuracy and maintaining public trust in national reference laboratories.

Role: Emiel attended and observed the external RvA audit, participated in follow-up meetings, reviewed deviation reports, and contributed to corrective action discussions.

4.3. Assessment of the quality management system at the host institute, RIVM

As part of the 'Biorisk and Quality Management' module, Emiel performed an assessment of the quality management system at the host institute. RIVM operates under a multi-level quality system, with designated personnel responsible for equipment and procedural oversight. An internal electronic system is used to manage SOPs staff qualifications, reagents, and equipment records. Deviations and errors are logged, investigated, and followed by corrective actions. Routine internal audits and participation in annual external audits are carried out to ensure compliance and continuous improvement.

4.4. Other activities related to laboratory quality management during the EUPHEM fellowship at RIVM

Emiel improved his understanding of laboratory quality management systems and their implementation within public health laboratories. Through the EUPHEM module AURORAE online seminar, and the EMLab core training, he explored ISO15189:2022 and ISO20387:2018 standards, verification and validation of molecular assays, and quality control practices. These experiences strengthened his ability to apply structured quality assurance approaches, evaluate laboratory performance, and promote continuous improvement.

5. Public health microbiology management

Project management during outbreak investigations and various other projects, RIVM, 2023–2025

This competency was developed through multiple projects and activities during the fellowship, combining on-the-job learning from colleagues at RIVM with structured programme modules. Each project contained elements of public health microbiology management, requiring coordination between laboratory, epidemiology, and public health partners. Through his involvement in outbreak investigations and research projects, Emiel gained experience in project and team coordination, planning, and stakeholder communication. His responsibilities included liaising with experts across departments, incorporating feedback, preparing study protocols, ensuring quality assurance, and contributing to reporting and dissemination. These activities strengthened his skills in leadership, organisation, and conflict resolution within multidisciplinary teams.

Infectious diseases early warnings meetings and bulletin, RIVM, 2023–2025

In the course of the fellowship, Emiel participated in the weekly infectious diseases early warnings meetings (Signaleringsoverleg) at RIVM, which is a national multidisciplinary discussion group combining expertise from different fields (epidemiology, public health microbiology, infectious diseases, infectious disease control, veterinary medicine, environmental sciences, and others upon invitation) chaired by Gijs Klous, Annelot Schoffelen, Jeannet Bos, Rogier Bodewes, and Alexander van der Gaag. The tasks of the group include collecting, selecting and summarising infectious diseases signals of public health importance from the Netherlands and abroad. Summarised signals are communicated to the wider professional community through a weekly confidential bulletin. Emiel contributed to discussions and provided input on signals within his areas of expertise, including virology and emerging pathogens.

6. Teaching and pedagogy

Development and facilitation of a tabletop exercise on a simulated **Candida auris** *outbreak, RIVM, 2023–2024*

Emiel co-designed and facilitated a half-day tabletop exercise simulating a national *Candida auris* outbreak during the mandatory Public Health course for medical microbiology residents at RIVM. He co-developed the scenario, injects, and facilitator materials, and guided the medical microbiology group during the session. The exercise trained 23 participants in structured outbreak decision-making and inter-disciplinary collaboration. This experience improved Emiel's instructional design, facilitation, and evaluation skills, and strengthened his understanding of simulation-based learning for public health training.

Supervision and guidance of a master's student for a master thesis project, RIVM, 2024

Alongside his host-site supervisor, Emiel supervised a master's student from the Erasmus Mundus Infectious Diseases and One Health (IDOH) programme during a four-month internship at RIVM. The student conducted phylogenomic analyses on Echovirus 11 within the ENPEN network. Emiel provided scientific guidance, coordinated project timelines, and supported data analysis and manuscript drafting. The experience strengthened his mentorship, communication, and feedback skills, while fostering a supportive and collaborative learning environment focused on scientific integrity, independence, and professional growth.

7. Communications related to the EPIET/EUPHEM fellowship

7.1. Manuscripts published in peer-reviewed journals

- **Vanhulle E**, de Schrijver S, Ingenbleek A, Alexakis L, Johannesen CK, Broberg EK, Harvala H, Fischer TK, Benschop KSM; ENPEN Study Collaborators. Epidemiological and Clinical Insights into Enterovirus Circulation in Europe, 2018-2023: A Multicenter Retrospective Surveillance Study. J Infect Dis. 2025 Jul 30;232(1):e104-e115. doi: 10.1093/infdis/jiaf179. PMID: 40184501; PMCID: PMC12308651. Available at: https://academic.oup.com/jid/article/232/1/e104/8106541
- **Vanhulle E**, Simões M, Ten Bruin H, Boland G, Benschop K. Diagnostic performance of Hepatitis B virus surface antigens in the Netherlands using genotype-specific external quality assessment. [Under preparation]

7.2. Other reports

- Signaleringsoverleg. Wekelijks Overzicht infectieziektesignalen (confidential). Voorzitters: Gijs Klous, Annelot Schoffelen, Jeannet Bos, Rogier Bodewes, and Alexander van der Gaag; 2023–2025.
- **Vanhulle E**, Tjon-A-Tsien A, Sips GJ. Measles outbreak investigation report, February–July, Rotterdam, The Netherlands. Rotterdam/Bilthoven: GGD RR/RIVM; 2025.
- **Vanhulle E**, Pluister G, de Beer-Schuurman I, Mariman R, van Sorge N, Steens A. Comparative overview of *Haemophilus influenzae* serotyping methodologies used in Europe and their sensitivity and specificity within a surveillance context in the Netherlands. Bilthoven: RIVM; 2025.
- **Vanhulle E**, Notermans D. EpiPulse Alert: (PVL)-Positive LA-MRSA Cluster in Central Netherlands. Stockholm: ECDC; 2024.
- **Vanhulle E**, Simões M, Ten Bruin H, Boland G, Benschop K. Diagnostic evaluation of the serological detection performance on HBV surface antigens in the Netherlands. Bilthoven: RIVM; 2024.

7.3. Conference presentations

- **Vanhulle E**, Simões M, Ten Bruin H, Boland G, Benschop K. Diagnostic performance of Hepatitis B virus surface antigens in the Netherlands using type-specific external quality assessment (ePoster flash presentation). Presented at the Congress of the European Society of Clinical Microbiology and Infectious Diseases (**ESCMID GLOBAL**); 14 April 2025; Vienna, Austria.
- **Vanhulle E**, de Schrijver S, Ingenbleek A, Alexakis L, Johannesen CK, Broberg EK, Harvala H, Fischer TK, Benschop K. Circulation of enterovirus types in Europe between January 2018 and August 2023: a retrospective multi-center surveillance study (moderated oral poster presentation). Presented at **ESCAIDE 2024**; 21 November 2024; Stockholm, Sweden.
- **Vanhulle E**, de Schrijver S, Ingenbleek A, Alexakis L, Johannesen CK, Broberg EK, Harvala H, Fischer TK, Benschop K. Changing epidemiological lanscape of enteroviruses in Europe (oral presentation). Presented at 26th Annual Conference of the European Society for Clinical Virology (**ESCV 2024**); 20 September 2024; Frankfurt, Germany.
- **Vanhulle E**, de Schrijver S, Ingenbleek A, Alexakis L, Johannesen CK, Broberg EK, Harvala H, Fischer TK, Benschop K. Circulation of enterovirus types in Europe between January 2018 and August 2023 (poster presentation). Presented at 26th Annual Conference of the European Society for Clinical Virology (**ESCV 2024**); 19 September 2024; Frankfurt, Germany.
- **Vanhulle E**, Simões M, Ten Bruin H, Boland G, Benschop K. Diagnostic evaluation of the serological detection of type-specific hepatitis B surface antigens in the Netherlands, using the WHO international hepatitis B reference panel (poster). Presented at: **Scientific Spring Meeting KNVM & NVMM 2024**; 9 April 2024; Arnhem – Papendal, the Netherlands.

7.4. Other presentations

- **Vanhulle E**. Outbreak investigation of a regional measles epidemic in Rotterdam-Rijnmond 2025. Project Review Module. Instituto Nacional de Saúde Dr. Ricardo Jorge (INSA); 27 August 2025; Lisbon, Portugal.
- **Vanhulle E**. Diagnostic evaluation of the serological detection performance on different HBV surface antigens. Presented during the bi-weekly IDS (Centrum Infectieziekteonderzoek, Diagnostiek en laboratorium Surveillance) virology unit meeting at RIVM; 26 November 2024; Bilthoven, the Netherlands.
- **Vanhulle E**, Bertran M. Presentation of a self-selected paper of choice during the EPI journal club, 14 October 2024, RIVM, the Netherlands.
- **Vanhulle E**. Changing epidemiological landscape of enteroviruses in Europe. Project Review Module. Instituto Nacional de Saúde Dr. Ricardo Jorge (INSA); 29 August 2024; Lisbon, Portugal.
- **Vanhulle E**. Diagnostic evaluation of the serological detection performance on different HBV surface antigens. Presented during the monthly EPIET-EUPHEM fellows meeting at RIVM; 8 July 2024; Bilthoven, the Netherlands.
- **Vanhulle E**. Diagnostic evaluation of the detection of different HBV types, using a type-specific EQA panel. Presented during a National Hepatitis B cross-connection meeting; 12 March 2024; Bilthoven, the Netherlands.
- **Vanhulle E**. Diagnostic evaluation of the detection of different HBV types, using a type-specific EQA panel. Presented during a stakeholder meeting for the non-profit organisation responsible for the external quality assessment of medical laboratory diagnostics (Stichting Kwaliteitsbewaking Medische Laboratoriumdiagnostiek; SKML) in the Netherlands; 26 February 2024; Bilthoven, the Netherlands.

- **Vanhulle E**. Presentation during the bi-weekly IDS (Centrum Infectieziekteonderzoek, Diagnostiek en laboratorium Surveillance) virology unit meeting; 14 November 2023; Bilthoven, the Netherlands.

8. EPIET/EUPHEM modules attended

- Introduction to R course, 19–22 September 2023, delivered by Applied Epi, virtual
- Introductory Course, 25 September–13 October 2023, Spetses, Greece
- Study Protocol and Scientific Writing, 26–27 October, and 7–8 November 2023, virtual
- European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE) 2023, 22–24 November 2023, Barcelona, Spain
- Multivariable Analysis, 19–23 February 2024, Berlin, Germany
- Vaccinology, 4–8 March 2024, virtual
- Writing Abstracts for Scientific Conferences, 14 March–20 March 2024, virtual
- Rapid Assessment and Survey Methods, 15–19 April 2024, Dublin, Ireland
- Public Health Microbiology II – Biorisk and Quality Management, 21–23 May 2024, virtual
- Public Health Microbiology III – Whole Genome Sequencing & Bioinformatics, 3–7 June 2024, Vienna, Austria
- Project Review Module, 26–30 August 2024, Lisbon, Portugal
- European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE) 2024, 20–22 November 2024, Stockholm, Sweden
- Writing Abstracts for Scientific Conferences, 21 March 2025, virtual
- Congress of the European Society of Clinical Microbiology and Infectious Diseases (ESCMID GLOBAL) 2025; 11–15 April 2025, Vienna, Austria
- One-Health, 12–15 May 2025, virtual
- Project Review Module, 25–29 August 2025, Lisbon, Portugal
- Public Health Leadership, 1–3 September 2025, Lisbon, Portugal
- European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE) 2025, 19–21 November 2025, Warsaw, Poland

9. Other training

- ECTMIH Academy Day, organised by the interdisciplinary academy of competence & education for global health (iACE) at the Bernhard Nocht Institute for Tropical Medicine, 28 September 2025, Hamburg, Germany
- CDC-FETP Leadership and Management training series 2024–2025, online
- Assess and mitigate the risk of locally acquired Aedes-borne viral diseases in the EU/EEA, 17 July 2025, online
- PETAL Seminar: Using AI in everyday epidemiology: an introduction, 26 May 2025, virtual
- EU Health Task Force, EUHTF, 6 May 2025, virtual
- Public Health and Social Measures for pandemic preparedness in the EU/EEA, 18 March 2025, online
- GenEpi-BioTrain - Virtual training 14 - R data analysis and visualisation for beginners, 17–20 February 2025, online
- Integrated respiratory virus surveillance 2025 – AURORAE, 12 February 2025, online
- WHO public health laboratories online seminar series, Diagnostic testing for viruses causing Marburg and Ebola diseases, 12 February 2025, online
- PETAL Seminar: Infodemic Management Seminar, 23 January 2025, virtual
- Public health interventions in pandemics and epidemics, WHO health emergencies programme, 18 December 2024, online
- Biosafety and quality assurance in a public health laboratory 2024 – AURORAE, 16 December 2024, online
- PETAL Seminar: Abstract writing workshop using the ECDC Crowd, 28 November 2024, virtual
- Veilig Werken met Gevaarlijke Stoffen, RIVM, 27 November 2024, online
- Bewust Veilig Biologisch (BVB), RIVM, 15 November 2024, online

- AURORAE Webinar - Introduction to INSaFLU-TELEVIR: an open web-based bioinformatics suite for viral metagenomic detection and routine genomic surveillance, 29 October 2024, online
- Every outbreak is a story, using qualitative and descriptive data clues to complete the story, Julie Harris, CDC, 23 October 2024, online
- 74th Session of the WHO Regional Committee for Europe, Preparedness 2.0: Mobile laboratories simulation exercises, 23 September 2024, online
- GenEpi-BioTrain - Virtual training 09 & 10 – Unix for beginners & Introduction to the Conda ecosystem, 20–22 August 2024, online
- e-module analyse bij een melding, RIVM, 9 July 2024, online
- Spillkit training, RIVM, 25 June 2024, RIVM, Bilthoven, the Netherlands
- EU Health Task Force, European Centre for Disease Prevention and Control, 17 June 2024, online
- Bash scripting – Linux shell script and command line for beginners, June 2024, online
- Introduction to the high-performance computing (HPC) environment, May 2024, RIVM
- e-module privacy, RIVM, 14 May 2024, online
- Rapid Risk Assessment e-Learning course, 12 April 2024, online
- Public Health Preparedness for Mass Gathering Events e-learning course, WHO, 8 April 2024, virtual
- GenEpi-BioTrain - Virtual training 07 – Phylogenetics and alignments, 19–20 March 2024, online
- UNBSAFE, UNDSS – WHO, 14 October 2022, renewal 14 March 2024, online
- Pilot of the e-learning Recovery from infectious diseases outbreaks, 7 December 2023, EVA, ECDC, online
- EAN mini-module molecular epidemiology-phylogeny, November 20–21, 2023, Barcelona, Spain
- Field Epidemiology information online seminar, Médecins Sans Frontières and EPIET Alumni Network, 2 November 2023, online
- Biosecurity kennisdag, 2 November 2023, Amersfoort, the Netherlands
- Epidemic intelligence e-learning course, October 2023, online
- How to design a Table-top exercise e-learning, September 2023, online
- UN Prevention of Harassment, Sexual Harassment and Abuse of Authority (PSEA), WHO, online
- Introduction on the prevention of and response to sexual exploitation, abuse, and harassment (PRSEAH), WHO, online
- United to Respect: Preventing Sexual Harassment and Other Prohibited Conduct, WHO, online
- UN Human Rights and Responsibilities, WHO, online
- WHO SOP for Emergencies, WHO, online
- Introduction to the emergency response framework (ERF), WHO, online
- GenEpi-BioTrain - Genetic Epidemiology and Bioinformatics Training Programme, online
- EVA e-learning Introduction to Outbreak Investigation e-learning, online

10. International assignments

International assignment – GOARN mission, Democratic Republic of the Congo (DRC), 2025

Emiel was selected for deployment through the WHO Global Outbreak Alert and Response Network (GOARN) to support the WHO Country Office in Kinshasa during the mpox outbreak. The role included coordinating integration of HIV and syphilis rapid testing for suspected mpox cases, supporting the mpox transmission study, and assisting laboratory data harmonisation with surveillance data. The assignment was approved by WHO, GOARN, ECDC, and his site supervisors and direct manager at RIVM. Emiel invested considerable time in preparations, including administrative procedures, vaccinations, and logistics. However, final approval was withheld by the RIVM Director of the Centre for Infectious Disease Control (CIb), due to safety and security concerns in the region, leading to the cancellation of the deployment despite prior institutional and operational endorsement.

11. Other activities

- Two-month operational support at the Dutch municipal public health service (GGD Rotterdam-Rijnmond) April–June 2025, Rotterdam, the Netherlands
- Attended monthly internal EPIET/EUPHEM meetings, 2023–2025, on-site at RIVM, Bilthoven, the Netherlands
- Attended weekly internal Signaleringsoverleg (early warning meeting), 2023–2025, on-site at RIVM, Bilthoven, the Netherlands
- Attend bi-weekly RIVM Epi refereer, EPI-Masterclass, IDS-VIR and BAC-PER seminar/webinar series, 2023–2025, Bilthoven, the Netherlands and online
- Received the ESCMID travel grant for participation in the 23rd annual ESCMID summer school in Dublin, Ireland, 29 June–5 July 2025. Because of health consequences, Emiel was not able to attend this planned summer school.
- Course public health care (OGZ). The course is intended for all residents in Medical Microbiology from the second year in the Netherlands. 7–11 October 2024, RIVM, the Netherlands.
- Core training for the European Mobile Laboratory (EMLab) at the EMLab headquarters, BNITM, 18–22 March 2024, Hamburg, Germany
- European Society of Clinical Microbiology and Infectious Diseases (ESCMID) member of the Study Group for Public Health Microbiology (ESGPHM).

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I also thank the colleagues at the Department of Infectious Disease Control at the GGD, Rotterdam-Rijnmond, for welcoming me into their team during my outbreak project. It was a great learning experience and I immediately felt included and valued.

A very special thank you to Marta, my co-EPIET fellow, for sharing this crazy adventure (even if we rarely took the same flights). The past two years have not been easy, and you were always there for me, even when I was not in the Netherlands. I made it here thanks to your constant support and friendship. I wish you everything you dream of, go get it!

Finally, to my dear co-fellows of Cohort 2023: thank you for all the fun, laughter, and many beers. These two years wouldn't have been the same without all of you. And to my family and close friends (you know who you are), thank you for always being there, ready to help when needed, no matter the distance.