MenMap
The Meningitis & Septicemia Mapping Network

Pre-conference Workshop Report

Invasive Bacterial Disease Surveillance Network in North Africa, Middle East, and Eurasia: Meningitis and Septicemia Mapping Network (MenMap)

MenMap in the Region: Advancing Meningitis Surveillance and Laboratory Capacities

Contents

Background

Invasive bacterial infections (IBI) are responsible for high morbidity and mortality worldwide and remain a big challenge in public health. IBI is caused frequently by four major agents: *Neisseria meningitidis* (Nm, meningococcus), *Streptococcus pneumoniae* (Sp, pneumococcus), *Haemophilus influenzae* (Hi), and *Streptococcus agalactiae* (group B streptococcus, or GBS). Although meningitis is the most known form of IBI due to these bacterial agents, other clinical forms are reported such as septicemia, bacteremic pneumonia, and septic arthritis. *Streptococcus pneumoniae*, *Haemophilus influenzae* type b (Hib), and *Neisseria meningitidis* constitute the three major causes of vaccine-preventable bacterial meningitis. For example, *S. pneumoniae* has been described as a major contributor to community-acquired meningitis outbreaks in Europe and the United States [1].

According to the World Health Organization (WHO), more than one million acute bacterial meningitis (ABM) cases occur each year worldwide (mainly in low-resource regions), with a 10% fatality rate. This is a serious situation in which the microbiological laboratory plays a critical role in the early identification of the etiological bacterial agent. Nm, Sp, and Hi are the primary causes of ABM in children >1 month of age. For instance, meningococcal meningitis occurs as sporadic cases in Europe and North America with occasional outbreaks, but it causes epidemics within the African meningitis belt, spanning the sub-Saharan region from Senegal in the West to Ethiopia in the East. Representative data from many other regions of the world are lacking and data from North Africa, the Middle East, and Eurasia (NAMEE) are scarce [2].

The pathogen-specific burden of disease data for bacterial meningitis is still limited to the Eastern Mediterranean region (EMR) [3]. Over the last decade, many countries in the region introduced Hib conjugate vaccines into routine childhood vaccination schedules which has led to a significant decrease in the burden of disease [4]. However, only a few countries in the region have introduced pneumococcal conjugate vaccines to date.

Comprehensive data is still lacking for the three agents in the EMR from many areas mainly due to the lack of an easy-to-use diagnostic test for IBI. Only one publication from Iraq reported two instances of *N. meningitidis* in Baghdad in 2013; there has been very little epidemiological data on *N. meningitidis* infections in the EMR. An investigation into the epidemiological patterns of meningococcal meningitis in Iraq was necessary due to the significant demographic and socioeconomic changes that have taken place in the nation recently, especially in light of the intensification of religious mass gatherings, which are linked to an increased risk of Invasive Meningococcal Disease (IMD) outbreaks [5]. Although the government does require travelers arriving from countries with endemic diseases to show proof of a quadrivalent vaccination before entry [6], these requirements do not take into account specific disease serotypes and are also not required for Iraqis or visitors from nearby nations, many of whom attend annual mass gathering events in Iraq. Nm, Sp, and Hi are capsulated

bacteria with different polysaccharide capsular types that define serogroups (for Nm) and serotypes (for Hi and Sp). The distribution of these serogroups and serotypes varies significantly worldwide and temporally.

Failure to identify bacteria due to their fragility or after early antibiotic treatment, as well as challenges in implementing traditional culture-based procedures in bacteriology laboratories, are obstacles to the culture-confirmed diagnosis of IBI. The use of molecular diagnostic and typing techniques, particularly those based on nucleotide sequences, should be expanded in clinical laboratories [7]. Although PCR-based non-culture approaches are now often employed to determine IBI in many nations, their use is still insufficient in several regions of the world. In many MENA countries, meningococcal disease continues to be a major contributor to endemic and epidemic illness; yet the epidemiological data that have been published so far appear to be few, disjointed, and gathered using various methods.

Purpose

This pre-conference workshop discussed surveillance, diagnosis, prevention, and control strategies supported by evidence-based data through collaborative efforts facilitated by the Meningitis and Septicemia Mapping Network (MenMap). By consolidating global and regional expertise from academics, the pharmaceutical industry, and governments, the network aims to boost research activities, foster innovation in the field of IBI research, and accelerate the transfer of knowledge to end users. The workshop aimed to present the implementation of real-time PCR testing techniques for improving the diagnosis of invasive bacterial infections caused by Nm, Sp, and Hi. This initiative aims to achieve the goal of “Defeating meningitis by 2030”, a call for action that was recently adopted by the WHO with the vision of creating “a world free of meningitis” [8].

Objectives

- Advocate for the MenMap Initiative and Share the network’s experience in surveillance, diagnosis, and control of IBI in countries like Egypt, Iraq, and Jordan, regarding surveillance, prevention, and control strategies with a focus on the current challenges for implementation.
- Promote awareness and understanding of the MENMAP initiative and its significance and strengthen the technical capabilities of participating laboratories.
- Discuss IBI epidemiology and immunization programs in the Middle East.
- Discuss the significance of multi-sectorial collaboration (from the healthcare sector, NGOs, and private sector partnerships such as pharmaceuticals) to mitigate the burden of IBI and develop effective control strategies in the region.
- Propose practical solutions for improving the management of IBI, focusing on awareness and best practices.

Workshop expected outcomes

The expected outcome of this roundtable session is a set of tangible recommendations for decision-makers and practitioners on the design and implementation of approaches to develop protocols for IBI surveillance, awareness, and a partnership platform for circular collaboration.

Introduction

The Eastern Mediterranean Public Health Network (EMPHNET) held its Eighth Regional Conference in Amman, Jordan on the 15th through the 18th of September 2023 at the Landmark Hotel in Amman. The theme of this edition of our regional conference is “Advancing Public Health Preparedness and Response: Challenges, Opportunities, and Ways Forward”. The conference sessions in the form of workshops, forums, and roundtables addressed challenges and identified opportunities to advance public health preparedness and response in the Eastern Mediterranean Region (EMR) and beyond.

The pre-conference workshop titled "MenMap in the Region: Advancing Meningitis Surveillance and Laboratory Capacities," held on September 15, 2024, at Landmark Hotel in Amman, was moderated by Dr. Tarek Al Sanouri, Laboratory, Biosafety & Biosecurity Senior Consultant. The opening remarks emphasized the importance of monitoring, diagnosing, and controlling infectious diseases, particularly meningitis, and improving public health capabilities regionally. EMPHNET is a public health regional organization focusing on enhancing public health and applied epidemiology capacities in collaboration with ministries of health and international partners, such as the CDC partnership.

This workshop sheds light on the critical nature of meningitis, its rapid spread, and its severe health, economic, and social impacts. It mentions the WHO's Call to Action to defeat meningitis by 2030 and discusses the variation in case definitions and diagnostic capabilities across the region, including challenges with PCR testing and the potential for antibiotic resistance.

The MenMap project, funded by SANOFI and implemented by EMPHNET, aims to advance research on vaccine-preventable invasive bacterial diseases, improve surveillance and laboratory diagnostics, and support public health policies related to meningitis and septicemia. MenMap's initial activities focus on workforce and laboratory capacity building, especially in real-time PCR use.

The agenda of the workshop included several presentations and discussions on global epidemiology, vaccination, country experiences in Egypt, Iraq, and Jordan, surveillance, genomic tools, and a guided demonstration of the MenMap website’s features and dashboard (Annex I).

Key speakers include experts like Prof. Dominique Caugant, Prof. Ray Borrow, and Prof. Muhamed-Kheir Taha, who presented topics ranging from the global epidemiology of meningococcal disease to the use of genomic tools in bacterial meningitis surveillance (Annex II).

The Global Epidemiology of Meningococcal Disease:

Prof. Dominique A. Caugant is Chief Scientist at the Division for Infection Control, Norwegian Institute of Public Health, and Head of the WHO Collaborating Centre for Reference and Research on Meningococci, Oslo, Norway. She is responsible for the National Reference Laboratories in Norway for *Neisseria gonorrhoeae* and *Neisseria meningitidis*.

Prof.Dominique has been an Adjunct Professor at the University of Oslo since 1999. Her main fields of research are population genetics and molecular epidemiology of pathogenic bacteria, developing molecular tools for the study of infectious disease transmission, the development of antibiotic resistance, and the evolution of pathogens. She is also involved in vaccine research, especially against meningococcal disease, including testing potential coverage of new vaccines and evaluation of the impact of vaccination.

In her presentation on the global epidemiology of Meningococcal Disease, she discussed the widespread impact and trends of meningococcal disease, which affects 1.2 million people annually, resulting in approximately 135,000 deaths. The disease incidence is notably higher among infants under five and teenagers, largely influenced by the presence of a polysaccharide capsule with twelve known serogroups. Among these, serogroups A, B, C, Y, W, and X are responsible for over 90% of global invasive meningococcal disease cases. The presentation emphasizes the genetic diversity within *N. meningitidis,* with over 15,000 sequence types identified through multi-locus sequence typing (MLST). Despite this diversity, only a limited number of highly virulent clones have been identified, and the distribution of serogroups and genotypes shows considerable variation across different regions and over time.

For instance, in North America, recent data show a decline in meningococcal disease incidence, with specific strains prevalent in different communities and instances of antibiotic resistance. Europe also reports relatively low incidence rates, with notable increases in certain serogroups among extreme age groups. The presentation points out that surveillance systems vary widely in effectiveness, with some regions lacking consistent data or comprehensive surveillance systems, underscoring the need for global collaboration and continual surveillance improvements to track and mitigate the disease's spread and resistance trends.

Discussion:

Q: Thank you for the presentation. I have a few questions regarding the distribution of meningitis cases by serogroups. From 2016 onwards, there seems to be an increase in cases caused by Serogroup C. Could this increase be due to improved surveillance or diagnostic tools? Or is this a genuine rise in cases?

A: The rise in Serogroup C cases in Africa, particularly since 2016, is attributed to a new variant that caused an outbreak, initially detected in Nigeria in 2013. Prior to that,

Serogroup C was rarely seen in the region, making its resurgence unexpected. The outbreak likely occurred because this variant acquired new capabilities, allowing it to spread, and because the population lacked immunity to Serogroup C, as it had not circulated much before. Although improved surveillance has helped identify cases more efficiently, the primary reason seems to be the emergence of this new variant, rather than just enhanced surveillance or diagnostic tools.

Q: You also mentioned that, despite the many types of meningitis, only a few serogroups are associated with severe cases. How effective are the current vaccines in protecting against these severe variants?

A: The available vaccines target the capsule of 4 to 5 key serogroups that are responsible for most severe cases of meningitis. These vaccines work by attacking the capsule, which is crucial for the bacteria’s ability to cause disease. As a result, they are generally very effective at preventing outbreaks caused by these major serogroups. However, there are some serogroups, particularly certain strains, for which no effective vaccines have been developed. This is partly because some strains are more difficult to target with vaccines, and so the coverage isn't complete for all circulating variants.

Q: Given the global nature of meningitis outbreaks, especially with reports of imported cases, how can we better map the source of infections? Could global surveillance and collaboration help limit transmission between countries?

A: Yes, global collaboration is key to controlling the spread of meningitis. Networks like MenMap, which connect countries to share data and track the movement of cases, play a critical role in this effort. By mapping the source of infections and identifying areas where meningitis is endemic or outbreaks are occurring, we can better understand the hotspots and transmission patterns. Some outbreaks, such as the W strain in 2001, spread rapidly across Europe and the Americas, but the original strain likely came from Asia. Having such data at a global level allows countries to implement targeted interventions, like enhanced surveillance at borders or travel-related recommendations, to limit the spread of infections. The importance of addressing transmission within countries is also critical, not just treating patients but ensuring that close contacts are also managed to prevent further spread.

Q: You also mentioned that meningitis transmission can occur within and between countries. Could international collaboration on public health interventions, such as travel restrictions or vaccination campaigns, help reduce transmission?

A: Absolutely. International collaboration is essential, especially when dealing with diseases like meningitis that can spread across borders. Countries can collaborate by sharing surveillance data and working together to track the movement of outbreaks. Global interventions, such as setting travel requirements for vaccination or issuing public health advisories, can help limit the spread of meningitis from one country to

another. Additionally, in-country interventions, such as vaccinating high-risk populations or treating close contacts of infected individuals, are important to control the spread within national borders.

Vaccination for Bacterial Meningitis and Septicaemia:

Prof. Ray Borrow PhD is Head of the Vaccine Evaluation Unit and Head of the Meningococcal Reference Unit at UK Health Security Agency, Manchester, UK. Prof. Ray is responsible for the evaluation of serological responses to various bacterial and viral vaccines.

Prof. Ray performed numerous research projects and clinical trials as a researcher, principal investigator, and chief investigator. He has authored over 470 peer-reviewed scientific publications. He is a Professor of Vaccine Preventable Diseases at the University of Manchester, a Visiting Professor at the Manchester Metropolitan University, and an Honorary fellow in the Department of Clinical Infection, at the University of Liverpool.

Until recently he served as a member of the DoH Joint Committee of Vaccination and Immunization (JCVI) and continues as an invited expert. He is a member of the SAGE meningococcal working group and an ad hoc advisor to WHO and PATH on both meningococcal and pneumococcal vaccines. He is a trustee of the charity the Meningitis Research Foundation.

The presentation by Professor Ray Borrow covers various vaccination strategies for bacterial meningitis and septicemia, focusing on the development and effectiveness of polysaccharide, conjugate, and protein-based vaccines. Polysaccharide vaccines, while essential in early immunization efforts since 1969, demonstrate limited efficacy in inducing long-term immunity, particularly in infants, and are not effective in preventing nasopharyngeal carriage in open populations. Conjugate vaccines, introduced in the 1990s, advanced this field by coupling purified polysaccharides with carrier proteins, enabling immunogenicity across all ages and promoting herd immunity through reduced bacterial carriage rates.

Several conjugate vaccines are available for key bacterial pathogens, including multivalent options that cover multiple *N. meningitidis* serogroups (A, C, W, Y, and X), *S. pneumoniae* (7-valent to 20-valent formulations), and *H. influenzae* type b. Studies show significant declines in disease cases when these vaccines are incorporated into public health schedules, especially when targeted to age groups most likely to carry and transmit the bacteria, like adolescents for *N. meningitidis.*

Travel vaccines play a crucial role, particularly in response to meningococcal strains like MenW, which has caused outbreaks among travelers to the Middle East, notably pilgrims attending Umrah. For serogroup B, protein-based vaccines have emerged as an alternative, but they primarily offer direct protection without reducing bacterial carriage, limiting their impact on herd immunity. Conclusively, the presentation

emphasizes the need for both direct and herd protection through strategic vaccination, especially for high-risk groups and in areas with documented outbreaks.

Discussion:

Q: You mentioned that vaccines, particularly the conjugate ones, have been very effective. However, we've seen some areas with high incidences of meningococcal disease, like Iraq and Chile. Can you elaborate on the role of risk factors and carrier states for meningococcal disease?

A: Vaccines, especially conjugate ones, have been highly effective in reducing the burden of meningococcal disease. In some areas, there have been increases in cases, but factors such as carrier states and regional differences in risk play a role. It's important to continue surveillance to better understand these variations and identify high-risk areas.

Q: If Egypt decides to introduce the pneumococcal conjugate vaccine (PCV), what factors should influence the selection of the vaccine type, whether it's the 10-valent, 13-valent, or 20-valent version? Does this decision rely only on circulating serotypes, or are there other considerations?

A: The choice of vaccine valency depends on multiple factors. Initially, the 7-valent vaccine was used, but it was replaced with the 13-valent version due to better coverage. Pfizer has also introduced a 20-valent version, which could eventually replace the 13-valent one. The higher the valency, the better, as it reduces the risk of serotype replacement, a phenomenon where other serotypes emerge once some are targeted by the vaccine. The decision should not only be based on circulating serotypes but also factors like potential replacement strains, cost, and the long-term effectiveness of the vaccine.

Q: Some claim increasing the number of serotypes in a vaccine could weaken its effectiveness. Is this true, or is it misinformation?

A: This is misinformation. While there are over 100 pneumococcal serotypes, not all are pathogenic. The newer vaccines, like the 20-valent, cover the most invasive serotypes, and the effectiveness isn't weakened by adding more serotypes. In fact, it's important to include a broader range of serotypes to ensure the vaccine covers as many invasive strains as possible. The newer conjugate vaccines are getting close to matching the coverage of older polysaccharide vaccines, such as the 23-valent vaccine, without compromising efficacy.

Q: In many countries, we are still using polysaccharide vaccines for meningococcal disease. Given that conjugate vaccines are more effective, should we move towards recommending conjugate vaccines globally? Is there any support for this transition?

A: Yes, conjugate vaccines are generally superior to polysaccharide vaccines, as they provide longer-lasting immunity and reduce transmission. The global trend is

moving towards conjugate vaccines, and major pharmaceutical companies have largely stopped producing polysaccharide vaccines. For example, in the 26 countries within the meningitis belt, the focus is now on rolling out conjugate vaccines like MenAfriVac. However, the transition also depends on factors like cost, vaccine availability, and the capacity of countries to implement the switch.

Q: Are there any global initiatives to support countries in moving from polysaccharide to conjugate vaccines, particularly to aid in the global elimination of meningitis?

A: Yes, there are global initiatives aimed at supporting countries in transitioning to conjugate vaccines. For example, Gavi, the Vaccine Alliance, helps low-income countries access vaccines. Moreover, as polysaccharide vaccines are becoming less available, most vaccine producers, including those in developing countries like the Serum Institute of India, have shifted their production focus towards conjugate vaccines. This aligns with the global push to eliminate meningitis and reduce transmission by using more effective vaccines.

The use of genomic tools in epidemiological surveillance of acute bacterial meningitis:

Prof. Muhamed-Kheir Taha MD, PhD HDR is a Professor at the Institut Pasteur, Paris, France where he heads the Invasive Bacterial Infections Unit, the National Reference Centre for Meningococci and *Haemophilus influnezae* and the WHO Collaborating Centre for meningitis. His research focuses on molecular pathogenesis, molecular epidemiology, antibiotic resistance, and vaccine research. He has authored 310 peer-reviewed scientific publications and served as a voting member of the French Technical Committee for Vaccination. He is a member of the WHO Road Map Technical Task Force “Defeating Meningitis by 2030” and the President of The European Meningococcal and Haemophilus Disease Society.

Professor Muhamed-Kheir Taha's presentation at the EMPHNET Regional Conference explores the critical role of genomic tools in the epidemiological surveillance of acute bacterial meningitis. Genomic technologies like Multi-Locus Sequence Typing (MLST) and Whole Genome Sequencing (WGS) offer high-resolution insights into bacterial genotypes, which are essential for monitoring changes in the age distribution, serogroups, and emergence of new pathogens. This detailed genomic surveillance enables more accurate outbreak detection, supports evidence-based vaccine introductions, and optimizes immunization programs by assessing vaccine effectiveness and the need for supplementary immunizations.

A significant focus of the presentation is on the multifocal emergence and spread of *N. meningitidis* serogroup W and other invasive strains, including examples of travel-linked cases in 2024. In the context of sub-Saharan Africa, genomic studies have traced the spread of the virulent MenC/CC10217 strain, particularly in Nigeria and Niger, revealing the continued evolution of this complex. The presentation highlights

the importance of expanding genomic surveillance geographically and to all relevant bacterial species to meet the WHO's 2030 roadmap goal of defeating meningitis.

Discussion:

Q: I have two questions. The first question is about molecular diagnostics. The use of BioFire FilmArray was mentioned earlier. It's great for diagnosing bacterial and fungal infections but doesn't provide serogroup or serotype information. Plus, it consumes a lot of cerebrospinal fluid (CSF). In the UK, this leaves us unable to conduct public health actions when we detect meningococcal bacteria, as we often don't have enough CSF left to identify the serogroup. Is this the best approach, or should we rethink how we use these tools?

A: Correct. BioFire and similar techniques are not suitable for reference labs that need to perform serogrouping and serotyping to control these diseases. These tools might be useful in peripheral hospitals, where the primary goal is rapid diagnosis. The positive samples from PCR can then be sent to reference labs for confirmation and characterization. It's essential not to use all the CSF in the BioFire test, leaving enough for further analysis at a reference lab.

Q: My second question is about the cross-reactivity of the H-binding protein in *N. meningitidis* and the P5 protein of *Haemophilus influenzae*. Is there any cross-reactivity between these proteins?

A: We've tested this in our lab, focusing on the P5 protein in *Haemophilus influenzae* as part of a vaccine mixture. So far, we haven't seen any cross-reactivity between P5 and the H-binding protein in *N. meningitidis* in terms of their denatured structures. However, we still need to investigate whether there's any cross-reactivity with the native protein. But for now, we haven't observed any.

Q: In France, despite high vaccine coverage, we've seen an increase in cases of invasive diseases. Do you have any explanation for this?

A: The vaccine coverage in France is high, over 95% for children under 5, so the increase isn't due to a lack of vaccination. The issue seems to be related to the vaccination schedule. In 2013, France switched from a 3+1 schedule (three doses at 2, 3, and 4 months, followed by a booster at 16–18 months) to a 2+1 schedule (two doses at 2 and 4 months, with a booster at 11 months). This simplified schedule may not provide enough immunity. Most cases we've seen have been in vaccinated children, indicating that the schedule might be suboptimal.

Q: We've seen significant changes in the serotypes of *S. pneumoniae* in Egypt over the past 20 years. Is this a normal change, and what impact does it have on vaccine strategy?

A: Serotype replacement is common, especially after vaccination. We've seen similar trends in other regions, which is why vaccines with higher valencies, like the 20-valent

vaccine, are being developed to cover more serotypes. It's crucial to continuously monitor which serotypes are circulating in Egypt and other regions to ensure vaccines remain effective. A study comparing current circulating serotypes with past data will help inform the best vaccination strategy moving forward.

Q: Given the challenges in implementing PCR and next-generation sequencing (NGS) in the Eastern Mediterranean and African regions, how feasible is it to roll out these technologies, considering infrastructure and capacity gaps?

A: There are significant challenges, including the need to build capacity in laboratories and improve surveillance systems. It's essential to first evaluate whether current systems capture all cases. Once the system is strengthened, countries can move towards implementing real-time PCR and NGS. This approach has been successfully implemented in northern African countries like Tunisia and Morocco and could be a model for other regions.

Q: How does the change in pneumococcal serotypes over time affect vaccine strategies, particularly in countries like Egypt?

A: As serotypes change, vaccines need to adapt. For example, the 7-valent vaccine wasn't suitable for Egypt due to its serotype distribution at the time. Now, the newer vaccines, like the 20-valent, cover more serotypes. It's crucial to continuously assess which serotypes are circulating and match the vaccines accordingly. Genomic methods can help with this. In the case of Egypt, a cost-effectiveness study could help determine the best vaccine strategy.

Panel Discussion: Country Experiences: Surveillance, Diagnosis:

The panel discussion centered on country experiences in meningitis surveillance and diagnosis, with a strong emphasis on laboratory practices. Joined by Dr. Mahmoud Gazo, Director of the Laboratory Directorate in Jordan, Dr. Hussein Alwan, Director of Iraq's CPHL, and Dr. Noha Salah, CPHL Focal Point in Egypt, who each represented their respective Central Public Health Laboratories (CPHLs), their insights provided an in-depth look at the methods and strategies used across the region to strengthen meningitis surveillance and response.

Q (Dr. Tarek): We will start the panel discussion with a focus on the laboratory section. What are the typing methods used to distinguish between different strains of meningitis-causing bacteria, and how does identifying these strains influence the management and control of meningitis outbreaks?

A (Dr. Hussein, Iraq): In Iraq, we use several methods, including serotyping by ELISA and molecular typing using PCR and whole genome sequencing. These methods help us in targeting vaccination strategies and identifying the prevalent strains in the region. They also guide antibiotic use and public health strategies, which are essential in managing outbreaks and preventing further transmission.

A (Dr. Mahmoud, Jordan): In Jordan, we also use real-time PCR to identify the type of bacteria, including serotyping for *S. pneumoniae* and *N. meningitidis*. This helps the Ministry of Health in targeting vaccinations and selecting the right antibiotics for treatment. It's also critical in outbreak investigations and containment efforts.

A (Dr. Noha, Egypt): In Egypt, we perform real-time PCR for meningitis diagnosis and serotyping for *N. meningitidis* and *S. pneumoniae*. We also provide capacity-building training for hospital staff and ensure high-quality laboratory practices through regular audits. This helps in supporting the surveillance and control of meningitis.

Q (Dr. Tarek): What role does your laboratory play in supporting meningitis surveillance, and how do you ensure high-quality laboratory practices and collaboration?

A (Dr. Mahmoud, Jordan): Our Central Public Health Laboratory plays a key role in testing, surveillance, and reporting data in a timely manner. We collect samples from multiple sites across Jordan, perform molecular testing, and share results with the communicable diseases department. We maintain high-quality standards through regular audits, external quality control programs, and internal quality assessments.

A (Dr. Noha, Egypt): In Egypt, we provide training for hospital staff to ensure proper sample collection and testing. We also perform regular quality control for samples and collaborate with various stakeholders to improve surveillance activities. We routinely audit hospital laboratories to identify gaps and improve performance.

Q (Dr. Tarek): What diagnostic schemes for meningitis are used in your country, and at what level are these tools available?

A (Dr. Hussein, Iraq): In Iraq, peripheral hospitals perform basic CSF analysis, including chemical testing, microscopy, and culture. These samples are then sent to the central laboratory for PCR and serotyping. Due to the frequent use of antibiotics, culture results are often negative, making molecular methods more important.

A (Dr. Mahmoud, Jordan): In Jordan, CSF analysis and culture are performed at hospitals. Part of the sample is sent to the Central Public Health Laboratory for PCR testing, which helps in identifying the three main causes of bacterial meningitis: *S. pneumoniae*, *N. meningitidis*, and *H. influenzae*.

A (Dr. Noha, Egypt): In Egypt, primary healthcare facilities and fever hospitals perform initial CSF analysis, including Gram staining and blood cultures. Advanced techniques, like PCR, are only available at central public health laboratories.

Dr. Tarek's Closing Remarks: Across different countries, there are variations in diagnostic schemes for meningitis. Our goal is to unify the protocols for sample collection, transportation, and testing. CSF is the primary sample collected, and in cases where it's not possible, whole blood is used. PCR capacity has improved in

many countries, and we hope to expand it further to include subtyping for *S. pneumoniae* and *H. influenzae*.

Panel Discussion: Country Experiences: Control Strategies, Challenges:

The following panel discussion shifted to country experiences in controlling meningitis, focusing on strategies and challenges faced in accurately capturing acute bacterial meningitis cases. The panel featured Dr. Adham Shatanwe, Head of the Surveillance Department and Community Medicine Specialist at the Jordan Ministry of Health; Dr. Ahmad Abdel Satar, Focal Point of the Respiratory Diseases Unit at Iraq's CDC and Dr. Marwa Abdelshafy, Focal Point of the Acute Infections Neurological Disease Control Program at Egypt's Ministry of Health and Population.

Q (Dr. Tarek): What do you consider the biggest challenge in accurately capturing acute bacterial meningitis cases in your country?

A (Dr. Adham, Jordan): One of the main challenges is parental refusal to allow lumbar punctures (LP) on their children due to fears of paralysis. Additionally, case definitions were not initially well understood by healthcare workers, and there is a misuse of antibiotics, which leads to incorrect diagnoses.

A (Dr. Marwa, Egypt): In Egypt, a key challenge is the nonspecific early symptoms of meningitis, which resemble those of less severe diseases. This often delays diagnosis. There's also reluctance from families to allow LP procedures and issues with self-medication using antibiotics.

A (Dr. Ahmad, Iraq): The rapid progression of the disease is a significant challenge. Like other countries, there's parental refusal of LPs and the overuse of antibiotics, which complicates the ability to isolate pathogens and determine accurate diagnoses.

Q (Dr. Tarek): What strategies or rules are in place to encourage healthcare providers to report suspected meningitis cases promptly and accurately?

A (Dr. Marwa, Egypt): We have a national surveillance system that requires mandatory reporting of meningitis cases through an electronic system. Sentinel sites also help monitor case reporting and provide feedback to physicians, encouraging them to report cases.

A (Dr. Ahmad, Iraq): In Iraq, we emphasize the importance of effective communication between physicians, lab technicians, and surveillance officers. We regularly conduct training to ensure healthcare workers understand the case definitions and reporting protocols.

A (Dr. Adham, Jordan): In Jordan, the surveillance system mandates reporting of all suspected infectious diseases. We also have a surveillance officer in each hospital responsible for visiting clinics and reviewing records to ensure cases are not missed.

Q (Dr. Tarek): What are your three key recommendations for enhancing meningitis surveillance and laboratory capacities in your country and the region?

A (Dr. Adham, Jordan):

1. Expand sentinel sites, especially in the north and south of Jordan.

2. Implement genome sequencing to identify serotypes more effectively.

3. Improve feedback mechanisms to engage all members of the project in addressing challenges.

A (Dr. Marwa, Egypt):

1. Conduct regional mapping for meningitis surveillance, not just in Egypt but across the region.

2. Provide continuous training for physicians to enhance case detection and reporting.

3. Raise awareness about the dangers of antibiotic misuse and its role in antimicrobial resistance.

A (Dr. Ahmad, Iraq):

1. Improve laboratory capacities, especially by using advanced diagnostic tools like the FilmArray Meningitis/Encephalitis Panel.

2. Promote the rational use of antibiotics to curb resistance.

3. Focus on capacity building for health personnel and surveillance officers.

Dr. Tarek's Closing Remarks: Thank you to all the panelists for highlighting the common challenges of antibiotic misuse and the need for better surveillance systems. Rational antibiotic use, training, and improving reporting systems remain key strategies for tackling meningitis across the region.

Live Q&A Poll

The poll was designed to gauge participants' understanding of the presentations and assess their broader knowledge of IBI and related surveillance topics. By analyzing responses to multiple-choice questions, the aim was to ensure that key concepts were effectively communicated. The results provide valuable feedback.

Participants achieved an average success rate of 85.3% across all questions, with several notable highlights. Questions 4, 6, 7, and 9 saw a 100% success rate, while Question 15 posed the greatest challenge with only an 8% success rate. For a more detailed overview, click here.

Conclusion

In conclusion, the MenMap pre-conference workshop underscored the importance of strengthening meningitis surveillance and laboratory capacities across the Eastern Mediterranean region. Through collaborative dialogue and shared expertise, participants emphasized the critical need for harmonized diagnostic protocols, advanced genomic tools, and enhanced data-sharing mechanisms. Discussions highlighted that while vaccination remains a cornerstone in controlling meningitis, gaps in diagnostic capabilities, especially PCR and genomic sequencing, still hinder effective surveillance and outbreak response. The MenMap initiative, backed by EMPHNET and supported by regional stakeholders, is set to play a pivotal role in bridging these gaps by fostering multisectoral partnerships, advocating for sustainable public health strategies, and driving forward the WHO's "Defeating Meningitis by 2030" roadmap. The workshop’s outcomes offer a pathway for informed decision-making, improved public health policies, and a robust framework for regional cooperation, ultimately contributing to a future free of meningitis-related morbidity and mortality.

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8. Defeating meningitis by 2030 https://www.who.int/activities/defeating-meningitis-by-2030

Annexes

Annex I: Pre-Conference Workshop Agenda

Workshop Title	MenMap in the Region: Advancing Meningitis Surveillance and Laboratory Capacities		
Date	September 15, 2024	**Time**	10:00 AM – 02:00 PM
Location	Ghoroob Hall (13th floor), Landmark Hotel, Amman		

Time	Activity	Presenter
10:00AM - 10:15 AM	Welcome and Opening Remarks	Dr. Tarek Al Sanouri
10:15AM - 10:30 AM	The Global Epidemiology of Meningococcal Disease	Prof. Dominique Caugant
10:30AM - 10:45 AM	Discussion	All participants
10:45AM - 11:00 AM	Vaccination for Bacterial Meningitis and Septicaemia	Prof. Ray Borrow
11:00AM - 11:15 AM	Discussion	All participants
11:15AM - 12:00 PM	Panel Discussion: Country Experiences: Surveillance, Diagnosis, Control Strategies, Challenges, part 1 CPHL representatives, part 2 MOH representatives	Dr. Hussein and Dr. Abdel Satar from Iraq, Dr. Marwa and Dr Noha from Egypt, Dr. Adham and Dr. Mahmoud from Jordan
12:00PM - 12:30 PM	**Networking Break**	
12:30 PM – 1:00 PM	Presentation of MenMap Website and Dashboard	Dr. Tarek and country representatives
1:00 PM - 1:15 PM	The use of genomic tools in epidemiological surveillance of acute bacterial meningitis	Prof. Muhamed-Kheir Taha
1:15 PM - 1:30 PM	Discussion	All participants
1:30PM - 1:45 PM	Live Polling and Q&A Platform	Maya Joukhadar
1:45PM - 2:00 PM	**Closing Remarks and Future Steps**	Dr. Tarek Al Sanouri

Annex II: Moderator and Speakers

Moderator

Name	Title/Position
Dr. Tarek Al Sanouri	Laboratory, Biosafety & Biosecurity Senior Consultant

Speakers

Name	Title/Position	Institution
Prof Ray Borrow	Consultant Clinical Scientist	UKHSA
Prof. Dominique Caugant	Chief Scientist	Norwegian Institute of Public Health
Prof. Muhamed- Kheir Taha	Director of the National Reference Center for Meningococci	Institut Pasteur
Dr. Hussein Alwan Hasan	CPHL Director,	MOH - Iraq
Dr. Ahmad Abdel Satar	Focal Point of Respiratory Diseases Unit	CDC - Iraq
Dr. Marwa Abdelshafy	Focal point of Acute Infections Neurological Disease Control Program MOHP – Egypt	MOHP - Egypt
Dr. Noha Salah	Focal point CPHL Egypt	MOHP - Egypt
Dr. Adham Haytham Shatanwe	Head of the Surveillance Department Community Medicine Specialist	MOH - Jordan
Dr. Mahmoud Gazo	Director of Laboratory Directorate	MOH – Jordan

Annex III: Audience

1	Dr. Rola	Ghanem	CRDF Global
2	Dr. Tareq	Aldamen	Jordanian MOH
3	Dr. Bisan	Hiresh	MOH
4	Dr. Mohammed	Ta'ani	Jordan Ministry of Health
5	Dr. Haitham	Jaser	MOH Jordan
6	Dr. Ibrahim	Adel Hamdoun Alfahadi	Al Neelian University, Khartoum, Sudan
7	Dr. Fatma	Ben Youssef	ONMNE
8	Dr. Qusai	Nasralla	MOH Jordan
9	Dr. Qusai	Adawi	JMOH
10	Dr. Ibrahim	Adel Hamdoun Alfahadi	Al Neelian University, Khartoum, Sudan
11	Dr. Fatima	Belhmer	Ministry of Public Health
12	Dr. Fathi	Abdullah	Ministry of Public Health and Population
13	Dr. Mysarah	Alfreihat	MOH Jordan
14	Dr. Ibrahim	Adel Hamdoun Alfahadi	MOH Iraq
15	Dr. Ghadeer	Musleh	MOH Jordan
16	Dr. Khalid A Elmardi	Abdelgadir	Ministry of Public Health, Qatar
17	Dr. Murad	Almhairat	MOH-JORADN
18	Dr. Cyrine	Ben Nasrallah	Department of epidemiology and preventive medicine, Monastir Tunisia
19	Dr. Mohammad	Abdallah	Jordan MOH
20	Dr. Yakout	Mestarihyeh	FETP
21	Dr. Nosayba	Alshehada	FETP
22	Dr. Ja'far	Alzghoul	Community Medicine Resident
23	Dr. Nijmetzahra	Damlakhy	FETP - MOH | Jo
24	Dr. Hedaya	Shdifat	FETP/Jordan MOH
25	Dr. Abeer	Elsayed Abdelaziz	Food Microbiology Department and Biorisk Officer of CPHL MOH Jordan

Annex IV: Photos

***Photo 1**: Online presentations*

***Photo 2**: Panel Discussion with CPHL representatives*

***Photo 3**: Panel Discussion with MOH representatives*

***Photo 4**: Interactive Q&A session*

***Photo 5**: Group photo with Esteemed Speakers online, Panelists, and Participants.*