



World Health
Organization



DEFEATING MENINGITIS BY 2030

A GLOBAL ROAD MAP





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A large, decorative graphic element consisting of two thick, curved, overlapping bands. The upper band is dark gray and the lower band is a lighter gray, both curving from the left side towards the right side of the page.

Defeating meningitis by 2030: a global road map

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Information sessions and road map consultations with Member States took place between October 2019 and May 2020. The Seventy-third World Health Assembly approved the road map in November 2020 (resolution WHA73.9). The definitive version of the global road map on defeating meningitis by 2030 can be found in the official records of the Seventy-third World Health Assembly (document WHA73/2020/REC/1, Annex 4).

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Abbreviations and acronyms

| | |
|--------|---|
| Gavi | Gavi, the Vaccine Alliance |
| GBS | group B streptococcus |
| Hi | <i>Haemophilus influenzae</i> |
| Hia | <i>Haemophilus influenzae</i> type a |
| Hib | <i>Haemophilus influenzae</i> type b |
| HIV | human immunodeficiency virus |
| Nm | <i>Neisseria meningitidis</i> |
| PAHO | Pan-American Health Organization |
| SEARO | WHO Regional Office for South-East Asia |
| Spn | <i>Streptococcus pneumoniae</i> |
| UNICEF | United Nations Children's Fund |
| WHO | World Health Organization |
| WPRO | WHO Regional Office for the Western Pacific |

Executive summary

Meningitis is deadly and debilitating; it strikes quickly, has serious health, economic and social consequences, and affects people of all ages in all countries of the world. Bacterial meningitis can cause epidemics, lead to death within 24 hours, and leave one in five patients with lifelong disability after infection. Many cases of and deaths from meningitis are vaccine preventable, but progress in defeating meningitis lags behind that for other vaccine-preventable diseases.

In 2017, representatives from governments, global health organizations, public health bodies, academia, the private sector and civil society called for a global vision to defeat meningitis as a public health threat. WHO took up the call for action and, with global partners and experts involved in meningitis prevention and control, developed a road map to defeat meningitis by 2030. Wide public and expert consultations took place throughout 2019.

This first global road map on meningitis sets out a plan to tackle the main causes of acute bacterial meningitis (meningococcus, pneumococcus, *Haemophilus influenzae* and group B *streptococcus*). The three visionary goals are to: (i) eliminate epidemics of bacterial meningitis; (ii) reduce cases of vaccine-preventable bacterial meningitis by 50% and deaths by 70%; (iii) reduce disability and improve quality of life after meningitis of any cause. In order to achieve these visionary goals, the road map identifies strategic goals, key activities and milestones across five pillars: prevention and epidemic control; diagnosis and treatment; disease surveillance; support and care for people affected by meningitis, and advocacy and engagement.

For prevention and epidemic control, the main goals are to achieve higher vaccine coverage among the population, develop new vaccines, improve prevention strategies and ensure a more effective response to meningitis epidemics. The diagnosis and treatment goals are focused on rapid confirmation of acute bacterial meningitis and optimal care. Improved global surveillance, based on effective national surveillance systems, is needed to guide meningitis prevention and control measures, document the impact of vaccines and improve estimates of disease burden, including sequelae of meningitis. In the area of support and care for people affected by meningitis, the focus is on access to care for early diagnosis and treatment, improved management of after-effects and the provision of support, including rehabilitation.

For advocacy and engagement, the aim is to ensure that the road map is prioritized and integrated into country plans, that there is high awareness of meningitis and its impact among the population and a commitment to equal access for meningitis prevention, treatment and support for all those affected by meningitis.

The meningitis road map has been designated as a flagship global strategy of the WHO's Thirteenth General Programme of Work, 2019–2023 and is an essential component in achieving universal health coverage. The road map will reinforce and combine with wider initiatives, such as those aimed at strengthening primary health care and health systems, increasing immunization coverage, improving global health security, fighting antimicrobial resistance and advocating for the rights of persons with disabilities. It will complement other global control strategies, such as those addressing sepsis, pneumonia, tuberculosis and HIV.

Implementation will be a challenge for all countries across the world, but especially in resource-poor settings where the burden of meningitis is greatest. The targets for the visionary and strategic goals will be adapted to regional and local contexts. Plans for monitoring and evaluation, communication and risk management will be available to guide and support implementation.

Global action to implement this road map and achieve the ambitious goals to defeat meningitis is needed now. Strong commitments from countries, partners and donors will be essential to success.

Meningitis – a call for action

This road map is a call for action. It is a call to defeat meningitis by 2030.

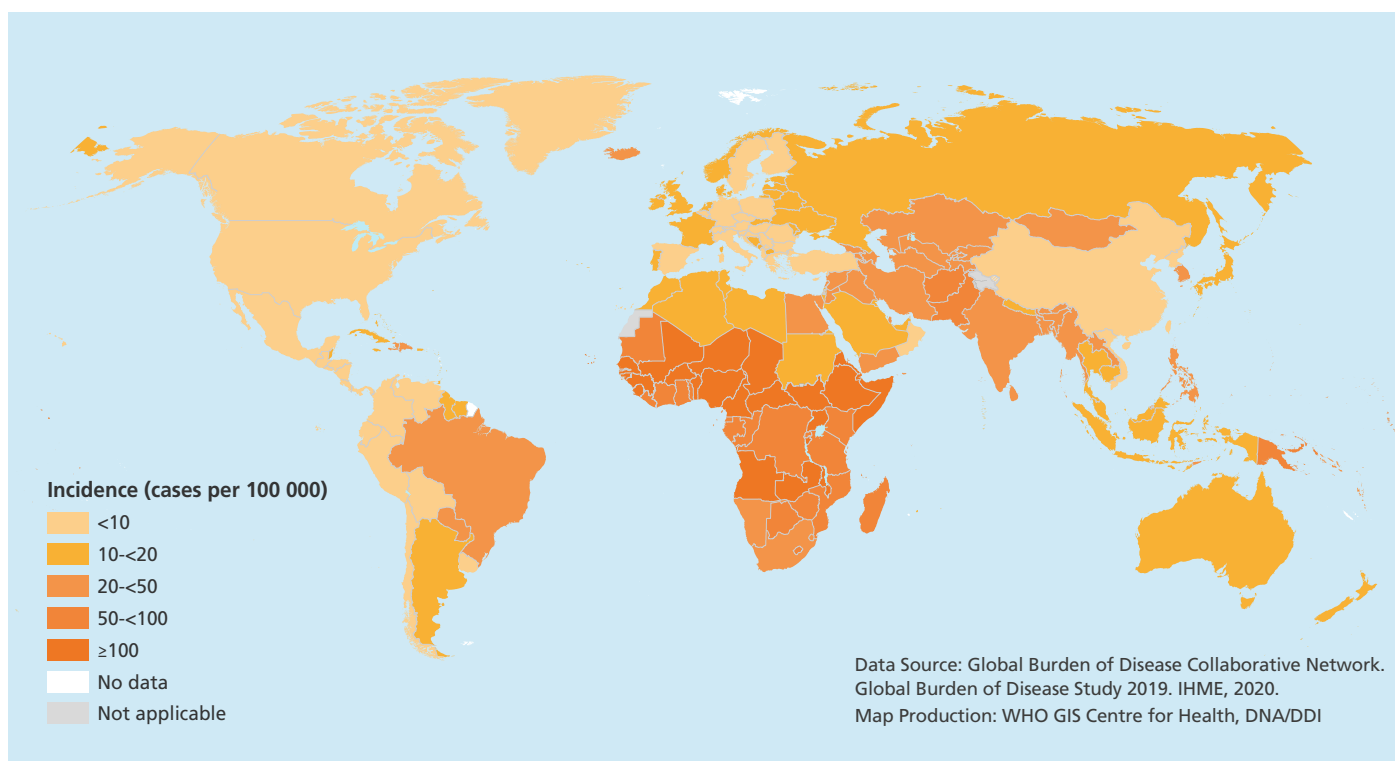
Meningitis is a life-threatening disease caused by inflammation of the membranes that surround the brain and spinal cord and is predominantly caused by infection with bacteria and viruses.¹ Acute bacterial meningitis (1) is one of the deadliest and most disabling forms of this illness (2–5); it can cause epidemics, lead to death within 24 hours and leave one in five people with lifelong disability after infection.

Many cases of and deaths from meningitis are vaccine-preventable, but progress in defeating meningitis lags behind other vaccine-preventable diseases (6). Despite significant progress in reducing the incidence of meningitis over the past 20 years, there were still an estimated 5 million new cases globally and 290 000 deaths from meningitis in 2017(7).^{2,3} Although meningitis affects all ages, young children are most at risk with around half of cases and deaths occurring in children under 5 years of age. Meningitis and meningitis-related sepsis can result in severe after-

effects, such as hearing loss, visual and physical impairment, cognitive disability and limb loss, which have a considerable emotional, social and financial impact on individuals, families and communities (8–10). In 2017, it was estimated that over 20 million years of healthy life (years of life lost due to premature mortality added to years lost due to disability) were lost from meningitis worldwide (5).

Although the burden of meningitis is greatest in the meningitis belt of sub-Saharan Africa, meningitis is a threat in all countries of the world (4,6,10) (Fig. 1). Since 2014, epidemics of bacterial meningitis have occurred in many countries including Kyrgyzstan, Fiji, Nigeria, Niger and Chile (11–13), and the spread of some virulent strains across the world has emphasized the need for a global approach to surveillance and prevention. Recommended vaccination programmes against some of the bacteria that cause meningitis have not yet been introduced in many countries, leaving their citizens at risk (5,14). Wherever it occurs, meningitis presents a major challenge for health systems, the economy and society.

Fig. 1. Incidence rates of all-cause meningitis per 100 000 population by country in 2017



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In May 2017, over 50 representatives from governments, global health organizations, public health bodies, academia, the private sector and civil society called for a global vision action to “defeat meningitis by 2030” (15). In September of that year, 200 representatives from the 26 countries of the African meningitis belt amplified this call and highlighted the need for equitable and sustainable access to meningitis vaccines (16).

The WHO is coordinating this call for action. A Technical Task Force of major partners historically invested in long-term meningitis control, with complementary focus and expertise, was convened to develop the road map presented here. A baseline situation analysis (5) was undertaken in 2018, and experts in meningitis, health and disability met early in 2019 to advance the draft road map (17), followed by wider expert and public consultations throughout 2019.

Patient groups around the world were extensively consulted about the global road map (18). In responses from over 600 groups in more than 90 countries, prevention was given the highest priority. The three most popular topics for inclusion in the road map were making vaccines more widely available, improved awareness and improved diagnosis (immediate, rapid).

The meningitis road map has been designated as one of the four flagship global strategies of the Thirteenth General Programme of Work, 2019–2023 to prevent high-threat infectious hazards. This strategy captures the essence of WHO’s mission to drive progress towards the United Nations Sustainable Development Goals, especially Goal 3 concerning health, which is structured around ensuring universal health coverage to protect the most vulnerable, and global health security to promote health and keep the world safe (19,20).

¹Meningitis can also be caused by infection with fungi and parasites, with cryptococcal meningitis having an increasing importance among adults living with HIV. Meningitis can also develop as a result of non-infectious factors, including certain medications, cancer and autoimmune diseases.

²Estimated cases and deaths due to tuberculous and cryptococcal meningitis are categorized under tuberculosis, HIV or other infectious diseases and are not included in these figures. Since deaths from viral meningitis are uncommon, the number of deaths from all-cause meningitis is likely to reflect the burden of acute bacterial meningitis and is close to the WHO estimate for global deaths from bacterial meningitis in 2015 (5).

³It is important to note that these estimated numbers of cases and deaths for 2017 (and for other years) are expected to change over time with modifications to the mathematical models.

Scope

The road map on defeating meningitis sets out a plan to tackle the main causes of acute bacterial meningitis: *Neisseria meningitidis* ((Nm), meningococcus), *Streptococcus pneumoniae* ((Spn), pneumococcus), *Haemophilus influenzae* (Hi) and *Streptococcus agalactiae* (group B Streptococcus (GBS)).⁴ This focus is based on: (i) evidence of the worldwide burden of disease due to these four organisms, which also cause sepsis and pneumonia and were responsible for over 50% of the 290 000 deaths from all-cause meningitis

in 2017 (7); (ii) the impact that this global strategy could have on diminishing the burden by 2030, since effective vaccines that protect against disease caused by all four organisms are currently available (or in development). Although the focus of this road map is not on other important causes of meningitis, such as tuberculosis, Cryptococcus, enteric bacteria and viruses such as enterovirus, several goals aimed at reducing the burden of disease are applicable to all causes of meningitis.

Vision

→ Towards a world free of meningitis

Our collective vision is “Towards a world free of meningitis”. Because meningitis has so many causes, it cannot be eliminated or eradicated. There will be no “world free” moment for meningitis, but we are committed to get as close as possible. This plan, therefore, aims to defeat meningitis as a public health threat, reducing the number of cases substantially and keeping them down.

Visionary goals by 2030

- ✓ Eliminate bacterial meningitis epidemics⁵
- ✓ Reduce cases of vaccine-preventable bacterial meningitis by 50% and deaths by 70%⁶
- ✓ Reduce disability and improve quality of life after meningitis due to any cause

All United Nations Member States are committed to achieving universal health coverage by 2030 (20). The visionary goals of eliminating epidemics, reducing the number of cases and deaths, and giving priority to caring for those with disability are fully aligned with universal health coverage and have equity as a guiding principle.

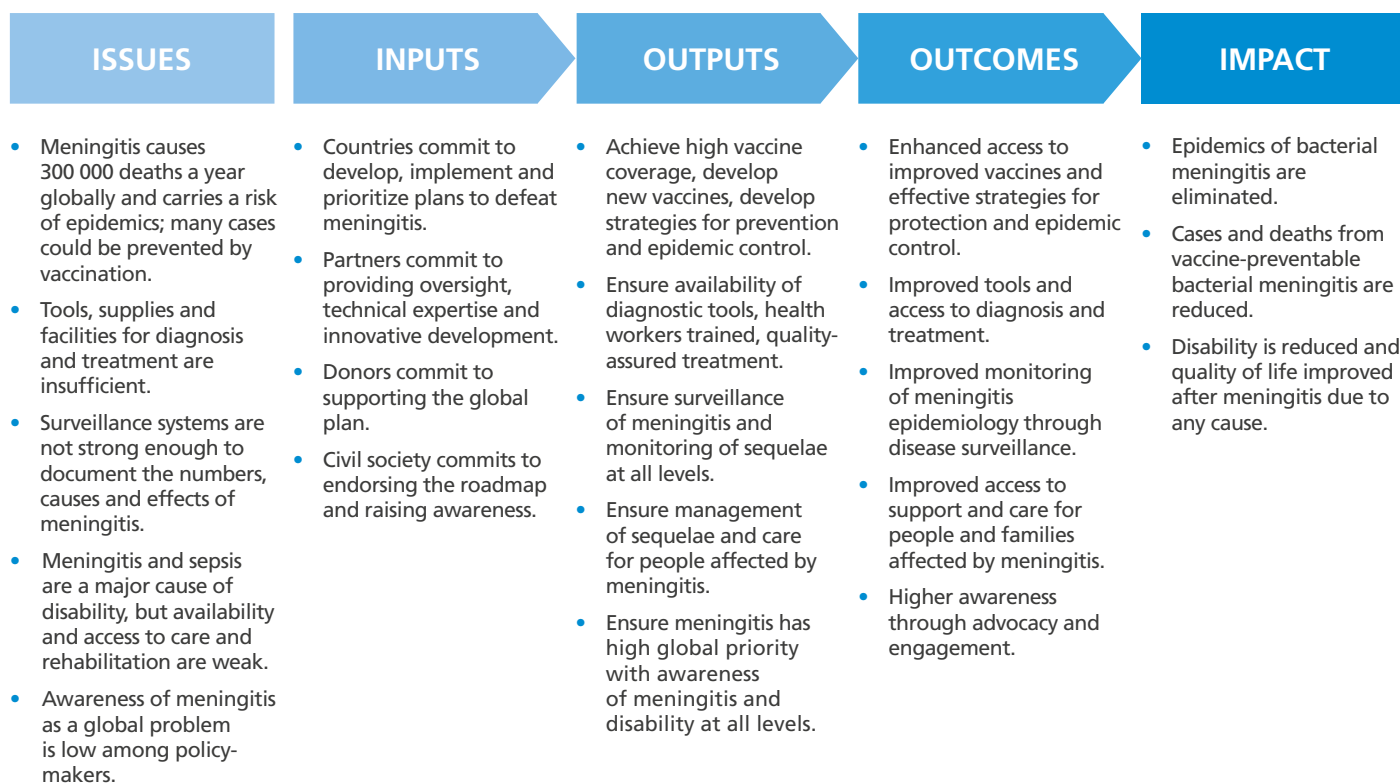
⁴Other bacteria, such as non-typhoidal salmonella, *Listeria monocytogenes*, *Streptococcus suis* and, in health care settings, pathogens such as *Staphylococcus aureus* or *S. epidermidis*, also cause meningitis, albeit less frequently.

⁵An epidemic is defined for this goal as a cumulative attack rate of >100 suspected meningitis cases/100 000 population within one year in a given population based on a definition used for the African meningitis belt (21). Each region will set its own definitions for epidemics/outbreaks and targets for reduction according to local epidemiology. Although epidemic and outbreak can be used interchangeably, an outbreak is normally smaller and more localized. The word epidemic has been used throughout this road map.

⁶The baseline year for these global targets is 2015. The targets were derived by assessing the likely impact of the road map milestones in consultation with experts across the world and will be measured by reductions in incidence and mortality rates. Vaccine-preventable bacterial meningitis refers to all acute bacterial meningitis caused by Nm, Spn, Hi and GBS whatever the serotype/group.

The overall framework (theory of change) of the road map is summarized in Fig. 2 below.

Fig. 2. Overall framework for the global road map to defeat meningitis by 2030



Pillars, strategic goals, key activities and milestones

The impact of achieving the three visionary goals will depend on the outputs and outcomes, which are organized into five pillars:

- **Prevention and epidemic control**
- **Diagnosis and treatment**
- **Disease surveillance**
- **Support and care for people affected by meningitis**
- **Advocacy and engagement**

Each pillar sets out strategic goals, key activities and specific milestones to be achieved in order to reach these goals. While serving to organize action, it is clear that the five pillars are interconnected: diagnosis is closely linked to surveillance; surveillance informs prevention and epidemic control; support and care for patients and families should commence during treatment at the time of diagnosis; and advocacy and engagement are necessary for the success of every pillar (Fig. 3).

Links between the five pillars and the 19 strategic goals are set out under each pillar. GBS is singled out for some goals, as: (i) GBS has a particularly high incidence in newborn babies; (ii) GBS vaccines are in development but not yet available; (iii) knowledge of the disease burden and prevention strategies are less advanced for GBS than for Nm, Spn and Hi, especially for low- and middle-income countries.

Fig. 3. The overlapping pillars to defeat meningitis



Wider benefits and complementarity

By complementing global control strategies for diseases such as sepsis and pneumonia that can be caused by the same organisms that cause meningitis, the road map will bring benefits that extend beyond meningitis. The roadmap will reinforce and complement wider initiatives relating to universal health coverage, primary health care, health systems strengthening, immunization, global health security, antimicrobial resistance, and the rights, support, rehabilitation and inclusion of people with disabilities (see the section entitled Connection to other global initiatives), and will also help to achieve existing country priorities. Activities under the road map will form an integral part of primary health care aligned with national strategies to achieve universal health coverage and other initiatives at all levels.



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Implementation

The successful implementation of the road map will depend, first and foremost, on regional and country engagement and political willingness to defeat meningitis. These efforts will require aligned and effective partner support, including from the private sector and civil society, to bring together all globally available resources (technical, human and financial) as well as the support of the WHO Secretariat. A business case will be used to mobilize sufficient resources for WHO and its partners to support Member States in delivering on the strategic objectives, together with a Public Health Value Proposition for one or more priority milestones. Global research priorities, which are needed to achieve the goals, will be identified separately in the implementation plan.

A Strategy Support Group of global-level partners and sponsors, committed to the mission of defeating meningitis, is expected to promote the road map through high-level advocacy, raising public awareness and supporting implementation activities.

The WHO Secretariat, made up of staff from the Department of Immunization, Vaccines and Biologicals, the Department of Mental Health and Substance Abuse, the Department for Management of Noncommunicable Diseases, Disability, Violence and Injury Prevention and the WHO Health Emergencies Programme, at country, regional and global levels, will provide integrated support, coordination and oversight, and will be accountable to Member States for the development and implementation of the road map.

Country planning will take into consideration regional specificities and will be adapted to country settings under different activity streams, including research, strategy and policy and country implementation. Targets for visionary and strategic goals will be prioritized and adapted according to the regional and local context, with priority countries identified within each region, taking into consideration factors such as the meningitis burden and equity of access to prevention and care. Plans for monitoring and evaluation, communication and risk management will be available to guide and support implementation. To ensure that regional needs and specificities are met and that regional commitment is promoted, regions will develop specific implementation frameworks, including key regional indicators, to be endorsed by the regional technical and advisory bodies.

Prevention and epidemic control

Achieved through development and enhanced access to affordable vaccines, effective prophylactic strategies and targeted control interventions.

Enhanced efforts are needed to encourage all recommended immunization, especially in low- and middle-income countries where the burden of meningitis is greatest, and to promote high levels of vaccine coverage at the national and subnational levels. Conjugate vaccines are dramatically reducing the global burden of disease caused by Nm, Spn and *Haemophilus influenzae* type b (Hib) but their global uptake and impact needs to be enhanced (5). However, not all serogroups/types are currently covered by these vaccines. Novel protein-based vaccines against Nm serogroup B (MenB) disease are now being used at the public health level in some high-income countries (5). No vaccine yet exists for the prevention of GBS disease, but GBS conjugate vaccine candidates are in development. Several Nm and Spn conjugate vaccine candidates are also in late-stage development, including multivalent products with broader serogroup/type coverage than existing vaccines. In addition, protein vaccine candidates against Nm, Spn and GBS are in various stages of development. Furthermore, as the high usage of antibiotics in the treatment of suspected meningitis can lead to the development of antimicrobial resistance, enhanced and sustained vaccination programmes being developed under the Immunization Agenda 2030 will have an increasingly important role in strategies for mitigating the negative impact of antimicrobial resistance. National plans should include vaccines as a key strategic priority or as a first line of defense against antimicrobial resistance in organisms that cause meningitis.

Chemoprophylaxis is generally used for close contacts of cases of meningococcal meningitis, but needs further evaluation, particularly in the context of epidemics in the African meningitis belt. Policies for preventing the mother-to-child transmission of GBS, using intravenous antibiotics, are currently being implemented using screening or risk-based strategies in many high-income countries. Evaluation of factors such as the GBS disease burden, epidemiology and transmission, health service infrastructure, health care access and antibiotic supplies is needed before implementing prevention strategies in low- and middle-income countries.

Although improvements in laboratory capacity have been seen through Invasive Bacterial Diseases Surveillance Networks, the most important challenges in the control of Nm or Spn meningitis epidemics include weak laboratory capacity to rapidly confirm the epidemic pathogen (see Pillar 2) and lack of timely access to sufficient quantities of affordable vaccines for epidemic response. For Spn meningitis epidemics, guidance on response is needed. Ultimately, evidence-based policy adjustment followed by high uptake of adequate preventive vaccination strategies, using appropriate vaccines, would ideally prevent infections and epidemics.

The aims of this pillar are to: (i) achieve and maintain high coverage of licensed/WHO prequalified vaccines against Nm, Spn and Hib with equal access in all countries, and introduce these vaccines in countries that have not yet introduced them in line with WHO recommendations; (ii) introduce effective and affordable new WHO prequalified vaccines targeting Nm, Spn, Hi and GBS; (iii) develop evidence-based policy on Nm, Spn, Hi and GBS vaccination strategies that result in optimal individual protection and, where possible, herd protection; (iv) develop and implement context-specific strategies to prevent GBS infection in infants; (v) develop and improve strategies for epidemic prevention and response including vaccination, chemoprophylaxis, infection control and risk communication, inclusive of mass gatherings and humanitarian emergencies.

NOTES (applicable to all pillars):

- (i) Dates in the milestones refer to the end of the year indicated.
- (ii) The road map applies to all countries worldwide. Targeted countries refers to those countries given priority within each region based on factors such as burden of meningitis (incidence of cases and deaths), vaccine coverage (Spn, Hib, Nm where relevant), health systems (strength, capacity, emphasis on surveillance, disability management), access to health services (equity), region-specific factors. The aim is to strike a balance between health needs and expected impact, i.e. to determine where resources could be best used.

| Pillar 1 strategic goals | Key activities | Landmark goals (milestones) |
|---|---|--|
| <p>Strategic Goal 1: Achieve and maintain high coverage of licensed WHO prequalified vaccines against Nm, Spn and Hib with equal access in all countries, and introduce these vaccines in countries that have not yet introduced them in line with WHO recommendations. (link to Strategic Goal 18 Health care rights, Strategic Goal 19 Vaccine confidence).</p> | <p>Implement locally appropriate tailored immunization strategies to achieve and maintain high vaccination coverage against Nm, Spn and Hib in all countries, reinforcing and complementing existing immunization strategies, including those targeting special risk groups.</p> <p>Ensure proper linkages and synergies with WHO, UNICEF, Gavi, the Vaccine Alliance and other global or regional initiatives aiming to reduce price and increase sustainable access to vaccines for low- and middle-income countries.</p> | <p><i>Nm (meningitis belt)</i> By 2021, vaccination against Nm serogroup A in routine immunization programmes in $\geq 18/26$ meningitis belt countries; by 2023, in all meningitis belt countries as per national priorities.</p> <p><i>Nm (other countries)</i> By 2024, locally relevant meningococcal disease vaccination strategies maintained or introduced in all countries as appropriate, in alignment with the epidemiological evidence and according to regional policies.</p> <p><i>Spn, Hib</i> By 2022, Hib conjugate vaccines and, by 2025, Spn conjugate vaccines, included in routine infant immunization programmes in all countries.</p> <p>By 2030, vaccine coverage of the full immunization schedule maintained or achieved in all countries (target coverage as defined by the Immunization Agenda 2030 and regional prioritization).</p> |
| <p>Strategic Goal 2: Introduce effective and affordable new WHO prequalified vaccines targeting Nm, Spn, Hi and GBS. (link to Strategic Goal 3 Vaccination strategy, Strategic Goal 10 Regional surveillance).</p> | <p>Support development, licensure, WHO prequalification and introduction of effective, affordable and safe new vaccines: additional multivalent meningococcal conjugate vaccines; additional MenB, pneumococcal and Hi vaccines; new GBS vaccines.</p> | <p><i>Nm</i> By 2020, WHO target product profile for multivalent meningococcal conjugate vaccine published, including thermostability considerations.</p> <p>By 2021, WHO Technical Report Series for multivalent meningococcal conjugate vaccine published.</p> <p>By 2022, at least one affordable multivalent (ACWXY) meningococcal conjugate vaccine licensed and WHO prequalified.</p> <p>By 2023, introduction of vaccination against Nm serogroups ACWY/ACWXY in routine immunization programmes started in ≥ 5 meningitis belt countries and, by 2030, vaccination against Nm serogroups ACWY/ACWXY implemented in all meningitis belt countries as per national priorities, with target coverage as defined by the Immunization Agenda 2030 and regional prioritization.</p> <p>By 2026, at least one affordable Nm serogroup B vaccine and sufficient sources of affordable multivalent meningococcal conjugate vaccines to ensure security of supply.</p> <p>By 2026, locally relevant meningococcal disease vaccination programmes, including Nm multivalent conjugate vaccines and/or Nm serogroup B vaccines as relevant, introduced in alignment with epidemiological evidence and according to regional policy in ≥ 10 countries.</p> |

| Pillar 1 strategic goals | Key activities | Landmark goals (milestones) |
|---|--|--|
| | | <p><i>Spn</i> By 2021, WHO Technical Report Series for pneumococcal conjugate vaccines updated. By 2021, at least one, and by 2025 at least three, additional affordable licensed and WHO prequalified pneumococcal conjugate vaccines, with coverage consistent with emerging data on serotypes causing invasive disease in low- and middle-income countries. By 2026, at least one new Spn vaccine with broader coverage – either higher valency pneumococcal conjugate vaccine or protein containing vaccine – licensed and WHO prequalified.</p> <p><i>GBS</i> By 2022, regulatory pathways for licensure of GBS vaccines defined, based on consultations with national regulatory authorities and the WHO Prequalification Team. By 2026, at least one affordable vaccine against GBS licensed and WHO prequalified for maternal immunization during pregnancy. By 2030, GBS vaccine introduced, if licensed/WHO prequalified, with Gavi support where needed, in ≥ 10 countries in line with WHO policy.</p> <p><i>Haemophilus influenzae type a (Hia)</i> By 2028, at least one vaccine against Hia licensed to address high burden of disease in some communities, for example, indigenous peoples in North America and Australia.</p> <hr/> <p>By 2030, sufficient sources of affordable and high-quality Spn and Nm multivalent conjugate vaccines to ensure security of supply. By 2030, sufficient quality-assured vaccine production capacity diversified into ≥ 5 low- and middle-income countries for Hib, Spn and Nm multivalent conjugate vaccines.</p> |
| <p>Strategic Goal 3: Develop evidence-based policy on Nm, Spn, Hi and GBS vaccination strategies that result in optimal individual protection and, where possible, herd protection. (link to Strategic Goal 2 New vaccines, Strategic Goal 18 Health care rights).</p> | <p>Evaluate vaccination strategies for use of multivalent meningococcal conjugate vaccines to achieve herd protection.</p> <hr/> <p>Develop global policy for use of MenB and multivalent meningococcal conjugate vaccines, update or develop policies on Spn, Hi and GBS vaccines, and support national policy-making as relevant. Enable and promote the sharing of knowledge between countries (for example, on accurate cost-effectiveness models) to support national policy decisions, particularly in low-incidence settings.</p> | <p>By 2022, modelling of research studies on multivalent meningococcal conjugate vaccination strategy completed and results disseminated with open access to support vaccine introduction strategies. By 2024, cluster randomized and/or other carriage studies on multivalent meningococcal conjugate vaccine to inform vaccination strategy completed and published.</p> <hr/> <p>By 2022, global policy available for use of MenB and multivalent meningococcal conjugate vaccines. By 2030, global policies on Nm, Spn, Hi and GBS vaccines updated or developed as new vaccines and evidence become available.</p> |

| Pillar 1 strategic goals | Key activities | Landmark goals (milestones) |
|---|--|---|
| | <p>Assess the overall vaccine impact, duration of protection, serotype replacement and indirect effects induced with different pneumococcal conjugate vaccine schedules to inform vaccination strategies for use of pneumococcal conjugate vaccines in order to maintain immunity in populations and to prevent/control vaccine-preventable pneumococcal disease among at-risk individuals.</p> <p>Establish immune correlates of protection (serogroup/type-specific) for Nm, Spn and GBS.</p> <p>Quantify the potential benefits of Nm, Spn, Hi and GBS vaccines on decreasing overall antibiotic use for invasive infections or prophylaxis and on reducing antimicrobial resistance.</p> | <p>By 2025, vaccine effects and duration of protection induced with different pneumococcal conjugate vaccine schedules documented, including feasibility of new dosing schedules, catch-up campaigns, and immunization programmes in older age groups to prevent serotype 1 epidemics.</p> <p>By 2026, global policy on pneumococcal conjugate vaccine schedules updated and implemented based on these findings.</p> <p>By 2025, studies to establish further immune thresholds or correlates of protection in different transmission settings conducted and published for Nm, Spn and GBS.</p> <p>By 2024, potential benefits of Nm, Spn, Hi and GBS meningitis vaccines quantified on decreasing overall antibiotic use and reducing antimicrobial resistance.</p> |
| <p>Strategic Goal 4: Develop and implement context-specific strategy to prevent GBS infection in infants.</p> <p>(link to Strategic Goal 8 GBS diagnosis, Strategic Goal 11 GBS surveillance, Strategic Goal 18 Health care rights).</p> | <p>Conduct research to further document transmission patterns of GBS and risk factors for early/late onset GBS disease.</p> <p>Develop and implement global policies on preventing GBS transmission to infants, taking into account evidence, burden and feasibility, with consideration for potential impact on antimicrobial resistance, linking with other sepsis, maternal and child health initiatives.</p> | <p>By 2023, study completed on transmission of GBS and risk factors for early/late onset GBS disease.</p> <p>By 2021, policy on microbiological screening-based or risk-based strategies against early onset GBS disease available for countries/regions according to disease burden and feasibility of implementation.</p> <p>By 2025, global guidelines on GBS prevention reviewed and updated.</p> <p>By 2028, recommended prevention policies implemented in medium/high-burden countries as set out in the GBS guidelines, unless superseded by a vaccination programme.</p> |
| <p>Strategic Goal 5: Develop and improve strategies for epidemic prevention and response including vaccination, chemoprophylaxis, infection control, and risk communication, inclusive of mass gatherings and humanitarian emergencies.</p> <p>(link to Strategic Goal 10 Regional surveillance, Strategic Goal 15 Prioritizing meningitis, Strategic Goal 19 Vaccine confidence).</p> | <p>Review and establish WHO definitions for epidemics of meningococcal and pneumococcal meningitis, (and clusters of late onset GBS disease) in all regions to guide investigation and control measures, including careful consideration of relevant spatial units (for example, districts, subdistricts).</p> <p>Develop, update and implement strategies on surveillance, preparedness and response to meningitis epidemics with attention to spatial units, including consideration of mass gathering issues, and enhancement of infection prevention and control programmes.</p> <p>Update strategies on vaccination during and after humanitarian emergencies for preventing epidemics among refugees and displaced persons.</p> <p>Consider multi-antigen campaigns as part of the above strategies, particularly for areas where population access to vaccination services is limited (for example, conflict zones), or for populations that are less likely to be included in vaccination campaigns (for example, people with disabilities).</p> | <p>By 2021, WHO definitions updated or established for meningococcal and pneumococcal meningitis epidemics (and late onset GBS disease clusters) in all regions.</p> <p>By 2023, strategies on surveillance, preparedness and response to meningitis epidemics updated, including updating reactive vaccination strategies and infection prevention and control programmes.</p> <p>By 2025, policies guidelines implemented in >80% of countries (including all targeted countries).</p> |

| Pillar 1 strategic goals | Key activities | Landmark goals (milestones) |
|--------------------------|--|--|
| | Develop strategies to ensure sufficient vaccine stockpile at the appropriate level (global, regional, national or subnational), and gradually transition from polysaccharide to affordable multivalent meningococcal conjugate vaccines to respond to epidemics. | <p>By 2022, International Coordinating Group (ICG) on Vaccine Provision stockpile of meningococcal vaccines appropriately replenished (quantity, composition, timeliness), building on predictive modelling research, to enable an early response to epidemics in the meningitis belt, as well as globally.</p> <p>By 2025, sufficient affordable multivalent meningococcal conjugate vaccines available globally to respond to epidemics in all regions without ICG intervention.</p> |
| | Define strategies to prevent/respond to pneumococcal meningitis epidemics. | By 2021, WHO strategy for pneumococcal meningitis epidemic prevention and response published and implemented. |
| | Conduct research and review policy for use of antibiotic prophylaxis as a control measure during meningococcal meningitis epidemics in the African meningitis belt, with consideration of potential impact on antimicrobial resistance. | <p>By 2021, additional study completed on the potential risks and benefits of this strategy of using antibiotic prophylaxis during meningococcal meningitis epidemics in the African meningitis belt.</p> <p>By 2022, revised policy (if necessary) on antibiotic prophylaxis during meningococcal meningitis epidemics in the African meningitis belt published, with possible time limit considerations (with due regard to and coordination with the introduction/availability of multivalent Nm conjugate vaccines).</p> |
| | <p>Building on the evidence and broader programming context, develop global messages, resources and tools for advocacy, community engagement, social change, and crisis communication to promote and sustain meningitis vaccine uptake.</p> <p>Collate implementation and digital data for real-time updates and guidance for strategic and operational recommendations.</p> | <p>By 2021, social and communication channels mapping completed in all targeted countries.</p> <p>By 2021, policies for monitoring secondary communication of messages and community rumours on meningitis epidemics available and used globally.</p> <p>By 2021, risk communications with mixed methods of messaging available and used in meningitis epidemics globally.</p> |



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PILLAR



Diagnosis and treatment

Achieved through improving diagnosis at all levels of health care, health worker training and prompt and effective case management.

Laboratory confirmation is well defined for the main bacterial pathogens, with culture and real-time polymerase chain reaction (PCR) being the gold standards. However, health workers may not be trained or have laboratory support to identify cases of meningitis. Cerebrospinal fluid samples are often not collected and laboratory capacity in low- and middle-income countries is often limited. There is a need for novel, rapid high-performance diagnostic assays that are affordable, deliver accurate and quick results to diagnose bacterial meningitis based on use, impact, target population and skill level, and can ideally measure antibiotic sensitivity. This is important because antibiotics may be given in the informal sector before patients present for medical care, or by health care staff before samples are taken, and there is a need for tests that can identify the causative organism after antibiotics have been given. Although antibiotic treatment regimens are well established, WHO guidelines for the treatment of adults with bacterial meningitis are not currently available and, in many settings, the recommended antibiotics are not always available. A review of the role of adjunctive therapies in low- and middle-income countries is needed.

The aims of this pillar are to: (i) improve diagnosis of meningitis at all levels of care; (ii) develop and facilitate access to diagnostic assays at all levels of care to increase confirmation of meningitis; (iii) develop and implement a context-specific strategy to identify mothers who are GBS carriers and for diagnosis, treatment and care of infant GBS, particularly for low-resource settings; (iv) provide and implement appropriate, context-specific, quality-assured guidance and tools for treatment and supportive care to reduce the risk of mortality, sequelae and antimicrobial resistance.

| Pillar 2 strategic goals | Key activities | Landmark goals (milestones) |
|---|--|---|
| Strategic Goal 6: Improve diagnosis of meningitis at all levels of care. (link to Strategic Goal 16 Population awareness, Strategic Goal 10 Regional surveillance). | Develop and disseminate regionally specific policies on testing requirements and tools for each level of the health system, according to the required decision-making (for example, for immediate clinical management, epidemic response, antimicrobial resistance). | By 2022, regionally specific policies developed on testing requirements and tools for each level of the health system, according to the diagnostic purpose or required decision-making. |
| | Evaluate role of blood sampling and dried bloodspots on filter paper in diagnosing meningitis/sepsis in low- and middle-income countries, especially in the African meningitis belt. | By 2022, studies published on performance of blood testing in the diagnosis of meningitis/sepsis in low- and middle-income countries, especially in the African meningitis belt. |
| | Evaluate reasons for the low frequency of lumbar punctures. | By 2022, report completed on reasons for the low frequency of lumbar punctures and recommendations for improvement. |
| | Increase timely collection and testing of diagnostic lumbar punctures, blood and other specimen samples by ensuring availability of sterile kits, supporting national policies that promote cerebrospinal fluid and blood sampling, including in infants, and by increasing acceptance of lumbar punctures among communities and health professionals. | By 2024, cerebrospinal fluid (and blood samples where feasible) collected in all targeted countries from >50% of suspected meningitis cases, including infants. |

| Pillar 2 strategic goals | Key activities | Landmark goals (milestones) |
|---|--|---|
| | Establish appropriate training and supervision of health workers at each level of care for timely identification, diagnosis, referral and treatment of meningitis in all age groups. | By 2026, a training programme on identification, diagnosis, referral and treatment of meningitis, including potential sequelae, established and integrated into existing training in >80% of countries (including all targeted countries). |
| Strategic Goal 7: Develop and facilitate access to diagnostic assays at all levels of care to increase confirmation of meningitis. | Establish innovative (pooled) funding mechanisms to facilitate the development and uptake of novel rapid diagnostic assays. | By 2022, funding mechanisms established to facilitate the development of rapid diagnostic assays and deployment into the field at scale. |
| | Develop/ensure a mechanism is in place to enable validation, production and adoption of diagnostic assays tailored to the intended populations and need. | By 2024, a mechanism is in place to enable validation, production and adoption of diagnostic assays tailored to the intended populations and need. |
| | Develop diagnostic assays (cerebrospinal fluid, blood or urine) to support immediate medical decision-making at the point of care. | By 2026, quality-assured, affordable and accessible rapid diagnostic assay developed to rapidly detect invasive bacterial versus viral infection to support immediate medical decision-making at the point of care. |
| | Develop diagnostic assays that identify the main pathogens of suspected meningitis cases and enable global access to the assays developed. | By 2026, quality-assured, affordable and accessible multiplex diagnostic test available to identify and distinguish the main pathogens responsible for meningitis. |
| Strategic Goal 8: Develop and implement a context-specific policy to identify mothers who are GBS carriers, and for diagnosis of infant GBS infection, particularly for low-resource settings. (link to Strategic Goal 4 GBS prevention, Strategic Goal 11 GBS surveillance, Strategic Goal 16 Population awareness). | Develop affordable diagnostic assays, suitable for low-resource settings, for (i) maternal carriage of GBS; (ii) infant GBS infection. | By 2026, a quality-assured, affordable and accessible diagnostic assay available to identify (i) maternal GBS carriage; (ii) infant GBS infection. |
| | Develop and implement a context-specific strategy for diagnosis of maternal carriage and of infant GBS infection, particularly for low-resource settings. | By 2026, strategies for diagnosis of maternal carriage of GBS and of infant GBS infection available for all countries. By 2030, recommended policy implemented in 80% of countries (including all targeted countries). |
| Strategic Goal 9: Provide and implement appropriate, context-specific, quality-assured guidelines and tools for treatment and supportive care to reduce the risk of mortality, sequelae and antimicrobial resistance. (link to Strategic Goal 13 Sequelae management, Strategic Goal 17 Impact and support). | Review the evidence on potential benefit of adjunctive therapies for bacterial meningitis for example, mannitol, steroids in low-and middle-income countries. | By 2022, potential benefit of adjunctive therapies in low-and middle-income countries reviewed. |
| | Develop and implement comprehensive, regionally adapted guidelines and recommended tools on patient treatment and care for all age groups and causes of bacterial meningitis (including invasive GBS disease in infants) from early diagnosis to early identification, treatment and care of sequelae, and addressing antimicrobial resistance and integration into existing guidelines. | By 2024, evidence-based guidelines and recommended tools developed on treatment and care of bacterial meningitis (including invasive GBS disease in infants) tailored to all resource settings made available for all regions and, by 2026, implemented in 80% of countries (including all targeted countries). |
| | Ensure that recommended and quality-assured antimicrobials and medical supplies needed for supportive care are affordable and accessible at country level. | By 2028, recommended, quality-assured antimicrobials and supplies for supportive care are affordable and accessible in >80% of countries (including all targeted countries). |

PILLAR



Disease surveillance

Achieved by surveillance of all major pathogens causing bacterial meningitis, and its sequelae, to guide meningitis control policies and accurately monitor progress toward the goals.

WHO vaccine-preventable disease surveillance standards cover three of the main bacterial pathogens (Nm, Spn, Hib). However, guidelines for national surveillance of meningitis pathogens are not uniformly implemented and most countries have no recommended guidelines for GBS surveillance. In many countries, weak surveillance systems hamper prompt epidemic detection and response and can only provide limited data to inform decisions about vaccine introduction. Building on the support of international laboratory networks and external quality assessment, laboratory capacity for diagnostic testing, including molecular characterization and antimicrobial resistance, needs to be strengthened for effective surveillance.

Accurate data on the burden of meningitis is not available in many parts of the world. Disease data reporting at the international level and whole genome sequence repositories are needed to strengthen global surveillance. There is little data on the long-term impact of meningitis and limited guidance on, or conduct of, studies and surveys of sequelae, for example, to measure the prevalence of deafness. Improving surveillance is key to establishing baseline data and measuring progress towards the road map targets.

The aims of this pillar are to: (i) ensure that effective systems for surveillance of meningitis and detection of the main meningitis pathogens are in place in each country; (ii) develop and implement global guidance for surveillance of invasive GBS disease, including for low-income settings; (iii) develop and conduct surveys and studies to establish the burden of sequelae.

Pillar 3 strategic goals

Key activities

Landmark goals (milestones)

Strategic Goal 10: Ensure that effective systems for surveillance of meningitis and detection of the main meningitis pathogens are in place.

(link to Strategic Goal 2 New vaccines, Strategic Goal 6 Improving diagnosis).

Review or develop surveillance strategy (aligned with WHO vaccine-preventable disease surveillance standards) for the main meningitis pathogens in each region for all age groups, including guidance in conflict settings and epidemics, to be revised as necessary (Strategic Goal 11 covers GBS surveillance).

Adopt, integrate and implement minimum standards for surveillance of the main meningitis pathogens at country level in terms of epidemiology (including all age groups), laboratory capacity (including the use of up-to-date diagnostic and antimicrobial tests), and data management.

Perform global surveillance of emerging resistance patterns of main pathogens, linking with antimicrobial resistance networks and control strategies.

Establish a global coordinated mechanism in all regions for molecular surveillance of bacterial meningitis pathogens allowing for timely strain identification and the sharing of information.

By 2021, surveillance strategy available in all regions for the main meningitis pathogens.

By 2025, minimum standards for surveillance of main bacterial meningitis pathogens implemented in targeted countries and integrated into national surveillance.

By 2030, implemented in >80% of countries (including all targeted countries).

By 2023, monitoring of the antimicrobial pattern of main meningitis pathogens (annual reports, alerts) integrated into existing global surveillance.

By 2023, representative proportion (target set by region) of Nm, Spn, Hi and GBS meningitis strains molecularly characterized and data shared in a globally coordinated network.

Pillar 3 strategic goals

Key activities

Landmark goals (milestones)

Establish a global genome partnership for meningitis pathogens (Nm, Spn, Hi, GBS), encourage participation, including the sharing of sequence information and associated clinical and epidemiological data, with clear governance and policies for access and use of strains.

By 2023, global genome partnership functional for each of the four pathogens.
By 2025, establish governance and policies for the sharing of strains and associated data, access and use of strains.

Strategic Goal 11: Develop and implement global strategies for surveillance of invasive GBS disease, including for low-income settings.

(link to Strategic Goal 4 GBS prevention, Strategic Goal 8 GBS diagnosis).

Develop epidemiological and economic analyses on the burden of GBS, including long-term disability, and on the avertable burden through interventions, including potential vaccines.

By 2021, publish value proposition for GBS based on worldwide data.

Conduct a situation analysis on surveillance of GBS invasive disease worldwide.

By 2021, situation analysis completed on GBS disease surveillance worldwide.

Develop global and regional strategies and tools for surveillance of GBS disease, including standardized case definitions, ascertainment methodologies and definitions of high-, medium- and low-burden.

By 2022, global and regional strategies for surveillance of GBS disease developed.

Establish surveillance systems for GBS according to global/regional strategies.

By 2024, surveillance of GBS implemented in high-burden regions and, by 2028, in medium-/low-burden regions.

Strategic Goal 12: Develop and conduct surveys and studies to establish the burden of sequelae.

(link to Strategic Goal 13 Sequelae management, Strategic Goal 14 Access to aftercare).

Develop and implement a global strategy and tools for studies and surveys to establish and monitor the burden of sequelae.

By 2022, global strategy and tools for studies and surveys to measure burden of sequelae developed and, by 2026, implemented.



Source: Centers for Disease Control and Prevention

PILLAR



Support and care for people affected by meningitis

Achieved by ensuring that effective health systems and communities are capable of timely identification and management of sequelae of meningitis, and that people, families and carers affected by meningitis can access appropriate support and care services that meet their needs.

One in five people surviving an episode of bacterial meningitis may have enduring after-effects (8). Common sequelae include seizures, hearing and vision loss, cognitive impairment, neuromotor disability and memory and behavioural changes, as well as scarring and limb amputations after meningococcal sepsis. Many people will also experience a range of less serious after-effects that are not always immediately apparent, for example, emotional difficulties. Aftercare is expensive and may not be affordable for families. Policies and services for assessment of sequelae, treatment, rehabilitation and follow-up, including those in communities, are often absent or insufficient, and access to them is uneven, especially in low- and middle-income countries. Appropriate training on timely identification and management of disability and bereavement for health care professionals and community workers is limited, with inadequate numbers of trained staff at all levels of care from community to hospital. Given the global distribution of meningitis, it is essential to build and strengthen health systems to ensure that they can provide the necessary care and programmatic support for everyone who needs it. The capacity of educational institutions needs to be strengthened and linkages with health care services need to be established to train health workers as well as community members in the early recognition of developmental, psychosocial and cognitive after-effects of meningitis.

This pillar applies to meningitis from any cause. The aims are to: (i) strengthen early recognition and management of sequelae from meningitis in health care and community settings; (ii) increase the availability of and access to appropriate care and support for people affected by meningitis, their families and carers.

| Pillar 4 strategic goals | Key activities | Landmark goals (milestones) |
|--|--|--|
| <p>Strategic Goal 13: Strengthen early recognition and management of sequelae from meningitis in health care and community settings.</p> <p>(link to Strategic Goal 9 Improving treatment, Strategic Goal 12 Sequelae burden, Strategic Goal 14 Access to aftercare).</p> | <p>Conduct research on: (i) socioeconomic impact of sequelae on children, adults and their families/carers; (ii) effectiveness of aftercare/support interventions in reducing impact.</p> | <p>By 2023, studies completed and published on effectiveness of aftercare/support interventions in reducing impact.</p> |
| | <p>Develop and implement best practice guidelines for low-and middle-income countries on detection, monitoring and management of meningitis sequelae after discharge from hospital, at all levels of health care and in community settings, for example, schools (including disability sensitization and communication skills).</p> | <p>By 2024, global guidelines for low-and middle-income countries in systematic detection, monitoring and management of sequelae after meningitis and, by 2026, adapted and implemented in >50% of low-and middle-income countries (to be integrated with Strategic Goal 9 guidelines).</p> |
| | <p>Promote community-based programmes to: (i) identify sequelae and disabilities, based on standardized instruments (especially for child development and hearing) and refer for assessment and appropriate care; (ii) provide care, support and aftercare to individuals, families and communities affected by meningitis, for example, psychosocial support.</p> | <p>By 2028, system of community-based identification of sequelae and disabilities, and referral for assessment and care established in >50% of countries (including all targeted countries).</p> <p>By 2028, community services for people with long-term impairments from meningitis integrated into existing disability inclusion initiatives in >50% of countries (including all targeted countries).</p> |

| Pillar 4 strategic goals | Key activities | Landmark goals (milestones) |
|---|---|--|
| <p>Strategic Goal 14: Increase the availability of and access to appropriate care and support for: (i) people affected by meningitis; (ii) their families and carers.</p> <p>(link to Strategic Goal 12 Sequelae burden, Strategic Goal 13 Sequelae management, Strategic Goal 17 Impact and support).</p> | <p>Map out existing services and support systems available by country for: (i) children and people with disabilities, including those with meningitis sequelae, and (ii) families/carers of people affected by meningitis; identify barriers to access, availability, and use, with the involvement of organizations for persons with disabilities and other networks where possible, and undertake a gap analysis to improve service provision.</p> <p>Strengthen partnerships between government and civil society organizations, including organizations for persons with disabilities and other networks, so that people with sequelae or disabilities, their families/carers and those bereaved due to meningitis have access to quality and effective services that are in line with international human rights standards and frameworks.</p> <p>Provide relevant, up-to-date information to people and carers affected by meningitis about access to services for managing sequelae as well as about the rights of people with disabilities guaranteed under national policies and laws and through global human rights instruments.</p> | <p>By 2023, services and support systems mapped out for: (i) people with disabilities including meningitis sequelae; (ii) families/carers of people with meningitis who have recovered or died, with a gap analysis in >80% of countries, (including all targeted countries).</p> <p>By 2024, gap analysis completed and linked to Strategic Goal 13.</p> <p>By 2025, strategies to facilitate access for people affected by meningitis to community-based rehabilitation and bereavement services developed and, by 2028, policies in place in >50% of countries (including all targeted countries).</p> <p>By 2027, relevant, up-to-date information provided by media, social media, schools, community-based mechanisms, etc. to people affected by meningitis on access to services and support in >50% of countries (including all targeted countries).</p> |



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PILLAR



Advocacy and engagement

To work with partners to raise public and political awareness of meningitis and its impact, including potential to cause disability, in order to improve health-seeking behaviour and access to prevention and care.

Advocacy can drive lasting change and makes the case for that change. Advocacy goals for meningitis include better protection against meningitis, better diagnosis and treatment and better support and aftercare for those who have experienced meningitis, and their families. Provision of general information about meningitis to the overall population and at-risk groups, improved education and training for health workers, and specific information for people who have been directly affected by meningitis, their families and their communities, can all play an important role in defeating meningitis but are often lacking. Meningitis poses specific challenges in terms of information. Its rapid onset leaves little time to act, increasing the need for accurate targeted information on prevention, early management and sequelae that are appropriate for different audiences. It is frequently confused with other febrile diseases such as malaria, and may also present as sepsis or encephalitis, increasing the need for health worker resources and training. Disability is a common feature of life after meningitis, meaning that good aftercare information is essential. Effective information can make people aware of the need to seek help based on awareness of the signs and symptoms of meningitis, and to increase demand from populations for vaccination and aftercare services.

Meningitis advocacy goals should be integrated into many other universal health coverage goals that are a priority for countries, including health security, promoting equal treatment and access to opportunities for those with disabilities, and reducing antimicrobial resistance.

The aims of this pillar are to: (i) ensure that funders and policy-makers at the national, regional and global levels recognize that the road map to defeat meningitis is prioritized and integrated into country plans at all levels; (ii) ensure awareness, among all populations, of the symptoms, signs and consequences of meningitis so that they seek appropriate health care; (iii) ensure and raise awareness of communities about the impact of meningitis and available support after meningitis; (iv) ensure that people and communities know how to access meningitis vaccines, other prevention and support after meningitis, and that they value and demand them; (v) maintain high vaccine confidence.

| Pillar 5 strategic goals | Key activities | Landmark goals (milestones) |
|--|--|---|
| <p>Strategic Goal 15: Ensure that funders and policy-makers at the national, regional and global levels recognize that the road map to defeat meningitis is prioritized and integrated into country plans at all levels.</p> <p>(link to Strategic Goal 18 Health care rights).</p> | <p>Raise awareness of meningitis as a health priority among funders and policy-makers through national and international champions, civil society organizations, advocacy groups and health care providers, including the disability sector.</p> <p>Identify and create synergies between key activities on strategy, implementation and communication with other initiatives at the global, regional and national levels, especially for the immunization and disability sectors.</p> | <p>By 2020, global meningitis dashboard developed and updated regularly to show burden of meningitis, its impact and global road map progress.</p> <p>By 2022, meningitis and related impact included in all relevant strategic and operational plans and budgets of WHO (Global and Regional), development organizations, and donors with plans to monitor progress.</p> <p>By 2020, global collaboration framework for meningitis road map developed.</p> <p>By 2023, an effective mechanism of coordination for technical support, resource mobilization, and partnership between immunization and disability sectors developed.</p> |

| Pillar 5 strategic goals | Key activities | Landmark goals (milestones) |
|---|--|--|
| | <p>Build a business case for investment in vaccines, surveillance, diagnosis, and treatment of meningitis, and for the prevention and management of sequelae, as set out in the road map, that is targeted for use by policy-makers, decision-makers and funders at the global, regional and national levels, including the disability sector.</p> | <p>By 2020, have a business investment case available and promoted at the global, regional and national level to mobilize resources, with potential for adjustments accounting for progress.</p> |
| | <p>Countries undertake needs assessment on meningitis and its impact, and create national action plans that address gaps and are aligned to the global road map.</p> | <p>By 2022, all targeted countries have undertaken a needs assessment of meningitis and its impact. By 2024, all targeted countries have a context-appropriate meningitis action plan and monitoring framework aligned to their national health strategy, budget and global road map through to 2030.</p> |
| | <p>Develop communications and engagement strategy and improve global recognition of World Meningitis Day and other global health dates (for example, sepsis, GBS, cerebral palsy, disability), adapt messaging to policy-makers as well as to the general public, and raise funding to promote activities that support the road map.</p> | <p>By 2021, communications and engagement strategy developed that defines key audiences, messages, channels, drivers and barriers for policy change from a country perspective. By 2022, World Meningitis Day and related global health dates visibly endorsed by global policy-makers/funders and used by >80% of countries (including all targeted countries) to assess/promote road map progress and share learning through human interest stories and best practice around the world.</p> |
| <p>Strategic Goal 16: Ensure awareness, among all populations, of the symptoms, signs and consequences of meningitis so that they seek appropriate health care. (link to Strategic Goal 6 Improving diagnosis, Strategic Goal 8 GBS diagnosis).</p> | <p>Undertake integrated communication programmes and activities that increase population awareness of the risk, symptoms, signs and consequences of meningitis and sepsis and of the recommended health-seeking response, and create community awareness of GBS disease and prevention.</p> | <p>By 2023, meningitis and sepsis awareness campaigns conducted in >80% of targeted countries and integrated with existing health awareness activities.</p> |
| | <p>Study the community understanding of the risk of meningitis, and the factors that facilitate or act as barriers to health-seeking behaviours for meningitis, and integrate actions into country plans to address the issues identified.</p> | <p>By 2025, region-specific research published into community knowledge of meningitis and practices that facilitate or act as barriers to health-seeking behaviours for meningitis and its sequelae. By 2026, national action plans updated based on the published research.</p> |
| <p>Strategic Goal 17: Ensure and raise awareness of communities about the impact of meningitis and available support after meningitis. (link to Strategic Goal 14 Access to aftercare).</p> | <p>Support global and national campaigns on the International Day of Persons with Disabilities to increase and raise awareness of communities about disability, and to address significant attitudinal barriers that lead to stigma and undignified treatment of people with disabilities. Raise awareness of new systems for data collection on sequelae/disabilities and of available support and specialist services.</p> | <p>By 2025, awareness raised on the International Day of Persons with Disabilities in >80% of countries (including all targeted countries) to increase awareness of communities on meningitis-related disability and on available support and specialist services.</p> |

| Pillar 5 strategic goals | Key activities | Landmark goals (milestones) |
|--|---|--|
| <p>Strategic Goal 18: Ensure that people and communities know how to access meningitis vaccines, other prevention and support after meningitis, and that they value and demand them.</p> <p>(link to Strategic Goal 1 Vaccine coverage, Strategic Goal 3 Vaccine strategy, Strategic Goal 4 GBS prevention, Strategic Goal 15 Prioritizing meningitis, Strategic Goal 19 Vaccine confidence).</p> | <p>Identify, encourage and support civil society organizations that do or could promote the interests of those affected by meningitis, including those with sequelae, and invite involvement in delivering the goals of the road map through their communities, engagement with national and regional authorities and international networks of civil society organizations.</p> <p>Study community understanding of current and new meningitis vaccines (for example, maternal immunization when available for GBS) and other preventive strategies.</p> | <p>By 2025, citizen representation and input to national meningitis annual plans in >50% of targeted countries.</p> <p>By 2025, research conducted and, by 2028, (depending on vaccine availability) GBS maternal vaccination promoted.</p> |
| <p>Strategic Goal 19: Maintain high vaccine confidence</p> <p>(link to Strategic Goal 1 Vaccine coverage, Strategic Goal 5 Epidemic response, Strategic Goal 18 Health care rights).</p> | <p>Develop risk and communication strategies to address issues of access, acceptance and generation of demand for vaccines.</p> <p>Develop risk and crisis communication plans for new and existing vaccines in order to address potential inaccurate communication of adverse events.</p> | <p>By 2023, risk and communication strategies addressing issues of vaccine access, acceptance and demand developed, integrated into national plans, and implemented in >50% of targeted countries and, by 2026, in >80% of targeted countries.</p> |



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Connection to other global initiatives

The multi-pathogen, multidisciplinary nature of the Defeating meningitis road map provides opportunities for linkage with other global projects and initiatives, which can drive accelerated progress towards mutual or complementary goals. The defeating meningitis Technical Task Force is actively working to identify potentially complementary initiatives and will establish and maintain linkages with these initiatives to ensure alignment of goals and integrated approaches, wherever possible.

Initiatives with potential synergy with the Defeating meningitis road map fall into several categories.

Maintain active collaboration:

- [WHO Sepsis programme](#)
- [Group B Streptococcus Vaccine Development Technology Roadmap](#)
- [Global Antimicrobial Resistance Surveillance System \(GLASS\)](#)
- [WHO Vaccines for Antimicrobial Resistance project](#)
- [WHO Package of Rehabilitation Interventions](#)
- [WHO Deafness and Hearing Loss programme](#)
- [Global Strategy on Comprehensive VPD surveillance](#)
- [WHO Global Invasive Bacterial Vaccine Preventable Disease Laboratory Network](#)
- [Market Information for Access to Vaccines \(MI4A\)](#)
- [Immunization Agenda 2030](#)
– Successor to the [Global Vaccine Action Plan](#)

Maintain communication to identify potential future opportunities:

- [Global roadmap for advancing development of vaccines against sexually transmitted infections](#)
- [Japanese Encephalitis prevention and control programmes \(WPRO, SEARO\)](#)

Share information to promote visibility of the Defeating meningitis road map or our goals/targets:

- [WHO Global Observatory on Health Research and Development](#)
- [Global Action Plan for Healthy Lives and Wellbeing For All](#)
- [IMPRINT – Immunizing Pregnant Women and Infants Network](#)
- [BactiVac Network](#)
- [The Vaccine Centre, London School of Hygiene and Tropical Medicine](#)
- [Global NITAG Network \(GNN\)](#)

Maintain awareness of initiative materials and activities:

- [Global Action Plan for Pneumonia and Diarrhoea](#)
- [Pocket Book of Hospital Care for Children](#) (next edition)
- [WHO Universal Health Coverage Package](#)
- [Global Strategy for Women’s, Children’s and Adolescents’ Health \(Every Woman Every Child\)](#)
- [Every Newborn Action Plan](#)
- [Africa Health Strategy 2016–2030](#)
- [WHO Global Strategy on Human Resources for Health](#)
- [Convention on the rights of persons with disabilities](#)

Identify potential for collaboration:

- [Global Pneumococcal Sequencing Project](#)
- [Cryptococcal disease component of the WHO HIV programme](#)
- [The End TB Strategy](#)
- [WHO Global Influenza Strategy 2019–2030](#)
- [WHO Vaccination in acute humanitarian emergencies: a framework for decision-making](#)
- [Gavi Health system and immunization strengthening support framework](#)
- [Global Health Security Agenda](#)
- [CEPI \(Coalition for Epidemic Preparedness Innovations\)](#)
- [Advancing Maternal Immunization \(AMI\)](#)
- [Global Hub for Vaccine Acceptance and Demand](#)
- [Every Breath Counts Coalition](#)
- [Fever diagnostic project \(ALIMA, PATH, Unitaid\)](#)
- [WHO medical devices programme](#)
- [Africa Collaborative to Advance Diagnostics \(AFCAD\)](#)
- [Vaccine Confidence Project](#)
- [UNICEF Immunization Roadmap 2018–2030](#)
- [Elimination of Mother-to-Child Transmission of HIV and Syphilis in the Americas \(PAHO\)](#)
- [Confederation of Meningitis Organizations \(COMO\)](#)
- [WHO Essential Medicines programme](#)
- [DHIS2 Burden of Disease Modules](#)

Key references

1. Managing meningitis epidemics in Africa: a quick reference guide for health authorities and health-care workers. Geneva: World Health Organization; 2015 (https://apps.who.int/iris/bitstream/handle/10665/154595/WHO_HSE_GAR_ERI_2010.4_Rev1_eng.pdf?sequence=1).
2. Zunt JR, Kassebaum NJ, Blake N, Glennie L, Wright C, Nichols E et al. Global, regional and national burden of meningitis 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Neurology*. 2018;17(12):1061–82.
3. van de Beek D. Progress and challenges in bacterial meningitis. *Lancet*. 2012;380(9854):1623–24.
4. McIntyre PB, O'Brien KL, Greenwood B, van de Beek D. Effect of vaccines on bacterial meningitis worldwide. *Lancet*. 2012;380(9854):1703–11.
5. Defeating meningitis by 2030: baseline situation analysis. Geneva: World Health Organization; 2019 (https://www.who.int/immunization/research/BSA_20feb2019.pdf?ua=1).
6. Global, regional and national age-sex specific mortality for 264 causes of death 1980–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet*. 2017;390(10100):1151–210.
7. Global Burden of Disease Collaborative Network. The Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle (WA): Institute for Health Metrics and Evaluation; 2018 (<https://gbd2017.healthdata.org/gbd-search>).
8. Edmond K, Clark A, Korczak VS, Sanderson C, Griffiths UK, Rudan I. Global and regional risk of disabling sequelae from bacterial meningitis: a systematic review and meta-analysis. *Lancet Infect Dis*. 2010;10(5):317–28.
9. Edmond K, Dieye Y, Griffiths UK, Fleming J, Ba O, Diallo N et al. Prospective cohort study of disabling sequelae and quality of life in children with bacterial meningitis in urban Senegal. *Pediatr Infect Dis J*. 2010;29(11):1023–29.
10. Kohli-Lynch M, Russell NJ, Seale AC, Dangor Z, Tann CJ, Baker CJ et al. Neurodevelopmental impairment in children after Group B Streptococcal disease worldwide: systematic review and meta-analyses. *Clin Infect Dis*. 2017;65(Suppl. 2):S190–S9.
11. Borrow R, Alarcon P, Carlos J, Caugant DA, Christensen H, Debbag R et al. The Global Meningococcal Initiative: global epidemiology, the impact of vaccines on meningococcal disease and the importance of herd protection. *Expert Rev Vaccines*. 2017;16(4):313–28.
12. Egorova EA OD, Ronveaux O, Wasley A. Nationwide Serogroup A Meningococcal outbreak in Kyrgyzstan, 2014–2015. In: Proceedings. 13th Congress EMGM, Amsterdam, the Netherlands, 14–17 September 2015. Amsterdam: European Meningococcal Disease Society; 2015.
13. International Coordinating Group on Vaccine Provision for Epidemic Meningitis: annual meeting 18 September 2018. Geneva: World Health Organization; 2018 (<https://apps.who.int/iris/bitstream/handle/10665/279828/WHO-WHE-IHM-2019.1-eng.pdf?ua=1>).
14. Global and regional immunization profile 2019. Geneva: World Health Organization; 2019 (https://www.who.int/immunization/monitoring_surveillance/data/gs_gloprofile.pdf?ua=1).
15. A global vision for meningitis by 2030 and an action plan to get there. Report of meeting held on 8–10 May 2017. Wilton Park: United Kingdom; 2017 (<https://www.wiltonpark.org.uk/wp-content/uploads/WP1521-Report.pdf>).
16. 14th Annual meeting on surveillance, preparedness and response to meningitis outbreaks in Africa & 4th Annual MenAfriNet partners' meeting: Ouagadougou, Burkina Faso, 12–15 September 2017. Geneva: World Health Organization; 2017.
17. Defeating meningitis by 2030: developing a global road map. Report of meeting held on 27 February–1 March 2019. Wilton Park: United Kingdom; 2019 (<https://www.wiltonpark.org.uk/wp-content/uploads/WP1675-Report-.pdf>).
18. Consultation on the global road map to defeat meningitis. Bristol: Meningitis Research Foundation; 2019 (<https://www.meningitis.org/getmedia/36018fd6-61d2-4a61-895b-36cc7512bcf9/Meningitis-2030-Consultation-public-survey-responses-FINAL>).
19. Thirteenth general programme of work 2019–2023. Geneva: World Health Organization; 2018 (<http://origin.who.int/about/what-we-do/gpw-thirteen-consultation/en/>).
20. Sustainable development goals. New York (NY): United Nations; (<https://www.un.org/sustainabledevelopment/sustainable-development-goals/>).
21. Lewis R, Nathan N, Diarra L, Belanger F, Paquet C. Timely detection of meningococcal meningitis epidemics in Africa. *Lancet*. 2001;358(9278):287–93.



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