WHO guidelines on meningitis diagnosis, treatment and care

Web Annex B. Qualitative and economic evidence reports

World Health Organization

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Contents

Abbreviations

CASP	Critical Appraisal Skills Programme checklist
CERQual	Confidence in the Evidence from Reviews of Qualitative Research
CT	computed tomography
GP	general practitioner
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HIC	high-income country
ICU	intensive care unit
LMIC	low- and middle-income country
LP	lumbar puncture
WHO	World Health Organization

I. Qualitative evidence on the experiences of receiving and providing care for meningitis and its sequelae, and factors influencing service uptake and provision: a systematic review

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Abstract

Background: Meningitis is a life-threatening condition caused by inflammation of the meninges, leading to substantial morbidity and mortality, particularly in cases of bacterial meningitis. Despite advancements in medical diagnostics and treatment, meningitis remains a significant health burden globally, with the highest incidence and mortality rates in low- and middle-income countries (LMICs). While quantitative research has advanced the understanding of treatment efficacy and diagnostic accuracy, qualitative data regarding the experiences of those affected by meningitis remain underexplored. This systematic review aimed to synthesize available qualitative evidence on the experiences of patients, caregivers and health-care providers regarding the diagnosis, treatment and care of meningitis and its sequelae. It also explored barriers and facilitators influencing service uptake and provision, aiming to inform the development of the World Health Organization (WHO) guidelines for improving meningitis care.

Methods: This systematic review was registered in PROSPERO (CRD42024514413). A search of four databases – Embase, MEDLINE, PsycInfo and CINAHL – was conducted to identify relevant qualitative studies published in English. Studies were included if they focused on patient, caregiver or health-care provider experiences related to meningitis diagnosis, treatment or long-term management of its sequelae. Qualitative data from the included studies were analysed using thematic synthesis, which involved line-by-line coding, generation of descriptive themes and subsequent development of analytical themes. The thematic synthesis aimed to identify the key values, beliefs and experiences of stakeholders, as well as the systemic and individual factors influencing health-care access and service provision.

Results: Out of 4735 identified studies, 19 were included in the final synthesis. These studies were conducted in a range of settings, including seven in LMICs and 12 in high-income countries (HICs). Key themes emerging from the data included diagnostic challenges and delayed care-seeking due to cultural and socioeconomic barriers, particularly in LMICs. In HICs, themes such as emotional distress and miscommunication were prevalent. The review identified critical barriers to care, including operational and systemic limitations of health care, financial constraints and inadequate public awareness of meningitis symptoms. Data on facilitators of the uptake of timely care were limited.

Conclusion: This qualitative evidence synthesis revealed significant disparities in meningitis care experiences between LMICs and HICs. In LMICs, financial and logistical barriers, cultural beliefs and health-care system challenges impeded timely diagnosis and treatment. In HICs, issues such as delayed recognition of symptoms and emotional distress played a prominent role in shaping care experiences. The findings highlighted the importance of addressing these barriers through culturally sensitive interventions, improving health-care infrastructure, enhancing communication between patients and providers and strengthening public health education. These insights are essential for

shaping WHO guidelines aimed at improving meningitis care and reducing its global burden, particularly in resource-limited settings.

1. Background

Meningitis is a serious, life-threatening condition characterized by the inflammation of the meninges, the protective membranes covering the brain and spinal cord. It can be caused by a variety of infections, including bacterial, viral, fungal or parasitic, with bacterial meningitis considered the most severe and often leading to significant morbidity and mortality *(1)*. Despite advances in medical science with high-quality diagnostic tools and treatment modalities in place, meningitis remains a global health challenge, particularly in low- and middle-income countries (LMICs) where access to health care and preventive measures can be limited *(2)*.

Existing literature predominantly focuses on the analysis of quantitative evidence, such as the effectiveness of specific diagnostic tools and interventions *(3–5)*. While the quantitative body of evidence is critical for our understanding of diagnostic accuracy and/or treatment efficacy, it leaves a gap in understanding the qualitative aspects of meningitis diagnosis and care. Qualitative evidence, which encompasses the values, beliefs and experiences of patients, caregivers and health-care providers, remains sparse. To date, no systematic review has synthesized this qualitative evidence, which is essential for a holistic understanding of the impact of meningitis and its sequelae on all relevant stakeholders, planning appropriate response from the public-health and policy-making perspective and for the development of care strategies.

The experiences of individuals who have undergone diagnosis, treatment and care for meningitis are critical in understanding potential barriers to care as well as the broader impact of the disease. Patients and their families often face substantial physical, emotional and financial burdens. These experiences are varied and influenced by numerous factors, including the severity of the disease, the timeliness of diagnosis and treatment and the support systems available. The sequelae of meningitis, such as neurological symptoms, hearing loss and/or cognitive impairments, may have long-lasting effects on quality of life *(6)*. It is also important to consider health-care provider experiences and perspectives as they are essential in identifying the challenges and barriers within health systems that affect the provision of care. Understanding these experiences can inform strategies to improve service delivery, enhance patient outcomes and support health-care providers in their roles. Potential differences between high-income countries (HICs) and LMICs may bring specifics pertinent to particular populations and settings *(7)*. These differences have not been comprehensively summarized, yet they are crucial for tailoring interventions and policies to diverse contexts.

This systematic review aimed to comprehensively assess qualitative evidence on the experiences of end-users, barriers and facilitators to health-care delivery of diagnosis and management of meningitis and its sequelae, to inform the scope of new *WHO guidelines on meningitis diagnosis, treatment and care*. This qualitative systematic review was undertaken to identify the values and experiences of individuals regarding the diagnosis,

treatment and care for meningitis, as well as the factors influencing the uptake and provision of these services. This review provides comprehensive insights into the barriers and facilitators in meningitis care, ultimately guiding improvements in clinical practice and health policy.

2. Methods

This systematic review employs a qualitative evidence synthesis to explore the experiences of end-users and health-care providers concerning the diagnosis, treatment and care of meningitis, and factors influencing uptake or provision of these services. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review protocol was registered with the National Institute for Health Research's PROSPERO on 22 February 2024 (PROSPERO 2024 CRD42024514413: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42024514413).

2.1 Search and screening

A comprehensive electronic search was conducted using Embase on 13 February 2024 and MEDLINE, PsycInfo and CINAHL databases on 14 February 2024. The search strategy incorporated a combination of free-text words and Medical Subject Headings (MeSH) terms related to meningitis, qualitative research and health-care experiences. The search strategies are provided in the Appendix WB.I.A1. At the screening phase, further studies were traced through reference lists of included studies to ensure that no original published data had been missed. Authors of identified papers and experts in the field were contacted for missing data when appropriate.

The identified items were imported into Covidence (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia). Pairs of authors (MA, MP, KK, ES, MS, DB, MK, and AM) independently conducted the title and abstract screening, followed by a full-text screening. Any disagreements between the screeners were resolved via consensus or involvement of a third reviewer (MA, MP and/or DM).

2.2 Eligibility criteria and selection of papers

This project has been designed to meet the needs of the WHO Guideline Development Group (GDG) on Meningitis and eligibility criteria were aligned to those used in the guideline development process.

2.2.1 Types of studies

Any studies that employed qualitative methods of data collection, such as individual interviews, focus group discussions, qualitative surveys and questionnaires, observations

or diaries, along with qualitative data analysis methods, including thematic analysis, grounded theory, framework analysis or thematic network analysis, were included. Mixed-methods studies with a significant qualitative component were also considered.

Studies were excluded if they reported on cryptococcal, tuberculous, hospital-acquired or non-infectious meningitis; involved participants younger than one month; or were books, abstracts, case reports, conference papers, theses, reviews or manuscripts without available full text. Only studies published in English were considered for inclusion in this systematic review.

2.2.2 Types of participants

End-users (adults, adolescents or children older than one month) defined as persons who have undergone diagnosis, treatment or care for meningitis were included. Caregivers and family members of people with community-acquired meningitis and health and care workers delivering care for meningitis were also included.

2.2.3 Types of interventions/exposures

Studies were included if they collected qualitative evidence involving values related to the main outcomes of diagnosis, treatment and/or care; views of end-users, caregivers or health-care professionals on acceptability of the services; feasibility, accessibility or affordability of the services; or how implementation of interventions for diagnosis, treatment or care impact health equity, equality and non-discrimination.

2.2.4 Outcomes of interest

Views or experiences of patients, carers and health-care providers of engagement with services in diagnosis, treatment or care of acute, community-acquired meningitis and its sequelae as well as factors influencing the uptake and/or provision of the diagnosis, treatment or care services were considered.

2.3 Data extraction and thematic analysis

All relevant data from the articles included in the study were extracted into Microsoft Excel spreadsheets. Data were extracted on the first author, year of publication, country and method of data collection and analysis. Additionally, information was gathered on study characteristics including number of participants, demographics and the etiology of meningitis (see Table WB.I.1). Any themes suggested by the study authors were recorded.

A thematic synthesis approach was selected for this qualitative evidence synthesis. Thematic synthesis allowed for flexible and rigorous integration and synthesis of individuals' views and experiences from primary studies. The process was conducted in

Microsoft Excel as a three-stage process: (i) line-by-line coding; (ii) generation of descriptive themes; and (iii) the development of analytical themes, supported by codes and descriptive themes, and then applied to the WHO Evidence-to-Decision (EtD) framework.

For each included study, all text within the results or findings sections of the manuscripts, including both author narratives and participant quotations, was coded by five team members (MA, MP, ES, MS and KK) independently to promote reflexivity and enhance rigour. An inductive and iterative approach to analysis was prioritized throughout, allowing significant themes, topics or models to emerge directly from the raw data. In the final stage of synthesis, a deductive phase was introduced to address the review question. Rigour and quality were further reinforced through a process of critical dialogue between coders and reviewers, wherein each member shared their interpretations and provided critical feedback. This process served as a theoretical sounding board, fostering reflection and the exploration of alternative explanations and interpretations. A reflexivity statement is provided in Appendix WB.I.A2.

Separate themes were developed for the "acute phase of meningitis" (stratified into pre-hospitalization and hospitalization periods) and "meningitis sequelae". "Experiences and values", "barriers to care delivery" and "facilitators of service uptake" were considered.

2.4 Risk of bias and certainty of evidence assessment

Although there is currently no agreed-upon consensus regarding the role of quality criteria and their application in qualitative evidence synthesis, we performed a quality assessment of each included study alongside the data extraction, using the Critical Appraisal Skills Programme (CASP) checklist for qualitative data (see Table WB.I.2). Any discrepancies in the quality assessment were addressed through discussion among the research team. Studies were assessed but not excluded based on the outcome of their quality assessment.

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) Confidence in the Evidence from Reviews of Qualitative Research (CERQual) approach (further information available on GRADE-CERQual at: https://www.cerqual.org/) was used to evaluate overall confidence in the evidence presented in the review findings across four domains – methodological limitations, coherence, adequacy of data and relevance – and was informed by the quality assessment of the included papers.

2.4.1 Role of the funding source

The funder of the study, WHO, was involved in the discussion of the inclusion criteria but had no role in the study design, data collection, data analysis and/or data interpretation.

3. Findings

The initial searches found 4731 publications; after removing duplicates (n = 647), 4084 records were identified, and titles and abstracts were screened. Of these, 103 met the inclusion criteria and were eligible for full-text assessment. Eighty-eight studies were further excluded, and four additional publications were identified through reference list screening (Fig. WB.I.1), with 19 papers included in this qualitative evidence synthesis (*8–26*).

3.1 Study characteristics

Studies were conducted in a range of countries (see Table WB.I.3), with seven in LMICs: Burkina Faso (n = 1), Malawi (n = 1), Nigeria (n = 3), Senegal (n = 1) and Zambia (n = 1). Twelve studies were undertaken in HICs: Australia (n = 2), France (n = 2), the United Kingdom of Great Britain and Northern Ireland (n = 5), the United States of America (n = 2), and with a single study conducted in both the United Kingdom and Ireland.

A variety of data collection methods were used across the studies. Semi-structured interviews were the most commonly used method (n = 8), followed by in-depth interviews (n = 4). Focus group discussions were held in three studies, while mixed methods were employed in a single study. Other methods included structured interviews (n = 2), narrative interviews combined with other approaches (n = 1), and telephone interviews (n = 2). Two studies involved triangulation techniques or used detailed sociodemographic and cost questionnaires in addition to interviews.

The sample sizes across the studies ranged from six to 281 individual participants or groups of participants. The types of participants varied, with health-care providers included in seven studies, patients in six studies and caregivers in 14 studies. Some studies involved patients, caregivers and health-care providers (n = 2), while others (n = 4) included specific groups such as meningitis survivors, religious/traditional leaders and community members. All studies were evaluated using the CASP checklist. The most common concern was related to uncertainty in adequacy of the relationship between researcher and participants, which was present in 13 (68%) studies. In seven studies (37%), the research design was not entirely appropriate to address the aims of the research or it was unclear. The GRADE-CERQual assessment of confidence of review findings is presented in Tables WB.I.4 and WB.I.5.

3.1.1 Final themes

Line-by-line inductive coding and data extraction informed the identification of 45 themes (18 related to the pre-hospitalization period, 14 to hospitalization and 13 to sequelae), which are defined in Table WB.I.3.

3.2 Acute phase of meningitis

3.2.1 Pre-hospital period

3.2.1.1 Health-care providers

Experiences and values

Evidence regarding experiences and values of health-care providers were available from HICs only, with three themes identified.

Many masks of meningitis clinical presentation

Meningitis presents with a wide range of symptoms, making it difficult for health-care providers to recognize it, especially when the clinical presentation does not follow classic "textbook cases". The classic meningitis symptom of a purpuric non-blanching rash was often considered a defining feature of the disease that prompted general practitioners (GPs) to admit patients to the hospital. However, many cases are less clear-cut, and GPs often struggle to identify meningitis in patients who exhibit vague or non-specific symptoms. One GP recounted how a patient's symptoms initially seemed unrelated to meningitis but raised concern due to a characteristic sign and the speed of deterioration: "I really didn't have a clue what was wrong with him … The only thing that made me seriously think about meningitis was the fact he'd had this ache in his neck the night before and became extremely ill quickly" *(12)*.

GPs also encountered cases where the symptoms suggested other conditions, such as Henoch-Schönlein purpura and thrombocytopenic purpura, or where a child appeared unusually well despite having a serious illness: "Whereas some children with rashes of meningococcal disease seemed to be well, a rash could have been missed if it was not specifically looked for in ill children" *(12)*.

The variety of presentations – from mild rashes to severe neurological symptoms – made diagnosing meningitis a challenging task, especially in primary care settings where patients presented early and subtle signs could be easily missed.

Role of context and parental input in clinical decision-making

GPs frequently mentioned the role of parental concerns in influencing their decisions, especially when they had an established relationship with the family. Parental emotional cues, such as visible distress and anxiety, were often used as key indicators to guide clinical action. In some cases, parents directly prompted GPs to reconsider their initial

assessments, as in one instance where a father's observation of a small lesion led the GP to re-evaluate the situation:

"Then Dad said he had noticed me prodding [a small petechial lesion] and said: 'What is that? I've not noticed that before.' And that was when I looked again" *(12)*.

Parental fear of meningitis often influenced consultations: many parents expressed concerns raised by awareness campaigns, leading GPs to consider meningitis as a cause of febrile illness even if they had not initially. GPs recognized that while parental fears were sometimes disproportionate, they were understandable given the potential severity of the disease. The awareness of parental fears combined with clinical judgement seemed to play an important role in guiding GPs towards an appropriate diagnosis, even when the presenting symptoms were ambiguous.

Intuitive and evidence-based practice

Another important theme arising from the published literature was that GPs often balanced evidence-based guidelines with intuitive, "experience-driven" decision-making. While GPs recognized the value of evidence-based guidelines, many emphasized the importance of intuition and gut feeling in diagnosing serious illnesses like meningitis. The unpredictable nature of the disease often called for experience-based judgements, as guidelines may not always capture the nuances of early-stage presentations: "Experience-based practice as opposed to evidence-based practice … There is an awful lot of general practice that is based on experience. You make an awful lot of decisions just for reasons that you can't define" *(8)*.

In particular, GPs frequently relied on less systematic indicators, such as the overall appearance of the child or changes in behaviour, to identify serious illnesses. While guidelines provided a framework for managing cases, many GPs felt that they could "depersonalize" the doctor–patient relationship and limit the role of intuition. They stressed the need to adapt guidelines to individual cases, as strict adherence might overlook critical, experience-based insights: "You could follow the guidelines and be ignoring your sixth sense … Guidelines should be thought of as guidelines, not strict protocols" *(8)*.

Barriers and facilitators

The reviewed studies revealed a complex interplay between logistical challenges, health-care providers' confidence in their expertise and certainty in diagnosis, comprising two themes related to barriers and facilitators. The data were available from HICs only.

Systemic and operational barriers in health-care organization

Health-care providers in HICs faced systemic and operational barriers that impacted their ability to provide immediate care for children suspected of having meningitis. These barriers came from a lack of experience, concerns about protocol and logistical challenges, all of which delayed timely intervention.

One of the most significant barriers reported by health-care providers was a lack of experience with administering parenteral antibiotics to children, which created anxiety among practitioners. Many GPs expressed discomfort with this responsibility, preferring instead to transfer the child to secondary care where more experienced clinicians could take over. This reluctance to administer antibiotics was explained by the difficulty in finding a vein for intravenous access and the potential delay it could cause in transferring the patient to the hospital: "I carry benzyl penicillin because I am meant to. I have never had to use it and I am not sure that I would. The most important thing is to get the child to hospital. If I am faffing around trying to find a vein and the ambulance crew is waiting for me, then I'm not sure it is helpful" *(8)*.

External advice, particularly from nearby emergency departments, also played a significant role in GPs' hesitation to initiate treatment. Concerns about overprescribing antibiotics, reinforced by messages from the National Prescribing Service, further discouraged GPs from administering antibiotics. The combination of logistical issues, concerns about proper antibiotic use and anxiety over lack of experience created substantial barriers to pre-hospital intervention in suspected cases of meningitis.

Factors influencing pre-hospital antibiotic treatment initiation

GPs were more likely to administer antibiotics pre-hospital when they were confident in their diagnosis, particularly when classic symptoms such as a haemorrhagic rash were present. However, even in cases where the diagnosis was less certain, the presence of severe symptoms often prompted GPs to act.

The presence of a non-blanching rash was identified as one of the most reliable indicators that led to the initiation of antibiotic treatment. This symptom significantly influenced the decision-making process and was viewed as an urgent sign requiring immediate action. "A non-blanching rash was the most important independent factor leading to hospital admission and initiation of antibiotic treatment beforehand" *(12)*.

GPs expressed a desire for clarity in symptoms before administering antibiotics. Many were hesitant to initiate treatment in the absence of definitive signs, preferring to wait until the diagnosis was clear: "I would only give pre-hospital penicillin if it was barn door, if there were spots, petechial spots or a positive sign of meningism. I wouldn't be shovelling penicillin in without those two symptoms" *(8)*.

3.2.1.2 Patients, carers and community members

Experiences and values

Five themes were identified, with two representing data from LMICs and three arising from HIC settings.

Knowledge and perceptions of meningitis

In LMICs, in rural communities, the causes of meningitis were frequently linked to spiritual or supernatural influences. For example, in northern Nigeria, respondents commonly believed that meningitis was an act of God or the result of spiritual forces. This perception was motivated by traditional beliefs in sorcery, jinn or witchcraft: "Participants believe that some bad jinn cause deadly diseases to people, such as meningitis, and suggest that jinn might have possessed those suffering from the disease" *(17)*.

While spiritual explanations were prevalent, some communities also attributed meningitis to environmental factors. The heat, sun and wind, particularly the Harmattan winds during epidemic seasons, were cited as causes for the disease. Dietary factors, such as food contaminated by wind during epidemic season, leftover food from an ill person and undercooked or oily food, were also perceived to elevate the risk of meningitis. Eating green mangos and natural causes in general were perceived to especially affect children: "These natural causes were used to explain the increased risk among children, who eat forbidden green mangos and play outside in the sun and wind" *(20)*.

Knowledge about meningitis symptoms varied across communities. Seizures, stiff neck and fever were the most commonly recognized symptoms, with stiff neck often serving as a primary indicator. Additionally, there was widespread recognition of the disease's potential for causing serious consequences: many respondents feared death and the long-term sequelae of meningitis, including hearing loss, mutism and mental impairment.

"Because this disease is very dangerous, if a person has convulsions it doesn't take time, a person can die so it's a dangerous disease" *(11)*.

"On my side, my younger sister has even lost hearing as a result of meningitis" *(9)*.

Conflict and convergence between biomedical and traditional treatment

Despite the persistence of traditional beliefs, many caregivers and patients expressed a preference for biomedical treatment when it came to managing meningitis. As one caregiver explained: "Medical treatment is the best because they diagnose, manage the disease and prescribe drugs to address the symptoms" *(17)*.

Sometimes the sentiment that biomedicine is the most effective in diagnosing and treating meningitis coexisted with spiritual beliefs about the cause of the disease. For

example, one caregiver noted: “While I understand that there are evil-doers and jinns, I still prefer medical treatments to traditional approaches” *(17)*.

Despite the growing acceptance of biomedical care, there remains a deep-rooted conflict with traditional beliefs about the illness, which were described in the previous theme. Some patients expressed scepticism toward the medical diagnosis of meningitis, attributing their illness to curses, dreams or old age. One elderly patient, for instance, was diagnosed with meningitis after his children took him to the hospital, but he continued to believe that his ailment was caused by a curse from an envious friend: “When my children took me to the hospital, the doctors said I had meningitis. That was not true because I know the person that is behind this” *(17)*.

Need for awareness and comprehensive knowledge about meningitis

The theme of knowledge of meningitis causes and symptoms was also apparent in HICs, but connotation of the theme was different. Parents often reported that they had very little or no prior knowledge of meningitis before their child’s diagnosis. Many participants shared that they had heard of the disease but did not fully understand its symptoms or severity. As one mother explained: “I didn’t even know what it was. I didn’t even know there were three forms of meningitis. I didn’t even know what purpura fulminans was … I’d never even heard of it” *(15)*.

Once meningitis was diagnosed, many parents expressed a strong desire to gain more knowledge about the disease, often approaching the internet or support groups to fill in the gaps. Some families also shared that health-care providers did not always provide sufficient details, prompting them to seek out this information on their own: “[Be]cause everyone’s very busy at the hospital … [we] just did our own little bit of research, giving ourselves more information so we knew what questions to ask” *(18)*.

Parents were highlighting the importance of better public education and awareness campaigns to ensure that more families could recognize the signs of meningitis early and beyond the commonly known rash: “Parents of children who haven’t had meningitis should be better informed about it” *(16)*.

Parental emotional reactions during initial stages of meningitis

Another theme in HICs covers intense emotional reactions parents experience when their child first shows symptoms of meningitis. These emotions range from fear and frustration to helplessness, as parents try to navigate the health-care system and manage their child’s deteriorating condition.

Parents expressed feelings of anger and disbelief when their concerns were initially dismissed by health-care providers. They felt that the severity of their child’s illness was underestimated, leading to delays in treatment: “I phoned the primary care centre at … hospital … and they sent her away and said she’d just got a virus” *(14)*.

Parents also described a profound sense of helplessness when they were unable to improve their child's condition. This loss of control was a common theme, as many felt that their role as a caregiver was undermined by the severity of the illness: "I'm the mum, I should be able to make my child better, but I couldn't" *(22)*.

Even when their child was transferred to the hospital by a specialist team, some parents continued to feel anxious and distressed as they were unable to accompany their child.

Parental intuition and recognition of illness

Parents' intuition was a key factor in prompting them to seek further medical attention, even when the symptoms did not immediately suggest meningitis. Many parents described how they knew their child was seriously ill based on changes in their behaviour or physical condition, often stemming from a deep, instinctual sense that something was wrong: "The first thing I say to people is he never had spots … he never vomited, he was sick and he was sick to the point where I knew something wasn't right, it wasn't a normal virus that he had" *(18)*.

In some cases, parents were able to identify worrying symptoms that health-care professionals initially missed, such as in the case of a child who presented with atypical symptoms: "She just had a few spots on her belly and was complaining of a headache and stomach-ache … and her feet were freezing … but the doctor blatantly told me I had nothing to worry about" *(14)*.

Parents used specific language to describe changes in their child's behaviour, which indicated that the illness had progressed from mild to serious. These phrases, such as "not herself" or "not there behind the eyes", were frequently missed by health-care professionals.

Barriers and facilitators

Several themes describe barriers on the way to diagnosis and management of meningitis in the pre-hospital period. All themes apart from sociocultural factors are described by study participants from LMICs.

A combination of cultural, financial and systemic factors contributed to delays in seeking timely medical care for meningitis in LMICs.

Sociocultural factors influencing help-seeking behaviour

Sociocultural factors play a critical role, impacting health-seeking behaviour regardless of the setting. These factors can either delay or lead to timely medical intervention depending on family structures, societal norms and community expectations.

In LMICs, health-seeking behaviour was often influenced by collective decision-making within families and communities. Individual recognition of illness severity was frequently insufficient to initiate seeking treatment. Instead, decisions were made through social validation from senior family members or community leaders. Gender roles further complicated decision-making, particularly for women, who often required confirmation from male relatives before seeking medical care. This delayed treatment, as women had to navigate familial hierarchies: "Mothers seek confirmation of extended family and friends more often than husbands or fathers" *(11)*.

Cultural practices and religious beliefs also shape health-seeking behaviour, as presented in the preceding sections outlining patient/carer experiences. In many cases, individuals preferred to seek treatment from traditional healers or religious leaders, particularly when the illness was believed to have spiritual causes. In some communities, individuals only sought hospital care after exhausting traditional remedies, which can lead to delays in appropriate medical treatment: "Initially they will start praying, using anointing oil and all those things with the impression that it is a spiritual attack … It is after they have exhausted those different options that someone will suggest they should go to the hospital" *(9)*.

Socioeconomic factors, such as the cost of health care, also played a significant role in delaying medical intervention. In resource-constrained settings, many families turned to traditional healers due to lower costs and shorter waiting times.

In HICs, sociocultural factors such as balancing parental responsibilities and perceptions of social norms around health-care use influenced health-seeking behaviour. Parents experienced conflict between meeting daily family obligations and recognizing the severity of their child's illness. This conflict could also lead to delayed medical care.

The fear of overusing medical resources or misjudging the severity of the illness can lead to further delays. Parents may hesitate to seek medical care due to uncertainty about whether the severity of child's disease warrants the use of health-care services. The appropriateness of using health-care services is perceived to be dictated by social expectations and norms, and some parents felt pressured to follow them: "This mother's decision-making appears to have been shaped by her perception of the social rules for service use as she was not aware that her child was seriously ill" *(22)*.

Initial response regarding preferred treatment

As already described, the prevalent belief in many communities was that diseases like meningitis are caused by spiritual influences and should be treated with traditional means. As a result, the majority of families used prayer and consultations with traditional healers as the first line of treatment, particularly in cases of mild symptoms. Families also turned to alternative care providers due to shorter waiting times and lower costs, with hospitals being viewed as a last resort. However, some participants noted that they

sought advice from traditional healers regardless of the availability of other resources, underscoring the strong influence of cultural beliefs on medical decision-making.

Self-medication is another common initial response, particularly when symptoms are perceived to be minor. Families administered over-the-counter drugs like paracetamol or used herbal remedies like anointing oil to manage symptoms, seeking medical care only when the condition worsened: "At [an] early stage when it starts with signs of fever, they used to give fever drugs like paracetamol. When they notice that the thing is so much that they can't handle they will then proceed to the hospital" *(9)*.

Lack of awareness and alertness to meningitis symptoms delays timely care

The lack of awareness and appropriate understanding of meningitis symptoms described earlier often led to delays in seeking appropriate medical care. Seizures and headaches – common symptoms of meningitis – were often mistaken for conditions prevalent in LMICs, such as malaria or epilepsy, which is considered a traditional disease in the community. This misattribution delayed recognition and treatment, as families relied on home remedies or over-the-counter medications: "Seizures were often associated more directly with epilepsy as an innate, traditional illness caused by 'internal worms', which was described as requiring traditional treatment, and delayed onset of biomedical treatment-seeking" *(11)*.

This problem was also illustrated by the lack of meningitis recognition as a possible diagnosis in elderly patients, with symptoms like weakness or loss of appetite attributed to old age.

Financial barriers to health care

Many families in LMICs delayed seeking treatment due to the financial burden associated with the health care. To cover emergency expenses, including transportation and medical costs, families may have had to borrow money, which led to further delays. Even in countries with universal health care, the indirect costs of seeking treatment, such as transportation, remained prohibitive for many families: "The wife delayed because of borrowing money, and the child died on the way" *(11)*.

Lack of funds also influenced the type of treatment families pursued, with many initially choosing alternative care providers due to financial constraints.

Impact of perceived health service quality on help-seeking behaviour

The perceived quality of health-care services significantly impacted decisions to seek medical treatment. Long waiting times, unreliable diagnosis, poor communication and inconsistent availability of drugs often deterred families from seeking care at public health-care facilities.

> Decisions to seek conventional medical treatment during early stages of illness were clearly affected by perceptions of the quality of service … Reports amongst primary health workers and patients highlighted a lack of quality care with long waiting times, presumptive diagnosis without examination, verbal mistreatment and erratic drug availability *(11)*.

Patients often turned to traditional healers, as described earlier, avoiding delays in treatment and high costs.

Lack of early recognition

As described in the section related to knowledge and perception of meningitis, many families did not recognize the early symptoms of the disease and only sought medical attention when the condition had progressed to a critical stage: "Maybe when you realize … it's when a child's body is stiff. When you are going to the hospital maybe you are late, it's a dangerous disease" *(11)*.

In some cases, patients and carers did not suspect meningitis until it was diagnosed at the hospital. Previous experience with the disease was rare and many families failed to recognize the seriousness of the symptoms early on.

Recognition of severity as a trigger for help-seeking initiation

An important aspect that facilitated the decision to seek medical care in LMICs was often influenced by the severity of the illness. Carers in LMICs often based their decision to seek medical treatment on the visible deterioration of the patient's condition rather than early symptoms. As long as the illness allowed the patient to maintain some level of normal activity or was amenable to traditional methods of treatment, carers may have delayed treatment. However, when the patient's illness became severe – marked by the inability to perform basic tasks or a noticeable decline in strength – carers were more likely to seek biomedical care: "When he became very sick, he failed to sit down, he failed to stand up … It's when he [a neighbour] suggested, 'This person should not stay here'. Yes, I can say the severity of the illness was what made us go" *(11)*.

Some carers also stated that their decision to seek medical care was often motivated by the disruption of the patient's ability to fulfil daily household duties. This disruption resulted in urgent action.

3.2.2 Hospitalization period

3.2.2.1 Health-care providers

Experiences and values

Data on the experiences of health-care providers were available from LMICs only an in relation to two themes.

Challenges in diagnosing meningitis

Health-care providers from a malaria-endemic region noted some challenges in diagnosing meningitis, despite claiming sufficient knowledge of its signs and symptoms. These difficulties were highlighted by frequent misdiagnoses of meningitis as malaria in both adult and paediatric cases, leading to the initial prescription of anti-malarial treatment. This approach, while understandable in the context of high alertness to malaria, may have led to critical delays in identifying and treating meningitis: "Patients were frequently diagnosed initially with malaria and prescribed anti-malarial medication" *(11)*.

Miscommunication between health-care providers and patients/carers

Health-care providers revealed dismissive attitudes to the concerns of patients and carers, particularly when they returned multiple times with unresolved symptoms. In some cases, patients and caregivers, especially mothers of sick children, were blamed for the persistence of illness, with health-care providers assuming that the prescribed medications had not been properly administered. Consequently, health-care providers failed to take patient or carer concerns seriously, dismissing their reports of persistent symptoms without adequate investigation. This underestimation may prevent timely diagnosis of meningitis, leading to delays in treatment.

> The woman comes, you think that it is not malaria, you give them painkillers, they go home. Then after 2 or 3 days they come back, they say there is no improvement. We think that woman is demanding for nothing. We send them home, but we are supposed to investigate further *(11)*.

Miscommunication also occurred when caregivers did not clearly state signs and symptoms but rather prematurely assumed the underlying illness. While these communication difficulties were a source of frustration for health-care providers, they were sometimes critical factors for patients and caregivers in deciding not to seek help at health-care facilities.

Barriers and facilitators

We identified two themes describing barriers to care delivery and one that may reflect on actions that may result in facilitation, with all evidence coming from LMICs.

Systemic and operational barriers in health-care organization

One of the challenges faced by health-care centres in both epidemic and non-epidemic settings in LMICs was the shortage of medicines, including those that are supposed to be provided free of charge. The inconsistent availability of medications not only delayed treatment but also diminished patients' trust in the health-care system. Moreover, in an epidemic setting, health-care providers were often unaware of official guidelines regarding different payment schedules, leading to increased out-of-pocket expenses for medications, despite official government policy.

Health-care providers faced barriers in performing critical diagnostic procedures, such as lumbar punctures (LPs). These barriers included time constraints, delays caused by the need for additional procedures, such as CT scans, and difficulties locating necessary consumables or even patients, which may indicate suboptimal hospital logistics. In some cases, a lack of proper sterile conditions during LP also contributed to the reluctance of health-care providers to perform the procedure. This may result in missed opportunities for timely diagnosis and treatment.

> Health-care workers identified further clinical barriers to LP uptake. These included the desire to consult other physicians about the need for LP, insufficient time to perform the procedure, inability to locate consumables such as CSF tubes or an inability to locate the patient after they have moved to a different ward *(21)*.

Some doctors reported incorrect knowledge about LP contraindications, which affected their willingness to perform LP. The uncertainty in expertise was further underscored by the desire to consult colleagues about the need for LP, potentially causing additional delays in the procedure. Moreover, some health-care providers indicated that a perceived lack of expertise among doctors could lead to their reluctance to undergo LP themselves or to recommend the procedure to others: "No, I would not do it [an LP on myself] and, no, I would not advise it because I am not comfortable with the expertise of most doctors" *(21)*.

Community apprehensions influencing health-care providers' decision-making

This theme was generated from the evidence available in Elafros et al. (2022) *(21)* only. It was noted that health-care workers were sometimes hesitant to perform LPs on patients in critical conditions due to fears that, if the patient died soon after, other caregivers and patients would perceive the procedure as the cause of death. This worry reflected a broader community belief that LP can be fatal.

> Recalling patients on whom an LP was clinically indicated but not performed due to the severity of illness on presentation, they [health-care workers] recollected their concern that other patients and caregivers on the ward would see the patient's demise as evidence that LP kills *(21)*.

In situations where a child is already in a terminal condition, some physicians opted not to perform the procedure, believing it would only exacerbate existing fears: "If a child is in the terminal stage, then it is appropriate not to do it, as it will reinforce the belief of death" *(21)*.

In some cases, this hesitancy was dictated by a personal, perhaps emotional, judgement of health-care workers. While caregivers were often more willing to consent to LPs later in the admission, health-care workers believed that at this stage the procedure would no longer have an impact on patient outcomes.

Consent practices facilitating lumbar puncture delivery

The evidence regarding this theme comes only from the study by Elafros et al. (2022) *(21)*. To encourage caregivers to consent to LPs and prevent refusal, health-care workers minimized or even omitted the potential risks of the procedure. Health-care workers framed LPs as safe and necessary for accurate diagnosis, which helped alleviate the concerns of patients and caregivers: "I told them, I am going to do a lumbar puncture and it's safe" *(21)*.

It was noted that consent was obtained verbally rather than in writing, which was a norm in this area. By omitting written consent, health-care workers believed this could prevent patients from having misconceptions about the procedure. While consent was obtained only verbally, LP refusal was formally documented in medical records.

The communal environment in hospitals provided an opportunity for health-care workers to use the experiences of other patients who have successfully undergone LPs to reassure caregivers. Seeing other patients go through the procedure without complications may help build a sense of trust and confidence in the caregivers, making them more likely to consent.

> Physicians would occasionally capitalize on the communal nature of the wards and use other patients as examples of individuals who had an LP without complications. Caregivers also used fellow patients for guidance *(21)*.

Health-care workers found that providing a simple explanation of the LP procedure and allowing for multiple conversations with caregivers increased the likelihood of obtaining consent. In some cases, however, health-care workers saw these discussions as protracted and delaying urgent patient care and, therefore, overlooked the consent process altogether.

3.2.2.2 Patients, carers and community members

Experiences and values

Two themes around patient/carer experience in LMICs and four in HICs were synthesized.

Perceptions of lumbar puncture outcomes

The evidence regarding this theme was generated from the Elafros et al. study (2022) *(21)* only. Death and paralysis were the most commonly reported outcomes of LPs. Patients and caregivers often believed that complications occurred only when the procedure was performed by an inexperienced clinician, although death and paralysis were attributed to some specific instances. Caregivers believed that death was tied to the timing of the procedure, particularly if the LP was performed too late or when the patient was perceived as too weak. Paralysis was linked to the positioning of the patient during or after the LP.

These fears were reinforced by personal or family experiences. For instance, one caregiver reported the death of a relative following an LP as a reason for concern: "I fear that my child might die because my father died after the procedure" *(21)*.

Despite these fears, patients and caregivers commented on the improvement of LP outcomes in recent years. Some participants attributed it to advancements in medical techniques, while others credited divine intervention: "Patients and caregivers felt that nowadays patients were more likely to survive LP than in the past and attributed this to a new technique for performing the procedure or, in some instances, to 'God's will'" *(21)*.

Economic impact of medical treatment on families

This theme was synthesized from the study by Griffiths et al. (2012) *(19)* only. Families cited the overwhelming financial burden of hospitalization and medical treatment, particularly due to the high cost of prescriptions. As a result, families were forced to sell possessions or borrow money to cover medical expenses: "We bought many medicaments and the prescriptions were very expensive. My parents assisted me to buy the prescriptions and I sold all my possessions" *(19)*. "During hospitalization we spent much money because the prescriptions were expensive. The injection was very expensive with the cost of one vial CFAF 8000 (US$ 16)" *(19)*.

The financial strain was especially severe for those caregivers who were unemployed. These families were unable to afford basic household expenses, with all available funds directed towards the child's treatment.

> I borrowed some money from my friend, but I only managed this situation with difficulties because I was unemployed. The hospitalization was a heavy financial charge and now we haven't got the household expenses. I used my only money for the child's treatment *(19)*.

Need for health-care providers' greater awareness/alertness and rapid decision-making

Many patients, both adult and paediatric, in HICs initially received alternative diagnoses, suggesting suboptimal preparedness of health-care providers for meningitis. Patients and carers recognized the issue and emphasized the need for greater vigilance and faster responses from medical staff. Families described how health-care providers initially dismissed or misinterpreted symptoms, which led to frustration, especially when they felt symptoms were clear:

> It lasted seven to eight hours and when they [the health-care providers] got to my room, there was panic on board … it's not normal. They could have considered my symptoms. Neck pain, intolerance to light and sound, vomiting and fever, they could have done at least one lumbar puncture to remove the doubt *(23)*.

Parents reported that sometimes health-care providers were not well-prepared to manage meningitis, making families feel concerned or desperate:

> The doctors didn't know much … When I did ask the doctor on the ward at the time something about it, she said she couldn't answer me because she wasn't familiar with it and she'd never treated it … very annoyed with the fact that they didn't know what they were doing because then they're treating him for something that they know nothing about … frustrating when you're in the moment and you had a question and they were like … "we don't know" *(18)*.

In contrast, parents were grateful and satisfied with the care when health-care professionals responded to meningitis with quick actions, for example, by promptly referring to a hospital after accurate recognition or by initiating empirical treatment: "I can't thank that paediatrician enough because he didn't know that it was meningitis yet, but he put a treatment in place … which saved us a few hours" *(15)*.

Importance of appropriate communication and information from health-care providers

Carers in HICs reported feeling frustrated and distressed when health-care providers provided insufficient or vague explanations about meningitis, both in general terms and in relation to their child's condition. A lack of detailed communication during hospital stays led families to seek information on their own. Others felt that health-care providers were dismissive or failed to address their concerns: "More communication … it was very frightening and we didn't know when he was out of danger. We were not sure it was meningitis because we weren't really told" *(16)*.

"Basically, it was 'you can go away, I'm not interested!' [referring to the doctors' attitude]. My mother went crazy (…)" *(23)*.

In contrast, parents whose health-care providers took the time to explain the situation clearly noted feeling satisfied with the support and a sense of control over the situation. "It was faultless from start to finish – from the paramedic to the hospital. They kept us informed – the good and the bad" *(16)*.

Parental emotional turmoil during hospitalization

The experience of having a child diagnosed with meningitis was described as an intense emotional journey for parents and carers. Parents described feelings of shock, disbelief and fear upon facing the meningitis diagnosis. The initial emotions persisted throughout the hospitalization as many parents were confused about what could possibly happen and fearing for their child's life.

"Not fully understanding the disease … having heard of it but not knowing what the implications and what the complications of the disease are, it was quite daunting" *(18)*.

" … I was completely shocked by his condition. I thought he was dying. In fact, I know he barely avoided death. I've always felt that my son was close to death" *(15)*.

The experience of hospitalization in an intensive care unit (ICU) added to the emotional burden of parents whose children had a particularly severe illness. Parents were distressed, anxious and emotionally unprepared to see changes in their child's appearance and behaviour caused by support equipment and treatments: "I freaked because … he was hooked up to everything, all the monitors … I had a bit of a breakdown" *(18)*.

Although the majority of parents described the experience of hospitalization as traumatizing, some parents found hospitalization a relief once their child was in a controlled hospital environment and receiving medical attention and care.

Coping strategies and emotional support during hospitalization

Parents in HICs reported that health-care providers, particularly nurses, helped provide emotional support during their child's hospital stay. Parents who received attentive care from nurses felt supported and expressed appreciation for the relationships they developed with them: "And the nurses I found were brilliant … I feel like they were my friends really, that they befriended me, they gave me support" *(14)*.

However, the quality of support from health-care providers varied, with some participants feeling that more consistent and structured support, such as counselling services, was needed. Emotional support was especially critical at the time of diagnosis and hospitalization in the ICU, where the lack of psychological support left parents struggling to cope.

> I had a very bad experience at the ICU because I found that the staff … well, I think they're people who see this every day and have to remain impassive before certain situations. But we, as parents, we need accompaniment, we need support, we need help, and that's not necessarily what we had *(15)*.

Some parents expressed gratitude for the practical assistance provided by hospitals. Special accommodations, like offering a place for parents to stay at the hospital, eased stress and helped families feel more supported.

Despite the importance of the support from health-care professionals, most parents cited family and friends as key sources of emotional and practical support during hospitalization. Participants described how family and friendship networks helped them manage the stress of the situation. For many, this support was seen as sufficient and they did not feel the need for additional professional support during their hospital stay.

Barriers and facilitators

Two themes describing barriers to care uptake and one that may reflect actions facilitating the uptake were synthesized, with all evidence coming from LMICs and the Elafros et al. (2022) study only *(21)*.

Fear of complications as a barrier to lumbar puncture uptake

Fear of LP-related complications, particularly death and paralysis, was a significant barrier to consent for the procedure. This fear was reported universally among adult patients and caregivers and some paediatric caregivers, and was influenced by prior negative experiences. Patients or caregivers knew someone who had experienced poor outcomes following an LP, which shaped their decision-making: "I fear that my child might die because my father died after the procedure (paediatric caregiver)" *(21)*.

Health-care providers acknowledged that LPs had gained a negative reputation during the HIV epidemic when the procedure was associated with high mortality rates. This historical context contributed to a deep-rooted apprehension surrounding LP, making it challenging for health-care providers to obtain consent.

Reliance on shared decision-making

The importance of shared decision-making within families and communities played a role in consenting to LP. Caregivers consulted extended family members, especially older male relatives or grandmothers, before deciding on LP. This reliance on collective decision-making could lead to delays, especially when the family lived far away and was not immediately available to consult. Some patients rescinded their consent after being influenced by their family or other patients and caregivers in the hospital ward, further complicating care delivery: "The father and uncle to the patient refused after the patient consented and doctors could not carry out the procedure". "Patients may rescind consent at the urging of other patients/caregivers on the ward if too much time passes between consent and LP completion" *(21)*.

Patients' values driving consent to lumbar puncture

Confidence in the competence of the treating physician influenced the consent process, enabling patients and caregivers to agree to LP. Trust in the health-care provider's

technical skills and intentions helped patients overcome fears associated with the procedure.

Additionally, patients and caregivers frequently cited obtaining a clear diagnosis as a strong motivator for consenting to the LP. Diagnostic clarity was seen to ensure correct treatment, as well as to shorten the duration of admission: "One might stay long because the doctors won't know what they are treating" *(21)*.

Concerns about a patient's health and disease severity and progression also stimulated families to proceed with the LP, often as a last resort for adult patients. As symptoms worsened, patients and caregivers saw the procedure as a necessary step in identifying the underlying cause of the illness: "We consented because the patient was getting worse, so we wanted to know the cause" *(21)*.

3.3 Meningitis sequelae

3.3.1 Health-care providers

No studies in either LMICs or HICs provided any data regarding experiences of health-care providers or described barriers/facilitators to care delivery.

3.3.2 Patients, carers and community members

Six themes around patient/carer experience were synthesized with one shared between LMICs and HICs, one LMIC-related and four HIC-related.

Experiences and values

Multifaceted impact of meningitis on physical, mental and social well-being

Meningitis survivors from LMICs were experiencing long-term physical impairments, cognitive and mental health decline and substantial changes in social roles and personal independence.

Older adults reported deterioration in physical health, including heart problems, partial paralysis, hearing and visual impairments and decline in cognitive and mental functioning: "I think I am experiencing mental fatigue because what I could do in the past with ease, I cannot do … anymore … I do not know anything. I do not know what is happening around me … Everything is blank" *(17)*.

In children, the disease severely impacts developmental progress, including motor, speech and language. Some parents also noted behavioural changes and inability of

children to care for themselves due to meningitis consequences: “The child does not speak, does not walk, he cannot even sit down. At the age of 8 years he cannot do anything, but is totally dependent. Since the attack of meningitis he is no longer at school” *(19)*.

Meningitis sequelae severely interfere with social participation and personal independence, which is especially evident in elderly people. Increased dependency was associated with a burden on families, which sometimes struggled to support their loved ones due to economic and social limitations: “As you see me, I am struggling a lot, and my children are not available to help. Although this is the time I need them most, I understand that they have to work, too” *(17)*.

In HICs, the impact of meningitis sequelae was no less devastating, with survivors experiencing severe physical sequelae, emotional trauma and disruptions to their life plans and careers.

Meningitis survivors in HICs faced physical impairments, including amputations, cardiac, hearing and vision problems in adults, and neurodevelopmental delay in children. Cognitive impairments, such as memory loss and executive dysfunction, were also reported.

The emotional toll of meningitis sequelae was also severe, with survivors experiencing depression, unresolved grief and anger. The psychological trauma of the disease extended beyond physical health, causing phobias, social isolation and long-term insecurity.

Participants reported how meningitis damaged their future and professional and personal lives. Some meningitis survivors had to change careers, education and family plans, while others experienced social isolation and a decline in personal motivation. Caregivers also faced disruptions, with family members often needing to quit their jobs to care for affected individuals: “Everything was going great, I was going to settle down, and it was the first time in my life that everything was going well. The meningitis ruined everything …” *(23)*.

Experiences with providing care for meningitis sequelae

This theme, synthesized from the caregiver experiences in LMICs, was characterized by difficulties balancing caregiving responsibilities for ailing family members with the need to maintain jobs to afford essential medications and health-care services. This tension between caregiving and financial obligations caused some frustration:

> My siblings are there despite not having much time because they are still in school. I am here in Lagos working. If I do not work, how will I pay the hospital bill? I must confess that I am not happy leaving my mum in such conditions, but what can I do? We need money, too, to take care of her *(17)*.

Caregiving also carried significant financial implications for families of children affected by meningitis sequelae. For some parents the burden was associated with the necessity of hiring special personnel, while others experienced financial difficulties due to the need to leave their employment.

Caregivers reported feelings of frustration and isolation due to their caregiving responsibilities, which cut them off from their social circles and impacted their emotional well-being. One caregiver described the following:

> I abandoned my job and personal life to give my sick mother everything she needed because of her sickness. However, I must tell you, living with her has been an enormous challenge for me. It appears that she is not appreciating the fact that I am giving her the necessary care she needs. I am not complaining because she is my mother. I understand that old age sometimes makes some older adults behave like a baby. I am trying to cope with her behaviours and actions toward me *(17)*.

Despite the challenges, some caregivers felt happier to return the care they once received from their parents.

Long-term psychological impact of hospitalization

Patients in HICs developed trauma and phobias related to their hospitalization. Some described phobias of hospitals and medical procedures as a direct result of previous traumatic hospitalization for meningitis:

> I'm (...) afraid of blood tests now. I hate it (...) it's true that when I find myself in a hospital room, it makes me think about it again (...), blood tests, I have a real problem with them. I pass out every time (...). When I had my last surgery, that was the hardest thing (...) to inject me, it took an hour to get the catheter in (...) The image of my blue arms where they were trying to stick it in has stayed with me ... It was horrible! It's been five years and I think it'll be a long time before I forget *(23)*.

For some children, fear of medical personnel persisted long after their recovery. One mother shared that her child would cry and scream whenever they saw her in her nurse's uniform, even two years after hospitalization.

Caregivers also faced the psychological impact of meningitis hospitalization, manifesting in depressive symptoms and feelings of helplessness. Some parents revealed that falling into depression required medication and therapy:

> At one point (...) I fell into a deep depression that lasted for two years. I was on medication, anxiolytics and antidepressants to get me out of this hellish spiral. I saw everything in black and I told myself that my daughter would never make it, that they would make fun of her and that life would be difficult for her *(15)*.

Participants reflected on the lasting impact of the traumatic experience, noting that despite the passage of time, memories of helplessness during hospitalization persisted. Some carers also described how the illness altered their lives permanently, extending its

effects far beyond the period of hospitalization: “It’s with me every day and it fuels every aspect of how I parent her. It feels like I’ve taken a deep breath and never exhaled” *(16)*.

Parental concerns about potential consequences of meningitis

Parents in HICs were concerned about the future challenges their children might face as a result of meningitis. They were also expressing anxiety over their child’s developmental progress, comparing them to peers and siblings and worrying about potential behavioural issues related to the disease: “Now I’m a little better, but there are always times when I think about the future, and I still have fears and anxieties about what might happen later on” *(15)*.

Need for care continuity, education and support

Parents in HICs felt the need for follow-up appointments as well as educational and psychological support to ensure their child’s full recovery. Some reported feeling confused and worried due to the lack of such follow-up and expressed a desire for additional consultations and medical tests after hospitalization.

Parents felt overwhelmed and struggled to cope with the emotional toll of caring for a child with meningitis sequelae, expressing the need for post-hospitalization psychological support and counselling: “Maybe a counselling session for parents and grandparents or whoever … to go in and sit down and talk to somebody … More so after what you have just been through, that would have been really helpful” *(18)*.

Some parents also highlighted a lack of knowledge about meningitis sequelae and a desire to receive more information and education regarding potential complications.

Perceptions of quality of aftercare for meningitis sequelae

The theme of aftercare for children with meningitis sequelae was synthesized based on data from the Clark et al. (2013) *(10)* study only. Parents in HICs reported challenges in accessing sufficient or timely aftercare due to staff shortages or budget restrictions. Some parents shared their frustration with inadequate customization of rehabilitation services, for example, prosthetic limbs: “… prosthetic limbs were found to be too heavy for children to use, or the support offered was not tailored with the needs of the child in mind” *(10)*.

Parents also felt that professionals failed to communicate effectively or listen to their concerns.

On the other hand, when parents were satisfied with the provided rehabilitation services, aftercare was tailored and suitable for their child’s needs. Effective communication and listening to parents' expectations of the process were seen to play a crucial role in good care.

Barriers and facilitators

Five themes describing barriers to care delivery (three in LMICs and two in HICs) and one theme from HICs reflecting actions that may result in facilitation, were synthesized.

Balancing marital and domestic responsibilities and caregiving

The data for this theme were synthesized from the Mahmoud et al. (2022) *(17)* study only. Adult daughters faced the challenge of balancing marital and domestic responsibilities while caring for ailing parents. Marriage distances women from their parental homes, making it difficult for them to provide hands-on care. For instance, a female caregiver lamented:

> I was supposed to have married a man from my hometown. If I had done that, I would have been able to take care of my sick mum. I married a man from Lokoja. Currently, I live in Lokoja and my sick mum is in Kaiama. It is not easy to be going there to take care of her. I am only sending money to her *(17)*.

In contrast, men may have greater availability to provide care for relatives with meningitis sequelae: "I take the responsibility of caring for our mother because all my female siblings are not around; they are in their various matrimonial homes outside our town. Since I am around and have my own house, I bring my mummy here, giving her every care she needs" *(17)*.

Preference for home care over institutionalization

The data for this theme were synthesized from the Mahmoud et al. (2022) *(17)* study only. Caregivers from LMICs reported a preference for home-based care over institutionalization of elderly parents. They believed institutionalization would worsen the health of their parents, while family care provides care and emotional support: "Family is the best home where they can see their loved one … However, there would be a significant problem if family members are not available to provide care and love to them" *(17)*.

This poses a barrier to considering formal care facilities, even when caregivers are unable to provide consistent care due to distance or personal responsibilities.

Financial burden as a barrier to uptake of aftercare services

The data for this theme were synthesized from the Griffiths et al. (2012) *(19)* study only. Financial constraints were already described in sections dedicated to the acute phase. Similarly, financial aspects were a significant barrier to accessing aftercare services for children who have experienced meningitis sequelae. Caregivers cited the high cost of transport, hospital consultations and necessary medical devices as reasons for discontinuing aftercare.

One caregiver expressed the struggle with hospital debt: "I had to stop visits to Albert Royer Hospital as I no longer had the means. I could not receive the records of the child because I have a debt to the hospital" *(19)*.

Another caregiver faced difficulties affording transport costs for follow-up care: "We had to stop the appointment at Albert Royer Hospital as [we were] unable to cope with the costs of consultation and transport" *(19)*.

These financial burdens prevented some caregivers from accessing essential treatments, including physiotherapy and hearing aids, precluding any rehabilitation for children with long-term consequences of meningitis.

Lack of appreciation for less apparent sequelae of meningitis

The data for this theme were synthesized from the Clark et al. (2013) *(10)* study only. Parents noted a lack of recognition and understanding of the less visible psychosocial and cognitive after-effects of meningitis. This lack of awareness about sequelae created barriers to accessing support services, especially in educational settings.

> You look at him against all his other class[mates] and you wouldn't straight away say this is the child who's had meningitis, this is the child who can't hear in one ear, this is the child who struggles in these areas of social behaviour … so just trying to access any extra help in school is like pulling teeth *(10)*.

Young age acted as an additional barrier to gaining access to aftercare because of the difficulty testing young children, misconceptions about the needs of disabled children and challenges in predicting cognitive after-effects at the time of discharge.

Systemic and organizational barriers to aftercare

Caregivers faced systemic barriers when attempting to navigate the health- and social-care systems to access aftercare services for their children. While most parents were able to access the support their child needed, this was sometimes achieved only after significant effort. Parents had to "learn the language" of the system, navigating complex bureaucratic processes with little guidance. This added an extra layer of stress and frustration, especially after their child's discharge from the hospital.

The challenge of navigating these systems was compounded by a lack of communication between different specialists, which resulted in unresponsive care. One parent recounted:

> Parent: "They've just given her some words to practise, she doesn't say the endings of any of the words … probably because she can't hear them … speech and language can't sort her hearing out, they can just try and help her with pronouncing the words, but if she can't hear them then they're hitting their heads against a brick wall." Interviewer: "Do speech and language and the audiology people, do they talk to each other?" Parent: "No, no" *(10)*.

Budget restrictions and staff shortages also exacerbated delays in receiving aftercare. In addition to these structural issues, the administrative burden of accessing services was another significant barrier. Some caregivers highlighted the psychological toll of constantly having to prove the legitimacy of their requests for services: "I always say the biggest handicap is administration … you have to keep fighting" *(15)*.

Parents also faced difficulties gaining access to specific services, such as hearing aids or mobility aids, due to restrictive criteria that did not always account for the child's needs: "She was told she would only have 35% hearing, but then told that she couldn't at that time apply for a hearing aid because she was borderline … so we went ahead and got one for her" *(10)*.

Third parties as facilitators of meningitis sequelae aftercare

The data for this theme were synthesized from the Clark et al. (2013) *(10)* study only. Schools proved to be an important facilitator of support provision for children with long-term sequelae of meningitis, particularly when children had a statement of special educational needs. These formalized plans enabled more streamlined access to aftercare services, reducing delays and ensuring that children received the necessary support over an extended period.

Another facilitator in the aftercare process was the role of multidisciplinary team meetings. These meetings, which brought together parents, school staff and health-care professionals, improved communication and cooperation, ensuring that the child's diverse needs were met in a coordinated and effective manner.

For parents who were able to overcome organizational barriers, having a key point of contact who was proactive in managing their child's care played a crucial role. In some cases, the presence of a consistent health-care professional, such as a consultant, ensured that care was well-planned and tailored to the child's specific needs: " … and nothing was ever planned without [the consultant's] say so … to me that said we have got your son's best interests at heart, we have a plan and we know what we're doing" *(10)*.

3.4 Strengths and limitations

This systematic review is the first to comprehensively synthesize qualitative evidence on the experiences of meningitis care across diverse settings, offering valuable insights into patient, caregiver and health-care provider perspectives. By including studies from both HICs and LMICs, the review provides a global perspective on the barriers and facilitators of meningitis care. The thematic synthesis allowed for a rich and nuanced understanding of how cultural, financial and systemic factors influence care-seeking behaviours and health-care delivery in different contexts.

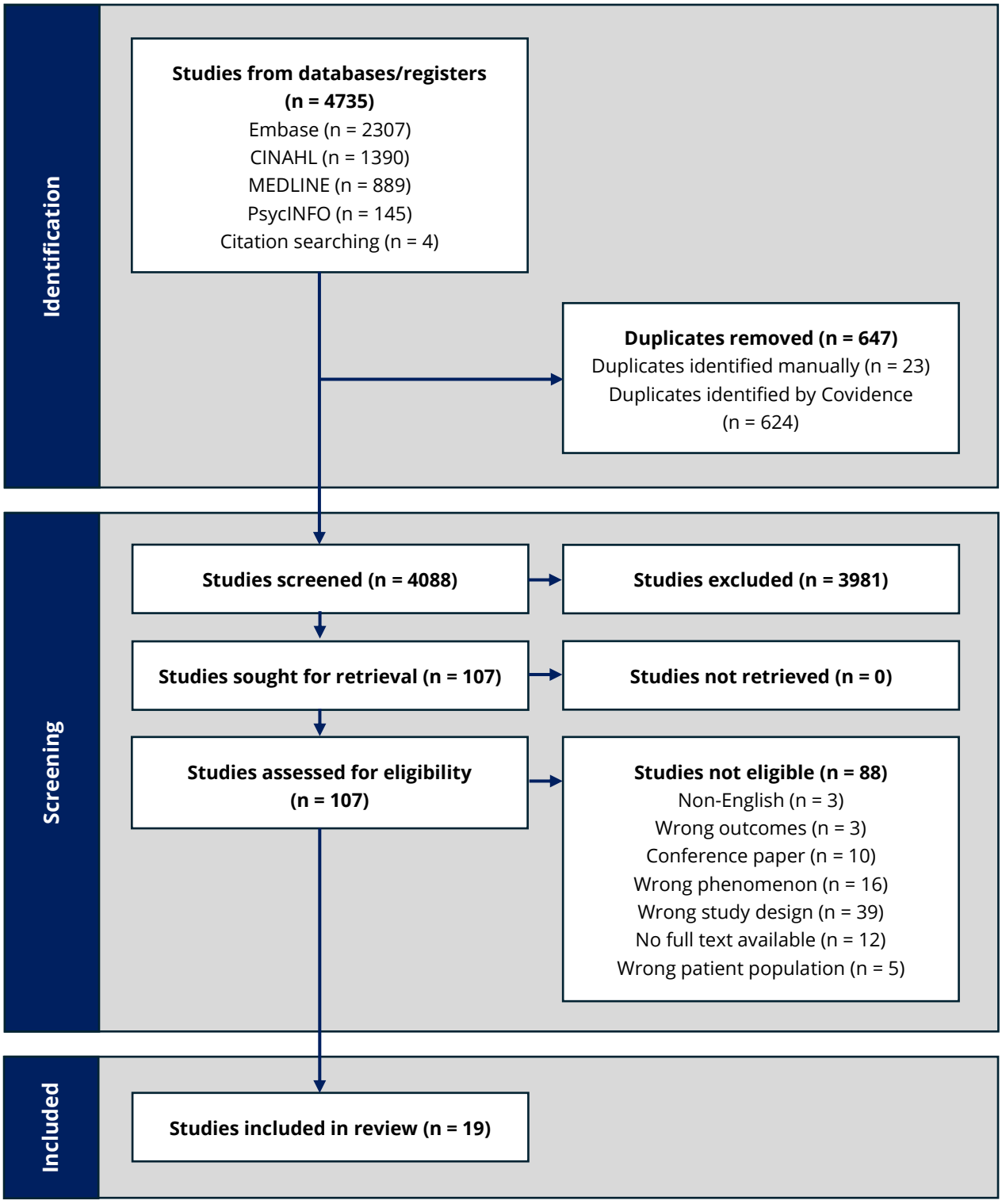
This review also had several limitations. The inclusion of only English-language studies may have resulted in the exclusion of relevant research published in other languages, particularly from LMICs. Additionally, the variability in study designs, participant demographics and health-care settings may limit the generalizability of some findings. While thematic synthesis allows for the integration of diverse qualitative data, the heterogeneity of the included studies may have influenced the interpretation of the results. Future research could benefit from including non-English-language studies and focusing on specific subgroups, such as paediatric populations, rather than parental proxy-reported experiences, to provide more detailed insights into particular aspects of meningitis care delivery and relevant barriers.

3.5 Conclusion and recommendations

This review underscores the need for context-specific interventions to address the diverse challenges faced in meningitis care across HICs and LMICs. In LMICs, efforts should focus on improving health-care access, reducing financial barriers and addressing cultural misconceptions about medical procedures. In HICs, enhancing early recognition of meningitis symptoms, improving patient–provider communication, and integrating psychological support services into care pathways are crucial for improving patient outcomes. Policy-makers, public health experts and health-care providers should collaborate to implement these strategies, informed by the qualitative evidence presented in this systematic review, to improve meningitis care globally and reduce the long-term burden of the disease.

4. Figures and tables

Figure WB.I.1 PRISMA flow diagram[1]



[1] PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table WB.I.1 Characteristics of included studies

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
Low- and middle-income countries								
Adedini, 2021 *(9)*	Nigeria	Carers (C), health-care worker (HCW)	Focus group discussions and in-depth interviews	Not reported (NR)	Thematic analysis	n = 259 (84 interviews: 60 in-depth interviews, 24 focus group discussions) Age: 18–34 years Sex = female 86.1%	Pregnant women/nursing mothers, older women, men, traditional birth attendants/traditional medicine practitioners, faith-based healers, skilled health-care providers, religious and community leaders Ethnicity: Hausa/Fulani, Igbo, Yoruba	• Respondents' perceptions and knowledge about the causes of pneumonia, diarrhoea, malaria and meningitis • Respondents' perceptions and knowledge about prevention of pneumonia, diarrhoea, malaria and meningitis • Respondents' perceptions and knowledge of symptoms and fatality of pneumonia, diarrhoea, malaria and meningitis • Caregivers' preventive practices and management of childhood pneumonia, diarrhoea, malaria and meningitis

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
Colombini, 2009 *(20)*	Burkina Faso	Patient (P), C, community (Com.)	Interviews with structured standardized questionnaires and focus group discussions	NR	Qualitative data analysis (specific method not reported)	People with lived experience n = 116; community members n = 165 Age: all ages	People with lived experience, carers, community members (including religious, administrative and traditional community leaders) Ethnicity: Lyé lé, Moaga	• Social constructions of meningitis • Preventive and therapeutic practices
Desmond, 2013 *(11)*	Malawi	P, C, HCW, Com.	Narrative in-depth interviews (P, C), semi-structured interviews (with HCWs) and focus group discussions (Com.)	NR	Thematic content analysis using an initial coding framework that further guided the development of a treatment-seeking framework	n = 133 (P/C n = 17, Com. n = 96, HCWs n = 20) Age: adults, median 28 years (range 18–48); children < 5 years	Patients identified as adult and paediatric hospital in-patients, carers, community (established community-based social groups such as women's or microfinance	• Recognition of Meningitis as dangerous • Recognition of severe illness • Delays in treatment-seeking • Following recognition of severe illness • Need to validate severity

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
							groups), HCWs (private and government primary and community health service workers)	• Household economics • Perceptions of service quality
Elafros, 2022 *(21)*	Zambia	P, C, HCW	Semi-structured interviews	NR	Modified thematic approach	n = 173 (24 adult patients, 36 carers of adult patients, 63 carers of paediatric patients, 20 doctors and 30 nurses) Age: "most were aged 24–48 y[ears]" Sex: female 66%	Included participant groups: Patients with a suspected central nervous system infection (meningitis), caregivers, doctors, nurses	Lumbar puncture (LP) barriers: • Community apprehensions • Proxy family consensus for LP consent • Competing clinical demands LP enablers: • Perceived utility of LP • Perception of HCW comfort with LP • In-person counselling
Griffiths, 2012 *(19)*	Senegal	C	Interviews using detailed sociodemogr	Median 5 years 5 months (interquartile	Qualitative: NR Quantitative: Cost data analysis	n = 66	Included participant groups: Caregivers of	None (Separate quotes on financial burden of treatment costs,

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
			aphic and cost questionnaires	range [IQR]: 54–75 months)		Age at follow-up: average = 6 years 8 months (4–10 years)	children with meningitis. Family members interviewed: Mother 62%; grandmother 17%; father 12%; grandfather 5%; other caregivers 5%. Ethnicity: 9 different ethnicities; nearly half of the children were Wolof	unaffordable treatment costs and productivity costs of caregivers' time)
Mahmoud, 2022 *(17)*	Nigeria	P, C, Com.	In-depth interviews (using multi-stage sampling technique and an	NR	Thematic framework approach	n = 43 (20 meningococcal meningitis patients, their carers [n = 20] and 3 traditional healers)	Included participant groups: patients (older patients), caregivers (daughters, sons, wives, spouses,	• Causes and symptoms of meningitis • Traditional treatment and management methods of meningitis

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
			informant-based survey; triangulation techniques in the form of interviewing medical personnel)			Age: (patients) average 72.4 years (SD 1.25); (caregivers) 25–49 years Sex (carers): female 50%	ex-wives, other family members), traditional healers	• Family caregivers for older patients suffering from meningitis
Omoleke, 2018 *(13)*	Nigeria	C, HCW, Com.	In-depth interviews, focus group discussions	NR	Thematic framework approach; content analysis method	n = 40 Age: 25–70 years	Carers, HCWs (from the communities and health facilities in the communities), community members (household heads, Quranic school mallams)	• Environmental factor as a driver or risk factor for cerebrospinal meningitis transmission • Economic factors • Sociocultural factors
High-income countries								

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
Brennan, 2003 *(8)*	United Kingdom	HCW	Semi-structured interviews	NR	Grounded theory	n = 26	GPs	• Fear about meningitis and septicaemia • Reaching a diagnosis of meningitis or septicaemia • Treating suspected cases and the value of guidelines
Clark, 2013 *(10)*	United Kingdom, Ireland	C	Multiple-choice questionnaire and semi-structured interviews	Median 5 years	Grounded theory (constant comparison method)	n included = 194, n interviewed = 18 Age of children at the time of illness: mean 3 years 10 months	Parent/legal guardian of children who had survived meningitis or septicaemia. Only those parents reporting permanent after-effects and who had accessed to aftercare and support were invited to the interview.	• Accessing appropriate support and follow-up care • Communication

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
Erickson, 2001 *(26)*	USA	P	Telephone interviews	NR	None	Number of interviewed participants included in the qualitative part of the study n = 17	Patients (college students)	None
Granier, 1998 *(12)*	United Kingdom	HCW	Semi-structured interviews	Mean 61 (SD 39) weeks	Qualitative data analysis (specific method not reported)	n (HCW) = 26; n included cases of IMD (general practice sample) = 31 Age: mean 42 years (range 29–55 years) Sex (HCW): female 38%	GPs who referred children and adolescents under 16 years old with IMD to hospitals	• Rashes • Abnormal illness • Puzzling findings • Misleading information • Role of parents • Management in primary care
Haines, 2005 *(14)*	United Kingdom	C	Focused interviews	1 month following discharge from hospital	Heideggerian phenomenological approach Colaizzi's	n = 7	Parents of childhood IMD survivors admitted to	• Complications/side effects of the disease • Emotional turmoil • Child's physical appearance

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
					interpretation process		paediatric ICU	• Family disruption • Fear of death • Loss of parenting role • Need for support and understanding • Need and value of communication/information/publicity • Parental intuition • Technological interventions • The impact of care delivery
Jarvinen, 2005 *(25)*	Australia	HCW	Structured phone interviews (based on the PRECEDE-PROCEED model), free discussion was encouraged	NR	None (some qualitative data was included)	Total n = 29, interviewed GPs n = 20 Sex: female 25%	GPs	None

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
Kupst, 1983 *(24)*	USA	C	Semi-structured interviews including follow-up interviews	NR (other assessments were performed 1–2 years post-diagnosis)	Quantitative analysis of semi-structured interviews (qualitative data)	n total = 28 families	Parents of childhood bacterial meningitis survivors	None
Neill, 2022 *(22)*	United Kingdom	C	In-depth interviews, focus groups (parents of meningitis patients were interviewed only in focus groups in stage II of the study)	NR (stage II data were collected for participants who had experience of meningitis between 2011 and 2018)	An explanatory modified grounded theory analysis; Glaser's 6 Cs coding frame (5 Cs were applied in the study: context, conditions/antecedents, causes, contingencies/influencing variables and consequences)	n = 18 (n = 16 families were engaged in stage II, and among them 88% [14 of 16] had experience of meningitis) Age (caregivers): 30–50 years (61% were 30–39 years [11 of 18] ; 28% were 40–49 years [5 of 18]) Sex: female 78%	Included participant groups: Caregivers of children with a serious infectious disease (mothers n = 15, fathers n = 2) Ethnicity: white British 67%, white other 17%	• Navigating uncertain illness trajectories • The family and the health services: Context • Social expectations and social hierarchies: The antecedents • Influencing variables or contingencies • Consequences

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
Scanferla, 2020 *(23)*	France	P	Semi-structured interviews	Average 8.9 years (SD 8.2)	Interpretative phenomenological analysis	Number of participants: n total = 9 Sex: female 78% Age at follow-up: 18–48 years (mean 28.3, SD 11.4)	People with lived experience of meningitis	• Meningitis disease (non-spontaneous theme) • Repercussions of the meningitis experience • Memory, memories • Knowledge/ignorance • Temporality • Emotions • Relationships • Health care and professionals

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
Scanferla, 2021 *(15)*	France	C	In-depth semi-structured interviews	Average 9.39 years (SD 5.4)	Interpretative phenomenological analysis	n = 11 Age of survivors: 3–30 years (mean 13.45, SD 9.37) at the time of the interviews Sex of survivors: female 73%	Carers of childhood meningitis survivors (10 mothers and 1 grandmother)	• Meningitis disease • Health-care services and professionals • Knowledge/ignorance • Repercussions of the meningitis experience: "Life afterwards" • Sick child attitudes/behaviour • Sibling attitudes/behaviour
Sweeney, 2013 *(16)*	United Kingdom	C	Structured interviews (3 open-ended questions)	NR	Qualitative content analysis of free-text responses	n = 244	Carers of childhood meningitis survivors	• Information provision • Symptom awareness • Medical follow-up care • Recognition of and provision for additional needs • Impact of the disease • Reassurance

First author, year	Country	Participant type	Method of data collection	Time between meningitis episode and interview	Method of data analysis	Sample size, age, sex	Participant characteristics	Themes suggested by the author
Wisemantel, 2018 *(18)*	Australia	C	Review of medical records and semi-structured interviews with parents; structured interview of a key informant (social worker)	5–6 years	Thematic analysis with inductive and deductive techniques	n = 6	Carers of childhood IMD survivors	• Unclear about IMD • Support needs • Emotional turbulence • Personal growth

C: carers; Com.: community; GP: general practitioner; HCW: health-care workers; HICs: high-income countries; ICU: intensive care unit; IMD: invasive meningococcal disease; IQR: interquartile range; LMICs: low- and middle-income countries; LP: lumbar puncture; NR: not reported; P: patients.

Table WB.I.2 Critical Appraisal Skills Programme (CASP) checklist for qualitative data

Author, year	Was there a clear statement of the aims of the research?	Is a qualitative methodology appropriate?	Was the research design appropriate to address the aims of the research?	Was the recruitment strategy appropriate to the aims of the research?	Was the data collected in a way that addressed the research issue?	Has the relationship between researcher and participants been adequately considered?	Have ethical issues been taken into account?	Was the data analysis sufficiently rigorous?	Is there a clear statement of findings?	How valuable is the research?
Adedini, 2021 *(9)*	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Brennan, 2003 *(8)*	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Clark, 2013 *(10)*	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Colombini 2009 *(20)*	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Valuable
Desmond, 2013 *(11)*	Yes	Yes	Can't tell	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Elafros 2022 *(21)*	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Erickson, 2001 *(26)*	Yes	Can't tell	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes	Valuable

Author, year	Was there a clear statement of the aims of the research?	Is a qualitative methodology appropriate?	Was the research design appropriate to address the aims of the research?	Was the recruitment strategy appropriate to the aims of the research?	Was the data collected in a way that addressed the research issue?	Has the relationship between researcher and participants been adequately considered?	Have ethical issues been taken into account?	Was the data analysis sufficiently rigorous?	Is there a clear statement of findings?	How valuable is the research?
Granier, 1998 *(12)*	Yes	Yes	No[a]	Yes	Yes	Yes	Can't tell	Yes	Yes	Valuable
Griffiths, 2012 *(19)*	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Haines 2005 *(14)*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Jarvinen, 2005 *(25)*	Yes	No[b]	Yes	Yes	Yes	Can't tell	Can't tell	Can't tell	Yes	Valuable
Kupst, 1983 *(24)*	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Mahmoud, 2022 *(17)*	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Neill, 2022 *(22)*	Yes	Yes	No[a]	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable

Author, year	Was there a clear statement of the aims of the research?	Is a qualitative methodology appropriate?	Was the research design appropriate to address the aims of the research?	Was the recruitment strategy appropriate to the aims of the research?	Was the data collected in a way that addressed the research issue?	Has the relationship between researcher and participants been adequately considered?	Have ethical issues been taken into account?	Was the data analysis sufficiently rigorous?	Is there a clear statement of findings?	How valuable is the research?
Omoleke, 2018 *(13)*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Scanferla 2021 *(15)*	Yes	Yes	No[a]	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Scanferla, 2020 *(23)*	Yes	Yes	No[a]	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Sweeney, 2013 *(16)*	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Wisemantel, 2018 *(18)*	Yes	Yes	No[a]	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Valuable

[a] Recall bias could have been introduced due to the time period between the meningitis case and participation in the study.

[b] The study results were mostly quantitative. Qualitative data were not sufficiently described.

Table WB.I.3 Themes synthesized from the available evidence

Theme	Caregivers (C) Community (Com.) Health-care worker (HCW) Patients (P)	Experience (E) Barriers (B) Facilitators (F)	High-income country (HIC) Low- or middle-income country (LMIC)
Pre-hospitalization			
Knowledge and perceptions of meningitis	Com.	E	LMIC
Conflict and convergence between biomedical and traditional treatment	P, C	E	LMIC
Sociocultural factors influencing help-seeking behaviour	P, C	B	LMIC
Initial response regarding preferred treatment	P, C	B	LMIC
Lack of awareness and alertness to meningitis symptoms delays timely care	P, C	B	LMIC
Financial barriers to health care	P, C	B	LMIC
Impact of perceived health service quality on help-seeking behaviour	P	B	LMIC
Lack of early recognition	C	B	LMIC
Recognition of severity as a trigger for help-seeking initiation	C	F	LMIC
Need for awareness and comprehensive knowledge about meningitis	P, C	E	HIC

Parental emotional reactions during initial stages of meningitis	C	E	HIC
Parental intuition and recognition of illness	C	E	HIC
Many masks of meningitis clinical presentation	HCW	E	HIC
Role of context and parental input in clinical decision-making	HCW	E	HIC
Intuitive and evidence-based practice	HCW	E	HIC
Sociocultural factors influencing help-seeking behaviour	C	B	HIC
Systemic and operational barriers in health-care organization	HCW	B	HIC
Factors influencing pre-hospital antibiotic treatment initiation	HCW	F	HIC
Hospitalization			
Perceptions of lumbar puncture outcomes	P, C	E	LMIC
Economic impact of medical treatment on families	C	E	LMIC
Challenges in diagnosing meningitis	HCW	E	LMIC
Miscommunication between health-care workers (HCWs) and patients/carers	HCW	E	LMIC
Fear of complications as a barrier to lumbar puncture uptake	P, C	B	LMIC
Reliance on shared decision-making	P, C	B	LMIC
Patients' values driving consent to lumbar puncture	P, C	F	LMIC

Systemic and operational barriers in health-care organization	HCW	B	LMIC
Community apprehensions influencing health-care workers' decision-making	HCW	B	LMIC
Consent practices facilitating lumbar puncture delivery	HCW	F	LMIC
Need for health-care workers' greater awareness/alertness and rapid decision-making	P, C	E	HIC
Importance of appropriate communication and information from health-care workers	C	E	HIC
Parental emotional turmoil during hospitalization	C	E	HIC
Coping strategies and emotional support during hospitalization	C	E	HIC
Sequelae			
Multifaceted impact of meningitis on physical, mental and social well-being	P	E	LMIC
Experiences with providing care for meningitis sequelae	C	E	LMIC
Balancing marital and domestic responsibilities and caregiving	C	B	LMIC
Preference for home care over institutionalization	C	B	LMIC
Financial burden as a barrier to aftercare services uptake	C	B	LMIC
Multifaceted impact of meningitis on physical, mental and social well-being	P, C	E	HIC
Long-term psychological impact of hospitalization	P, C	E	HIC
Parental concerns about potential consequences of meningitis	C	E	HIC

Need for care continuity, education and support	C	E	HIC
Perceptions of quality of aftercare for meningitis sequelae	C	E	HIC
Lack of appreciation for less apparent sequelae of meningitis	C	B	HIC
Systemic and organizational barriers to aftercare	C	B	HIC
Third parties as facilitators of meningitis sequelae aftercare	C	F	HIC

B: barriers; C: caregivers; Com.: community; E: experiences; F: facilitators; HCW: health-care worker; HIC: high-income country; LMIC: low- or middle-income country; P: patients.

Table WB.I.4 Summary of qualitative findings

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
Hospitalization – high-income countries (HICs)				
1	**Need for greater awareness/alertness and rapid decision-making among health-care workers (HCWs)** Patients and caregivers reported suboptimal knowledge about meningitis and invasive meningococcal disease among HCWs, as evidenced by the fact that many patients received alternative initial diagnoses. The perceived lack of expertise evoked frustration and concern when HCWs were unable to respond to questions about the disease. Patients and carers also shared that, even in the face of obviously serious symptoms and poor condition, some doctors were slow to react, with some being passive and others panicking. On the other hand, families were satisfied with the provided medical care when doctors rapidly recognized the symptoms or initiated early treatment.	Low confidence	Serious concerns regarding methodological limitations: Potential recall bias in 4 studies and lack of reflexivity in 2 studies, which was judged to have potentially influenced the finding. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 5 studies offered moderately rich data, with less data available on the positive perceptions of doctors' performance. No/very minor concerns regarding relevance.	Scanferla, 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18)*; Neill et al. 2022 *(22)*; Scanferla et al. 2020 *(23)*
2	**Importance of appropriate communication and information from HCWs** Caregivers emphasized the importance of appropriate communication and a simple explanation from HCWs. Insufficient communication sometimes caused frustration and prompted families to seek information independently. Carers noted that clear communication and more information about meningitis helped alleviate distress. In contrast, some expressed	Moderate confidence	Serious concerns regarding methodological limitations: Potential recall bias in 4 studies, no reflexivity statement in 4 studies, and insufficient information about data analysis in 1 study. No concerns regarding coherence or adequacy. Very minor concerns regarding relevance: While the finding may not	Clark et al. 2013 *(10)*; Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16);* Wisemantel et al. 2018 *(18)*; Neill et al. 2022 *(22)*; Scanferla

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	satisfaction with the information provided, particularly in written form, as well as with the support from the population health service. However, families also reported instances of disrespectful and dismissive communication, which contributed to their distress. Finally, parents felt that their concerns were unrecognized or underestimated by HCWs.		have been directly related to health-care services, it offered information about experiences during hospitalization in general.	et al. 2020 *(23)*; Kupst et al. 1983 *(24)*
3	**Parental emotional turmoil during hospitalization** The period of hospitalization was an overwhelmingly difficult emotional experience for parents. Given the serious nature of the disease, parents' primary concern revolved around the survival of their child, with many expressing profound worry about this outcome. After receiving the diagnosis of meningitis, parents were shocked, confused and daunted. The diagnosis was described as unexpected, as many parents had never considered it could happen to their child. Although the majority of parents described the experience of hospitalization as traumatizing, some parents found hospitalization a relief, once their child was in a controlled hospital environment and receiving medical attention and care. The experience of hospitalization in an ICU added to the emotional burden of parents whose children had a particularly severe illness. Parents were distressed, anxious and emotionally unprepared to see changes in their child's appearance and behaviour caused by support equipment and treatments.	Low confidence	Serious concerns regarding methodological limitations: Potential recall bias in 3 studies, which were judged to have influenced the finding. Minor concerns regarding coherence: The finding was consistent with the supporting data, but left out some experience with a less negative sentiment. No/very minor concerns regarding adequacy. Minor concerns regarding relevance: The finding did not reflect experiences with health-care services but hospitalization in general.	Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16);* Wisemantel et al. 2018 *(18);* Kupst et al. 1983 *(24)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
4	**Coping strategies and emotional support during hospitalization** Caregivers reported diverse experiences regarding emotional support during hospitalization. While some expressed a need for additional support, such as counselling services, and noted that the assistance from HCWs was inadequate, others were satisfied with the care provided in hospitals or felt that support from family and friends was sufficient, eliminating the need for further psychological assistance during their admission. Additionally, caregivers identified several factors that helped them manage stress, including support from family members, shared responsibilities with relatives and friends, interactions with other parents in the hospital, intervenors, religious beliefs, the attentiveness and hospitality of HCWs, the quality of medical care, prior experiences and a positive attitude.	Low confidence	Serious concerns regarding methodological limitations: Potential recall bias in 3 out of 5 studies, no reflexivity statement in 2 studies, and insufficient information about data analysis in 1 study. No concerns regarding coherence or adequacy. Moderate concerns regarding relevance: The finding was not directly related to experience with health-care services.	Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16);* Wisemantel et al. 2018 *(18)*; Kupst et al. 1983 *(24)*
Hospitalization – low- and middle-income countries (LMICs)				
5	**Perceptions of lumbar puncture outcomes** Patients and caregivers perceived LP as a potentially fatal procedure associated with adverse outcomes. Most notably, the fear of death and paralysis emerged as a dominant concern. Death was attributed to delayed procedure uptake or a patient's poor overall condition, along with concerns that the patient's position during or after the procedure could lead to paralysis. These perceptions were further fuelled by second-hand	Moderate confidence	Very minor concerns regarding methodological limitations: No reflexivity in 1 study. No concerns regarding coherence. Moderate concerns regarding adequacy: 1 study with moderately rich data contributed to the finding. Minor concerns regarding relevance: Relevant data	Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	experiences with adverse outcomes. However, patients and caregivers have observed improvements in the outcomes of LP in recent years, which they attributed to advances in procedural techniques and, in some instances, to divine intervention.		about the experience with LP, but only from 1 study.	
6	**Economic impact of medical treatment on families** Orthodox treatment carried a great financial burden for families: Medicaments and prescriptions were costly, requiring caregivers to sell their properties and incur substantial debts to afford treatment expenses. The lack of funds was the primary reason for seeking alternative types of treatment before going to the hospital.	Moderate confidence	Minor concerns regarding methodological limitations: There were concerns about reflexivity and potential recall bias in the single contributing study. Considering the sensitive nature of the finding, this limitation could have influenced participants' responses. No/very minor concerns regarding coherence. Moderate concerns regarding adequacy: 1 study contributed to the finding, offering relatively thin data. No/very minor concerns regarding relevance.	Griffiths et al. 2012 *(19)*
7	**Challenges in diagnosing meningitis** HCWs claimed knowledge of meningitis signs and symptoms but highlighted difficulties in diagnosing the disease. Meningitis was sometimes misdiagnosed as malaria, resulting in the prescription of anti-malarial medication.	Very low confidence	Serious concerns regarding methodological limitations: No reflexivity statement in 1 study. Concerns about research design. No concerns regarding coherence. Serious concerns regarding adequacy:	Desmond et al. 2013 *(11)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
			Only 1 study with thin data. No concerns regarding relevance.	
8	**Miscommunication between HCWs and end-users** Narratives from HCWs and patients revealed that it is common for patients to be verbally mistreated, which affects their decision to seek help at conventional health-care facilities. Doctors stated that patients can be shouted at, disregarded and blamed, specifically for failing to control the symptoms of meningitis.	Low confidence	Moderate concerns regarding methodological limitations: No reflexivity and potential recall bias. No concerns regarding coherence. Serious concerns regarding adequacy: Only 1 study with relatively thin data. No concerns regarding relevance.	Desmond et al. 2013 *(11)*
9	**Fear of complications as a barrier to LP uptake** Patients and caregivers expressed fear about potential complications related to LP, specifically death and paralysis. These concerns were shaped by previous negative experiences with the procedure and the historical association of LP with high mortality rates during the HIV epidemic.	Low confidence	Moderate concerns regarding methodological limitations: No reflexivity statement in 1 study. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 1 study with relatively thin but descriptive data. No concerns regarding relevance.	Elafros et al. 2022 *(21)*
10	**Reliance on shared decision-making** The decision to consent to a medical procedure was influenced by the shared nature of decision-making. Caregivers and patients consulted older family members when deciding to consent to LP, in some cases to share responsibility and avoid being blamed. Even when the patient was sufficiently well to make their own medical decisions family consensus may have	Moderate confidence	Very minor concerns regarding methodological limitations: No reflexivity. No concerns regarding coherence. Moderate concerns regarding adequacy: 1 study with moderately rich data. No concerns regarding relevance.	Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	overruled patient wishes, especially if too much time passed between consent and procedure completion.			
11	**Patients' values driving LP consent** Patients identified several factors influencing their decision to consent to LP. Trust in physicians and confidence in their technical abilities facilitated the acceptance of the procedure. The desire for diagnostic clarity and appropriate treatment also served as a justification for LP, with some viewing the procedure as a way to potentially reduce the length of hospital stays. Concern over the patient's health and disease progression further motivated families to agree, typically later in the illness course.	Low confidence	Moderate concerns regarding methodological limitations: No reflexivity statement. No concerns regarding coherence. Moderate concerns regarding adequacy: 1 study with moderately rich, but descriptive data. No concerns regarding relevance.	Elafros et al. 2022 *(21)*
12	**Systemic and operational barriers in health-care organization** Reports among HCWs highlighted several issues related to the organization of health-care services. These included poor hospital logistics, lack of sterility, risk of iatrogenic infections, time constraints and the requirement for a CT scan prior to performing a lumbar puncture. Additionally, some HCWs addressed the lack of expertise and knowledge about contraindications of lumbar puncture among doctors, with some citing it as a reason they would be hesitant to undergo or perform the procedure. Drug supply shortages were also noted in both epidemic and non-epidemic settings. In epidemic settings, it was reported that HCWs were often unaware of	Moderate confidence	Moderate concerns regarding methodological limitations: No reflexivity, concerns about data analysis and potential recall bias. No concerns regarding coherence. Minor concerns regarding adequacy: 1 study with moderately rich data, 2 studies with thin data. No concerns regarding relevance.	Desmond et al. 2013 *(11);* Colombini et al. 2009 *(20)*; Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	official guidelines regarding different payment schedules, which led to increased out-of-pocket expenses for medications despite official government policy.			
13	**Community apprehensions influencing HCW's decision-making** HCWs reported that community apprehensions influenced their decision to refer patients for LP. HCWs were reluctant to perform LPs on terminally ill patients due to concerns that if the patient died shortly after, others might perceive the procedure as the cause of death. While caregivers were often more willing to consent to LPs later in the admission, HCWs believed that at that stage the procedure would no longer have a meaningful impact on patient outcomes.	Low confidence	Moderate concerns regarding methodological limitations: No reflexivity statement, which might have influenced HCWs' replies. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 1 study with thin data. No concerns regarding relevance.	Elafros et al. 2022 *(21)*
14	**Consent practices facilitating LP delivery** First, consent was provided only verbally, as it was the norm for LP in this area. By omitting written consent, HCWs believed they could prevent patients from having misconceptions about the procedure. While consent was obtained only verbally, the LP refusal was formally documented in medical records. Second, HCWs prioritized patient care over the consent process to save time. While some entirely skipped the consent process, others modified it to obtain consent more rapidly: They recalled manipulating (i.e. minimizing or omitting) risks of LP during the consent process to reduce the probability of LP refusal. Finally, HCWs believed that by clearly explaining the purpose of LP and	Moderate confidence	Moderate concerns regarding methodological limitations: As the finding reflected consent practices reported by HCWs themselves, lack of reflexivity was judged to have potentially influenced the finding. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study contributed to the finding, offering a moderately rich and sufficiently large quantity of data.	Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	effectively communicating with patients they were more likely to obtain consent.		No/very minor concerns regarding relevance.	
Post-hospitalization – HICs				
15	**Multifaceted impact of meningitis on physical, mental and social well-being** Meningitis survivors and their carers reported disabling physical and mental health sequelae of meningitis, causing daily frustration and limitations in social activities. Among some of the cited sequelae were limb loss, hearing and vision impairment, paralysis, depression, memory impairment in adults and developmental delay in children. Additionally, meningitis survivors highlighted the impact of these sequelae on their social and personal activities and life perspectives. Some patients had to change career, education and family plans, while others reported social isolation and changes in personal motivation. Rehabilitation was an additional source of daily psychological distress, especially when patients were involved in long periods of rehabilitation.	Low confidence	Moderate concerns regarding methodological limitations: Potential recall bias in 2 studies, which was judged to have minimal impact on the finding. Concerns about study design, reflexivity and ethical approval in 1 study, which raised concerns about the quality of the provided qualitative data. Minor concerns regarding coherence: Generally coherent, but mostly reflected major patterns in the underlying data. No/very minor concerns regarding adequacy. Serious concerns regarding relevance: Indirect relevance; did not reflect experience with health-care services but meningitis sequelae in general.	Scanferla et al. 2021 *(15)*; Scanferla et al. 2020 *(23)*; Erickson et al. 2001 *(26)*
16	**Long-term psychological impact of hospitalization** Some patients had traumatic experiences and developed phobias related to medical procedures, personnel or the hospital environment following their hospitalization. In some	Moderate confidence	Moderate concerns regarding methodological limitations: Potential recall bias in 4 studies, no reflexivity statement in 2 studies and insufficient information about data analysis in 1	Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16);* Wisemantel et al. 2018 *(18)*;

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	cases these fears persisted long after their recovery. The psychological impact of meningitis hospitalization also manifested in distress and feelings of helplessness and depression among both survivors and their caregivers.		study. Minor concerns regarding coherence: The finding lacked specific descriptions of psychological changes. Very minor concerns regarding adequacy: The overall richness of data was considered to be moderate. No/very minor concerns regarding relevance.	Scanferla et al. 2020 *(23)*; Kupst et al. 1983 *(24)*
17	**Parental concerns about potential consequences of meningitis** Caregivers of children who had survived meningitis were concerned about potential long-term consequences of the illness. Some parents questioned if their child's health, development and behaviour were normal or if any abnormalities could be treated as after-effects of meningitis. Others were anxious about their child's future and well-being in general.	Low confidence	Minor concerns regarding methodological limitations: Potential recall bias in 3 studies, which was judged to have minimally influenced the finding. Insufficient data on reflexivity in 2 studies and on data analysis in 1. These limitations were judged unlikely to have influenced the finding. No/very minor concerns regarding coherence. Moderate concerns regarding adequacy: All 4 studies offered thin data, but 1 of them provided data from a large sample (n = 244). Moderate concerns regarding relevance: The finding mostly reflected general experience with caregiving and not health-care services.	Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18)*; Kupst et al. 1983 *(24)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
18	**Need for care continuity, education and support** Caregivers emphasized the need for prolonged care, support and education regarding meningitis sequelae. Parents wanted reassurance from HCWs about their child's medical condition and highlighted the importance of follow-up appointments, additional medical tests and specialist assessments to evaluate potential sequelae and identify any special needs. Furthermore, some caregivers reported a lack of knowledge about meningitis sequelae and expressed a desire for more information. Additionally, parents noted feeling overwhelmed and distressed following the diagnosis and indicated a need for psychological support after their child's discharge.	Low confidence	Moderate concerns regarding methodological limitations: Potential recall bias in 3 studies, no reflexivity statement in 2 studies and insufficient information about data analysis in 1 study. No concerns regarding coherence. Very minor concerns regarding adequacy. Moderate concerns regarding relevance: The finding was not directly related to the values and experiences with health-care services, but it offered information about experiences with meningitis sequelae in general.	Clark et al. 2013 *(10)*; Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18)*
19	**Perceptions of quality of aftercare for meningitis sequelae** Parents of children with meningitis sequelae had contrasting experiences with aftercare services. Some parents were unhappy with the provided care and reported inadequate customization of prosthetic limbs and orthopaedic devices. Carers also noted poor communication between different members of the aftercare process and different anticipated goals of rehabilitation, which delayed timely and sufficient care. On the other hand, when parents were satisfied with the provided rehabilitation services, aftercare was tailored and suitable for their child's needs. Effective communication and	Moderate confidence	Moderate concerns regarding methodological limitations: No data to judge if reflexivity was adequate, which could have influenced the finding. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study offered rich data, which was considered adequate for a descriptive finding. No/very minor concerns regarding relevance.	Clark et al. 2013 *(10)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	listening to parents' expectations of the process were seen to play a crucial role in good care.			
20	**Lack of appreciation for less apparent sequelae of meningitis** A lack of recognition and understanding of the less visible psychosocial and cognitive after-effects of meningitis hindered parental ability to access support services, particularly in educational settings. Young age acted as an additional barrier to gaining access to aftercare because of difficulty testing young children, misconceptions about the needs of disabled children and challenges in predicting cognitive after-effects at the time of discharge.	Moderate confidence	Very minor concerns regarding methodological limitations: No reflexivity statement in 1 study. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 1 study with relatively thin data. Minor concerns regarding relevance: While the finding did not directly describe experiences with health-care services, it provided information about potential barriers to gaining access for patients with meningitis sequelae.	Clark et al. 2013 *(10)*
21	**Systemic and organizational barriers to aftercare** Parents of childhood meningitis survivors reported difficulties with accessing and navigating aftercare services, including disability living allowance and social care, and expressed a need for support. Carers cited factors such as lack of staff, lack of communication between different members of the process, restricted budget and complex bureaucratic procedures as barriers to timely, sufficient and tailored rehabilitation. Additionally, they emphasized the limited inclusion criteria, which posed significant barriers for young children and those	High confidence	Minor concerns regarding methodological limitations: Potential recall bias in 2 of the 3 studies, no reflexivity in 1. These limitations would be unlikely to influence the finding given its more generic scope. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study offered rich data, and 2 offered thin data. The data were judged to be adequate as the	Clark et al. 2013 *(10)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	with cognitive or psychological sequelae. Impairments in these children were sometimes borderline and less apparent and aftercare services failed to recognize the link between meningitis and such non-physical sequelae, further complicating access to rehabilitation.		finding was descriptive. No/very minor concerns regarding relevance.	
22	**Third parties as facilitators of meningitis sequelae aftercare** Parents highly valued tailored care suitable for their child's needs. School was seen as having a special role to play in providing accessible, long-term and timely follow-up care. Additionally, parents reported the active involvement of a consultant and multidisciplinary team meetings including parents, school staff and health visitors as factors helping overcome difficulties in accessing aftercare.	Moderate confidence	Very minor concerns regarding methodological limitations: No reflexivity statement in 1 study. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 1 study with relatively thin data. Minor concerns regarding relevance: While the finding did not directly describe experiences with health-care services, it provided information about potential facilitators to gaining access for patients with meningitis sequelae.	Clark et al. 2013 *(10)*
Pre-hospitalization – HICs				
23	**Need for awareness and comprehensive knowledge about meningitis** Patients and caregivers had little or no prior knowledge about meningitis etiology and symptoms before the diagnosis. Once meningitis was diagnosed, people expressed a strong desire for	Low confidence	Very minor concerns regarding methodological limitations: Concerns about reflexivity, data analysis and recall bias. Very minor concerns regarding coherence. No concerns regarding adequacy. Serious concerns	Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18)*;

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	more information about the disease, often consulting the internet or contacting associations to fill in the gaps. Parents and carers highlighted the need for better public education and awareness campaigns to help people recognize the signs of meningitis.		regarding relevance: Indirect relevance; did not reflect experience with health-care services but meningitis in general.	Scanferla et al. 2020 *(23)*
24	**Parental emotional reactions during initial stages of meningitis** Prior to hospitalization, parents experienced complex emotions ranging from anger and disbelief to fear and a sense of loss of control. Parents revealed they experienced immense fear in the face of a serious disease, which sometimes led to denial of the illness. The fear was exacerbated by a sense of helplessness and loss of control over their child's condition. Feelings of anger and disbelief occurred when parents failed to find the expected confirmation of their concerns and appropriate support during first contact with health-care services. Transportation to the health-care facility was another source of emotional burden during the initial stages of the illness. Parents were stressed when they were prevented from accompanying their child, but understanding the rationale behind it and involvement of a team of health specialists helped to ease the stress.	Low confidence	Moderate concerns regarding methodological limitations: Potential recall bias in 1 study could have affected the finding. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 3 studies offered moderately rich data, which was considered sufficient given that the finding was descriptive. Moderate concerns regarding relevance: The finding provided little data on experiences of caregivers with health-care services before hospitalization.	Haines 2005 *(14)*; Neill et al. 2022 *(22)*; Kupst et al. 1983 *(24)*
25	**Parental intuition and recognition of illness** Intuition motivated parents to seek medical attention even when the symptoms did not immediately suggest meningitis. They	Moderate confidence	Moderate concerns regarding methodological limitations: Concerns about recall bias, reflexivity and data analysis. Very minor concerns	Brennan et al. 2003 *(8);* Haines 2005 *(14)*; Wisemantel et al. 2018

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	recognized the overall deterioration of their child's health based on subtle changes in their behaviour or physical condition.		regarding coherence: in 1 study it was not explicitly stated that intuition motivated help-seeking. Minor concerns regarding adequacy: Data were moderately rich but the finding was rather descriptive. Minor concerns regarding relevance: The finding was indirectly related to the uptake of health-care services.	*(18)*; Neill et al. 2022 *(22)*
26	**Many masks of meningitis clinical presentation** General practitioners (GPs) reported having limited experience diagnosing meningitis and meningococcal disease, which can present with diverse clinical manifestations and pose diagnostic challenges. Symptoms such as a non-blanching purpuric rash, neck pain and rapid disease progression increased the certainty of a meningitis diagnosis. Conversely, non-specific symptoms were often less apparent to HCWs and could mislead the diagnostic process. Despite the uncertainty in the diagnosis of meningitis, doctors acknowledged that atypical clinical presentations might indicate a more serious underlying illness, prompting them to hospitalize such patients. Additional symptoms that led to the admission of these complex cases included lethargy, decreased mobility, altered consciousness and mental state, pallor, cyanosis and abnormal crying.	Low confidence	Serious concerns regarding methodological limitations: Potential recall bias in 1 study and lack of reflexivity in the other study, which could have influenced the finding. Minor concerns regarding coherence: The finding did not reflect some minor opposing data but provided data on major trends in medical practice. No/very minor concerns regarding adequacy. No/very minor concerns regarding relevance.	Brennan et al. 2003 *(8)*; Granier et al. 1998 *(12)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
27	**Role of context and parental input in clinical decision-making** GPs noted that parental anxiety significantly influenced their clinical decision-making, particularly when they had an established relationship with the family. Some parents expressed fear of meningitis that, according to HCWs, emerged as a result of the prevalence of awareness campaigns. GPs recognized that while these fears were sometimes disproportionate, awareness campaigns are still needed due to the severity of meningitis. Parental concerns sometimes served as facilitators for further clinical evaluation, with some parents directly prompting GPs to reconsider their initial assessments.	Moderate confidence	Moderate concerns regarding methodological limitations: Concerns about reflexivity, recall bias and ethics. Minor concerns regarding coherence: Several parts of the finding were supported by only 1 citation. No concerns regarding adequacy. No concerns regarding relevance.	Brennan et al. 2003 *(8)*; Granier et al. undefined *(12)*
28	**Intuitive and evidence-based practice** GPs revealed that in general practice they rely much more on experience and intuition rather than evidence and logic. GPs acknowledged the utility of guidelines, but expressed scepticism about their application and noted challenges in keeping up with updates. They stressed that guidelines can undermine individualized and personal patient care and interfere with the more intuitive approach to diagnosis, which was deemed more helpful in case of an unusual clinical presentation. Moreover, GPs stated that their priority was to identify a serious illness – where intuition was a key factor– rather than to make a definitive diagnosis. When identifying a serious illness, GPs often recognized the overall poor condition, changes in usual	Low confidence	Serious concerns regarding methodological limitations: No reflexivity in 2 studies and potential recall bias in 1, which could have significantly influenced the finding. Concerns about qualitative data collection and analysis in 1 study. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study offered rich and comprehensive data, while the other 2 offered thin data. No/very minor concerns regarding relevance.	Brennan et al. 2003 *(8)*; Granier et al. undefined *(12)*; Jarvinen et al. 2005 *(25)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	behaviour of patients and so-called puzzling findings, rather than specific signs and symptoms.			
29	**Sociocultural factors influencing help-seeking behaviour** Caregivers expressed hesitance in seeking assistance due to concerns about the potential misuse or overuse of health-care resources, particularly when uncertain about the severity of the illness. This reluctance to overutilize the health-care system, along with other parental responsibilities, ultimately delayed their decision to seek medical attention.	Low confidence	Moderate concerns regarding methodological limitations: Potential recall bias, no reflexivity. No concerns regarding coherence. Serious concerns regarding adequacy: 1 study offered thin data. Minor concerns regarding relevance: The finding was indirectly related to the uptake of health-care services.	Neill et al. 2022 *(22)*
30	**Systemic and operational barriers in health-care organization** HCWs in primary care settings reported not being confident with lack of experience treating meningitis, thus they were more focused on getting the child hospitalized as early as possible rather than starting treatment on their own. The primary source of concern was lack of experience with administering parenteral antibiotics and potential difficulties with intravenous access. Additionally, GPs revealed that treatment could have been delayed due to advice or disapproval from clinical or prescription consultants and lack of immediate access to antibiotics.	Very low confidence	Serious concerns regarding methodological limitations: No reflexivity in 2 studies, which could have significantly influenced the finding. Concerns about qualitative data collection and analysis in 1 study. No/very minor concerns regarding coherence. Serious concerns regarding adequacy: 2 studies offered thin data, 1 of which did not provide any details behind the data. No/very minor concerns regarding relevance.	Brennan et al. 2003 *(8)*; Jarvinen et al. 2005 *(25)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
31	**Factors influencing pre-hospital antibiotic treatment initiation** GPs were more likely to administer antibiotics pre-hospital when they were confident in their diagnosis. In cases with less certainty, the presence of severe symptoms sometimes motivated GPs to take action. However, some GPs were hesitant to initiate treatment without definitive signs, preferring to wait until the diagnosis was clear. The presence of a non-blanching rash was identified as one of the most reliable indicators that led to the initiation of antibiotic treatment.	Low confidence	Moderate concerns regarding methodological limitations: In 1 study there could have been potential recall bias. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 2 studies contributed to the finding, offering relatively thin data. No concerns regarding relevance.	Brennan et al. 2003 *(8)*; Granier et al. undefined *(12)*
Pre-hospitalization – LMICs				
32	**Knowledge and perceptions of meningitis** Community members perceived meningitis as a dangerous disease typically presenting with stiff neck and seizures. Participants acknowledged that meningitis can result in death and disability, which was particularly frightening in children due to the potential loss of productivity and income in the future. Despite previous educational efforts, communities' knowledge about the causes of meningitis was limited and centred around spiritual or supernatural influence rather than modern medical information. Some participants additionally referred to direct contact with an ill person, specific weather conditions and foods that were associated with meningitis.	Low confidence	Very minor concerns regarding methodological limitations. Moderate concerns regarding coherence: The finding captured only the most dominant patterns, while the data were more varied. Very minor concerns regarding adequacy. Serious concerns regarding relevance: The finding reflected experiences with meningitis in general, not with health-care services.	Adedini et al. 2021 *(9)*; Desmond et al. 2013 *(11)*; Mahmoud et al. 2022 *(17);* Colombini et al. 2009 *(20)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
33	**Conflict and convergence between biomedical and traditional treatment** Many caregivers and patients showed a preference for biomedical treatment in managing meningitis, particularly after realizing the limitations of traditional healing methods. It was emphasized that the hospital was the preferred option for treatment due to doctors' expertise despite the endurance of spiritual beliefs about the disease's origins. However, other end-users still favoured traditional medicine. Some of them expressed doubt about the medical diagnosis of meningitis, attributing their illness to curses, dreams or old age.	Low confidence	Moderate concerns regarding methodological limitations: No reflexivity statement in 2 studies. Minor concerns regarding coherence: 1 of 2 studies did not provide information about the values of patients, while the other offered data from both patients and caregivers. Moderate concerns regarding adequacy: 1 study offered rich data, while the other provided only thin data. No/very minor concerns regarding relevance: 1 study provided only thin data about end-users' values related to meningitis treatment.	Adedini et al. 2021 *(9)*; Mahmoud et al. 2022 *(17)*
34	**Sociocultural factors influencing health-seeking behaviour** Health-seeking behaviour was largely influenced by sociocultural norms established in the community. In a hierarchical society, patients and caregivers, especially women, usually sought validation of disease severity from senior and often male family or community members. In contrast to men, many women had limited or no formal education and were unemployed, which constrained their capacity to make independent decisions. Confirmation of disease severity was essential to warrant funding. However, this was commonly recognized only when the disease interfered with a patient's social activity, delaying timely	Moderate confidence	Minor concerns regarding methodological limitations: Lack of reflexivity in 4 studies, which could have influenced the finding. Moderate concerns regarding coherence: The finding captured only the most dominant patterns, leaving out contrasting patterns present in the aspect of the finding related to gender inequalities. No/very minor	Adedini et al. 2021 *(9)*; Desmond et al. 2013 *(11)*; Omoleke et al. 2018 *(13)*; Mahmoud et al. 2022 *(17)*; Colombini et al. 2009 *(20)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	care. Treatment preferences were also driven by the widespread perception among patients, carers of adult and paediatric patients and community members that meningitis had supernatural causes and should be treated with Islamic or traditional methods. Families consulted traditional healers despite acknowledging the effectiveness of conventional medicine and its availability, particularly to discern if the disease had supernatural origins.		concerns regarding adequacy. No concerns regarding relevance.	
35	**Initial response regarding preferred treatment** The initial response to disease signs in caregivers and patients involved self-medication and alternative treatment. Several families reported administering medications such as paracetamol to alleviate fever or headaches during the early stages of the illness. Caregivers also frequently mentioned favouring alternative medicine, including the help of prayers, traditional healers and soothsayers, to orthodox care. This preference was associated with the prevailing reliance on supernatural explanations for the illness and was particularly evident among older patients and caregiver groups that belonged to rural communities. Some caregivers also clarified that the reasons for favouring alternative medicine were the shorter waiting period, lower cost and less severe illness. Patronage of government hospitals was considered the last resort when the illness became severe and not amenable to alternative care.	Moderate confidence	Moderate concerns regarding methodological limitations: No reflexivity in 3 out of 4 studies; 1 study lacked information about data analysis; and in 1 study it was unclear whether the research design was appropriate to address the aims. Minor concerns regarding coherence: 3 studies reported both alternative medicine and self-medication as an initial response, while the other reported only self-medication. Very minor concerns regarding adequacy. No concerns regarding relevance.	Adedini et al. 2021 *(9)*; Desmond et al. 2013 *(11)*; Omoleke et al. 2018 *(13)*; Colombini et al. 2009 *(20)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
36	**Lack of awareness and alertness to meningitis symptoms delays timely care** Community members, patients and caregivers often underestimated meningitis symptoms, attributing them to more familiar causes such as malaria or traditional illnesses that were usually treated at home. Some non-specific symptoms, including severe headache, body weakness and loss of appetite, were not considered a real illness, which was associated with the delay in timely help-seeking.	High confidence	No/very minor concerns regarding methodological limitations. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study offered moderately rich data and 2 offered thin data. Data were considered adequate (minor concerns) for a descriptive finding. No/very minor concerns regarding relevance.	Desmond et al. 2013 *(11)*; Mahmoud et al. 2022 *(17);* Griffiths et al. 2012 *(19)*
37	**Financial barriers to health care** Patients and caregivers delayed seeking treatment due to the financial burden associated with health care. These financial constraints included not only direct costs of medical services but also transportation to health facilities. Some families reported having to borrow money to cover health-care expenses. In some cases, these financial limitations motivated them to seek alternative medicine before pursuing hospital care.	Moderate confidence	Very minor concerns regarding methodological limitations: No reflexivity statement in 2 studies. No concerns regarding coherence. Minor concerns regarding adequacy: 1 study with rich data, 2 studies with thin data. Minor concerns regarding relevance: 1 study only focused on experiences of caregivers.	Desmond et al. 2013 *(11)*; Omoleke et al. 2018 *(13)*; Griffiths et al. 2012 *(19)*
38	**Impact of perceived health service quality on health-seeking behaviour** Both patients and HCWs reported poor organization of health-care services with long waiting times, presumptive diagnosis without examination, verbal mistreatment and lack of follow-up guidance. The perceived suboptimal quality of care prompted	Low confidence	Moderate concerns regarding methodological limitations: No reflexivity statement in 1 contributing study, which could have potentially influenced the finding. No/very minor concerns regarding coherence.	Desmond et al. 2013 *(11);* Omoleke et al. 2018 *(13)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	patients to avoid hospitals and seek medical advice from alternative service providers.		Moderate concerns regarding adequacy: 2 studies offered thin data. No/very minor concerns regarding relevance.	
39	**Lack of early recognition** Caregivers reported not recognizing the early symptoms of meningitis and only seeking help in health-care facilities when the disease had progressed. Prior experience with meningitis helped raise suspicion earlier.	Very low confidence	No/very minor concerns regarding methodological limitations. Minor concerns regarding coherence: 1 study supported all aspects of the finding while the other only 1 part of the finding. Serious concerns regarding adequacy: Overall richness and quantity of data were relatively low. Minor concerns regarding relevance: The finding provided information about 1 barrier to health-care services uptake.	Adedini et al. 2021 *(9);* Desmond et al. 2013 *(11)*
40	**Disease severity initiates help-seeking behaviour** The key factor that encouraged caregivers to seek help at conventional health-care facilities was recognition of disease severity rather than recognition of specific signs and symptoms of meningitis. Indicators of severity, such as disruption of social life, severe weakness, loss of appetite and the inability to work, were among the cited reasons driving individuals to seek help.	Moderate confidence	No/very minor concerns regarding methodological limitations. Moderate concerns regarding coherence: 1 study reported cases when help-seeking at conventional health-care facilities was initiated following failed attempts to control the disease with alternative medicine. However, the finding did not cover such cases. Moderate concerns regarding	Desmond et al. 2013 *(11);* Omoleke et al. 2018 *(13)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
			adequacy: 1 study on which this finding mostly relied offered moderately rich data, while 1 of the contributing studies offered thin data. No/very minor concerns regarding relevance.	
Sequelae – LMICs				
41	**Multifaceted impact of meningitis on physical, mental and social well-being** Patients emphasized the long-term effects of meningitis on their physical, mental and social well-being. Older patients and caregivers of children reported a range of complications, including cardiovascular problems, paralysis, hearing and vision impairments, cognitive decline and psychological changes. Meningitis sequelae significantly disrupted social activities and reduced the level of independence.	Very low confidence	No/very minor concerns regarding methodological limitations: No reflexivity in 2 studies. Moderate concerns regarding coherence: The finding left out several reported aspects. Minor concerns regarding adequacy: 1 study offered relatively thin data and the other moderately rich data. Serious concerns regarding relevance: The finding reflected experiences with meningitis sequelae in general, not with health-care services.	Mahmoud et al. 2022 *(17);* Griffiths et al. 2012 *(19)*
42	**Experiences with providing care for meningitis sequelae** Aftercare for family members with meningitis sequelae was associated with some practical and psychological challenges. Carers reported the need to balance work commitments and	Low confidence	No/very minor concerns regarding methodological limitations. No/very minor concerns regarding coherence. Moderate concerns regarding adequacy: Of the 2 contributing	Mahmoud et al. 2022 *(17)*; Griffiths et al. 2012 *(19)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	caregiving responsibilities. Those caregivers who continued to work struggled to provide consistent and sufficient care, while others had to abandon their jobs to care for their loved ones. Additionally, a single caregiver reported hiring specialized personnel to look after the child with sequelae, which posed a financial strain on the family. Psychologically, caring for older parents was perceived as a rewarding experience by some participants, but as a stressful experience by others. Psychological stress was induced by the feelings of isolation, frustration with taking care of older family members and fear of economic instability.		studies, 1 offered moderately rich data and 1 offered thin data. Psychological burden of caregiving was reflected in only 1 study and supported by relatively thin data. Serious concerns regarding relevance: The finding reflected general experiences with caregiving and not experiences with rehabilitation services.	
43	**Balancing marital and domestic responsibilities and caregiving** Female caregivers faced challenges with balancing marital and domestic responsibilities while caring for ailing parents. Some women noted that marriage distanced them from their parental homes, complicating their ability to provide care. In contrast, men were reported to have greater availability to provide care for relatives with meningitis sequelae.	Very low confidence	Very minor concerns regarding methodological limitations: No reflexivity. No concerns regarding coherence. Serious concerns regarding adequacy: 1 study with thin data. Serious concerns regarding relevance: The finding reflected experiences with meningitis sequelae in general, not with health-care services.	Mahmoud et al. 2022 *(17)*
44	**Preference for home care over institutionalization** Most caregivers were sceptical about the benefits of professional aftercare services and feared that institutional care could lead to further deterioration of the health of their loved	Moderate confidence	Moderate concerns regarding methodological limitations: Concerns regarding reflexivity and potential recall bias, which could have affected the finding. No/very minor concerns	Mahmoud et al. 2022 *(17)*

No.	Theme Summary of findings	GRADE-CERQual assessment of confidence	Explanation of GRADE-CERQual assessment	References
	one. This led to a belief that care should ideally be managed at home within the family.		regarding coherence. Moderate concerns regarding adequacy: 1 study contributed to the finding, offering relatively thin data. No/very minor concerns regarding relevance.	
45	**Financial burden as a barrier to aftercare services uptake** Financial aspects were a barrier to accessing aftercare services for children and adults who had experienced meningitis. Caregivers reported that the high costs associated with transportation, hospital consultations and medical devices, such as hearing aids, contributed to the discontinuation of aftercare.	Moderate confidence	Very minor concerns regarding methodological limitations: No reflexivity. No concerns regarding coherence. Moderate concerns regarding adequacy: 1 study with relatively thin data. No concerns regarding relevance.	Griffiths et al. 2012 *(19)*

CERQual: Confidence in the Evidence from Reviews of Qualitative Research; GP: general practitioner: GRADE: Grading of Recommendations Assessment, Development and Evaluation; HCW: health-care worker; ICU: intensive care unit.

Table WB.I.5 Evidence profile

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
Hospitalization – high-income countries (HICs)							
1	**Need for greater awareness/alertness and rapid decision-making among health-care workers (HCWs)** Patients and caregivers reported suboptimal knowledge about meningitis and invasive meningococcal disease among HCWs, as evidenced by the fact that many patients received alternative initial diagnoses. The perceived lack of expertise evoked frustration and concern when HCWs were unable to respond to questions about the disease. Patients and carers also shared that, even in the face of obviously serious symptoms and poor condition, some doctors were slow to react, with	Serious concerns Serious concerns regarding methodological limitations. In 4 of the 5 studies that contributed to the finding, recall bias could have been introduced due to the time between the acute episode of meningitis and the interview. In 1 study this period was not reported. The 2 studies did not report the relationship between researcher and participants, 1 of which also did not provide sufficient	No/very minor concerns No concerns regarding coherence. The finding reflected all views on the expertise and clinical behaviour of HCWs that were shared in the contributing studies.	Minor concerns Minor concerns regarding adequacy. Five studies contributed to the finding, together offering moderately rich data. There were less supporting data on perceptions of satisfactory responses from doctors. However, considering the finding is descriptive, there were minor concerns regarding adequacy.	No/very minor concerns Direct relevance. No concerns regarding relevance. The finding gives insights into caregivers' experiences with health-care services, answering the review question.	Low confidence Serious concerns regarding methodological limitations: Potential recall bias in 4 studies and lack of reflexivity in 2 studies, which was judged to have potentially influenced the finding. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 5 studies offered moderately rich data, with less data available on the positive perceptions of doctors'	Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18)*; Neill et al. 2022 *(22)*; Scanferla et al. 2020 *(23)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	some being passive and others panicking. On the other hand, families were satisfied with the provided medical care when doctors rapidly recognized the symptoms or initiated early treatment.	details on data analysis. Overall, these methodological limitations were judged to have potentially influenced the finding. As the finding reflected experiences during hospitalization and attitudes towards HCWs, recall bias and lack of reflexivity could have been critical in this case.				performance. No/very minor concerns regarding relevance.	
2	**Importance of appropriate communication and information from HCWs** Caregivers emphasized the importance of appropriate communication and a simple explanation from HCWs. Insufficient communication sometimes caused frustration and prompted families to seek information	Serious concerns Serious concerns regarding methodological limitations. In 4 of the 8 studies that contributed to the finding, recall bias could have been introduced due to	No/very minor concerns No concerns regarding coherence. The finding completely reflected the range of the underlying data.	No/very minor concerns No concerns regarding adequacy. Eight studies contributing to the finding together offered very rich and diverse data. While 3 studies provided	No/very minor concerns Very minor concerns regarding relevance. The finding is primarily focused on caregivers' experiences with communication with HCWs. While it may	Moderate confidence Serious concerns regarding methodological limitations: Potential recall bias in 4 studies, no reflexivity statement in 4 studies, insufficient information about	Clark et al. 2013 *(10)*; Haines 2005 (14*)*;Scanferla et al.2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18)*; Neill et al. 2022 *(22)*;

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	independently. Carers noted that clear communication and more information about meningitis helped alleviate distress. In contrast, some expressed satisfaction with the information provided, particularly in written form, as well as with the support from the population health service. However, families also reported instances of disrespectful and dismissive communication, which contributed to their distress. Finally, parents felt their concerns were unrecognized or underestimated by HCWs.	the time between the acute episode of meningitis and the interview. In 1 study, this period was not reported. The 4 studies did not report the relationship between the researcher and participants, 1 of which also did not provide sufficient details on data analysis. Overall, these methodological limitations were judged to have potentially influenced the finding. As the finding reflected experiences during hospitalization and attitudes towards HCWs, recall bias and lack of reflexivity		relatively thin data, the remaining 5 offered detailed and comprehensive information.	not be directly tied to health-care services, it nonetheless offered valuable information about experiences during hospitalization more broadly.	data analysis in 1 study. No concerns regarding coherence. No concerns regarding adequacy. Very minor concerns regarding relevance: While the finding may not be directly related to health-care services, it offered information about experiences during hospitalization in general.	Scanferla et al. 2020 *(23)*; Kupst et al. 1983 *(24)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		could have been critical in this case.					
3	**Parental emotional turmoil during hospitalization** The period of hospitalization was an overwhelmingly difficult emotional experience for parents. Given the serious nature of the disease, parents' primary concern revolved around the survival of their child, with many expressing profound worry about this outcome. After receiving the diagnosis of meningitis, parents were shocked, confused and daunted. The diagnosis was described as unexpected, as many parents had never considered it could happen to their child. Although the majority of parents described the experience of hospitalization as traumatizing, some parents found hospitalization a relief	Serious concerns Serious concerns regarding methodological limitations. In 2 of the 5 studies that contributed to the finding recall bias could have been introduced due to the time between the acute episode of meningitis and the interview. In 1 study this period was not reported. Relationship between researcher and participants was not reported in the 2 studies, 1 of which also did not provide sufficient details on data analysis. Overall, these	Minor concerns Minor concerns regarding coherence. The finding generally supported the underlying data and reflected the terrifying experience of caring for a hospitalized child with meningitis. Some less negative emotions, such as feeling the necessity to be strong for others or feeling lucky after recovery, were not included in the finding. However, these data were very scarce.	No/very minor concerns Very minor concerns regarding adequacy. Five studies contributed to the finding: 3 offered thin data and 2 offered rich data, with 1 providing more insights on hospitalization in general and the other on hospitalization to ICU.	Minor concerns Minor concerns regarding relevance. While not necessarily commenting on experiences with health-care services, the finding reflected the relevant experiences of hospitalization in general.	Low confidence Serious concerns regarding methodological limitations: Potential recall bias in 3 studies, which were judged to influence the finding. Minor concerns regarding coherence: The finding was consistent with the supporting data, but left out some experience with a less negative sentiment. No/very minor concerns regarding adequacy. Minor concerns regarding relevance: The finding did not reflect experiences with health-care	Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18);* Kupst et al. 1983 *(24)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	once their child was in a controlled hospital environment and receiving medical attention and care. The experience of hospitalization in an intensive care unit (ICU) added to the emotional burden of parents whose children had a particularly severe illness. Parents were distressed, anxious and emotionally unprepared to see changes in their child's appearance and behaviour caused by support equipment and treatments.	methodological limitations were judged to have a potential influence on the finding. As the finding reflected emotional experiences during hospitalization, recall bias could have been critical in this case.				services but hospitalization in general.	
4	**Coping strategies and emotional support during hospitalization** Caregivers reported diverse experiences regarding emotional support during hospitalization. While some expressed a need for additional support, such as counselling services, and noted that the assistance	Serious concerns Serious concerns regarding methodological limitations. In 3 of the 5 studies that contributed to the finding, recall bias could have been introduced due to	No/very minor concerns No concerns regarding coherence. The finding completely reflected the range of the underlying data.	No/very minor concerns No concerns regarding adequacy. Three out of the 5 studies contributing to the finding offered rich data. Overall, the richness and quantity of all data	Moderate concerns Indirect relevance. The finding provides information about the emotions and psychological coping strategies of caregivers during hospitalization, which is not directly	Low confidence Serious concerns regarding methodological limitations: Potential recall bias in 3 out of 5 studies, no reflexivity statement in 2 studies, insufficient	Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18);* Kupst et al. 1983 *(24)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	from HCWs was inadequate, others were satisfied with the care provided in hospitals or felt that support from family and friends was sufficient, eliminating the need for further psychological assistance during their admission. Additionally, caregivers identified several factors that helped them manage stress, including support from family members, shared responsibilities with relatives and friends, interactions with other parents in the hospital, intervenors, religious beliefs, the attentiveness and hospitality of HCWs, the quality of medical care, prior experiences and a positive attitude.	the time between the acute episode of meningitis and the interview. In 1 study, this period was not reported. This limitation was judged to have a potentially significant influence on participants' responses. Additionally, the 2 studies did not report the relationship between researchers and participants, and 1 did not provide sufficient details on data analysis. As the finding reflected experiences during hospitalization and attitudes towards HCWs' support, recall bias and lack of reflexivity could have been critical in this case.		provided by the 5 studies were considered to be high, so it was concluded that there were no concerns about adequacy.	related to experiences with health-care services.	information about data analysis in 1 study. No concerns regarding coherence. No concerns regarding adequacy. Moderate concerns regarding relevance: The finding was not directly related to experience with the health-care services.	

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
Hospitalization – low- and middle-income countries (LMICs)							
5	**Perceptions of lumbar puncture outcomes** Patients and caregivers perceived lumbar puncture (LP) as a potentially fatal procedure associated with adverse outcomes. Most notably, the fear of death and paralysis emerged as a dominant concern. Death was attributed to delayed procedure uptake or a patient's poor overall condition, along with concerns that the patient's position during or after the procedure could lead to paralysis. These perceptions were further fuelled by second-hand experiences with adverse outcomes. However, patients and caregivers observed improvements in the outcomes of LP in recent years, which they attributed to advances in procedural	No/very minor concerns Very minor concerns regarding methodological limitations because 1 study supporting the finding lacked a reflexivity statement. However, this limitation was assessed as not having a significant influence on the finding.	No/very minor concerns Since the finding was based on 1 study and reflected all the relevant data, there were no concerns regarding coherence.	Moderate concerns Moderate concerns regarding adequacy because only 1 study contributed to the finding, even though it provided moderately rich data and had a relatively large sample size.	Minor concerns Minor concerns regarding relevance because even though the finding provided relevant information about values and experiences with a specific health-care service, only 1 study contributed to the finding.	Moderate confidence Very minor concerns regarding methodological limitations: No reflexivity in 1 study. No concerns regarding coherence. Moderate concerns regarding adequacy: 1 study with moderately rich data contributed to the finding Minor concerns regarding relevance: Relevant data about the experience with LP, but only from 1 study.	Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	techniques and, in some instances, to divine intervention.						
6	**Economic impact of medical treatment on families** Orthodox treatment carried a great financial burden for families: Medicaments and prescriptions were costly, requiring caregivers to sell their properties and incur substantial debts to afford treatment expenses. The lack of funds was the primary reason for seeking alternative types of treatment before going to the hospital.	Minor concerns Minor concerns regarding methodological limitations. The single contributing study did not report sufficient information on the relationship between researcher and participants. Considering the sensitive nature of the finding, this limitation could have influenced participants' responses. However, it was concluded that this would be unlikely.	No/very minor concerns Since the finding was based on 1 study and reflected all the relevant data, there were no concerns regarding coherence.	Moderate concerns Moderate concerns regarding adequacy. One study contributed to the finding, offering relatively thin data. Considering the finding was rather descriptive, it was concluded that there were moderate concerns about data adequacy.	No/very minor concerns The finding reflected one of the major barriers to health-care services, therefore there were no concerns regarding relevance.	Moderate confidence Minor concerns regarding methodological limitations: There were concerns about reflexivity and potential recall bias in the single contributing study. Considering the sensitive nature of the finding, this limitation could have influenced participants' responses. No/very minor concerns regarding coherence. Moderate concerns regarding adequacy: 1 study contributed to the finding, offering relatively	Griffiths et al. 2012 *(19)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
						thin data. No/very minor concerns regarding relevance.	
7	**Challenges in diagnosing meningitis** HCWs claimed knowledge of meningitis signs and symptoms but highlighted difficulties in diagnosing the disease. Meningitis was sometimes misdiagnosed as malaria, resulting in the prescription of anti-malarial medication.	Serious concerns Serious concerns regarding methodological limitations. In 1 study that contributed to the finding, the relationship between researchers and participants was not stated. This limitation was assessed to be critical since the finding described the experiences of HCWs. Additionally, it was unclear whether the research design of the study was appropriate to address the aims of the research.	No/very minor concerns No concerns regarding coherence.	Serious concerns Serious concerns regarding adequacy because only 1 study supported the finding, offering thin data.	No/very minor concerns No concerns about relevance because the finding highlighted the experiences of HCWs in providing care for patients with meningitis, particularly in misdiagnosing meningitis with malaria.	Very low confidence Serious concerns regarding methodological limitations: No reflexivity statement in 1 study, concerns about research design. No concerns regarding coherence. Serious concerns regarding adequacy: Only 1 study with thin data. No concerns regarding relevance.	Desmond et al. 2013 *(11)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
8	**Miscommunication between HCWs and end-users** Narratives from HCWs and patients revealed that it was common for patients to be verbally mistreated, which affected their decision to seek help at conventional health-care facilities. Doctors stated that patients could be shouted at, disregarded and blamed, specifically for failing to control the symptoms of meningitis.	Moderate concerns Moderate concerns regarding methodological limitations. The 1 contributing study did not provide sufficient data on the relationship between the researcher and participants. Considering that the finding reflected participant experiences with and attitudes towards health-care services, this limitation was judged to have potentially influenced the finding. Additionally, recall bias could have been introduced, which would not be expected to influence the finding.	No/very minor concerns The finding fully reflected data from the single contributing study, hence there were no concerns regarding coherence.	Serious concerns Serious concerns regarding adequacy because only 1 study contributed to the finding, offering relatively thin data.	No/very minor concerns No concerns regarding relevance. The finding reflected HCWs' experiences with health-care services provision.	Low confidence Moderate concerns regarding methodological limitations: No reflexivity and potential recall bias. No concerns regarding coherence. Serious concerns regarding adequacy: Only 1 study with relatively thin data. No concerns regarding relevance.	Desmond et al. 2013 *(11)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
9	**Fear of complications as a barrier to LP uptake** Patients and caregivers expressed fear about potential complications related to LP, specifically death and paralysis. These concerns were shaped by previous negative experiences with the procedure and the historical association of LP with high mortality rates during the HIV epidemic.	Moderate concerns Moderate concerns regarding methodological limitations. The 1 contributing study did not provide sufficient data on the relationship between the researcher and participants. Considering that the finding reflected participants' attitudes towards health-care services, this limitation was judged to have potentially influenced the finding.	No/very minor concerns The finding fully reflected data from the single contributing study, hence there were no concerns regarding coherence.	Moderate concerns Moderate concerns regarding adequacy. Only 1 study contributed to the finding, offering relatively thin data. Considering the finding is rather descriptive, it was concluded that there were moderate concerns about data adequacy even though only 1 study contributed to the finding.	No/very minor concerns No concerns regarding relevance because the finding reflected factors influencing the uptake of health-care services.	Low confidence Moderate concerns regarding methodological limitations: No reflexivity statement in 1 study. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 1 study with relatively thin but descriptive data. No concerns regarding relevance.	Elafros et al. 2022 *(21)*
10	**Reliance on shared decision-making** The decision to consent to a medical procedure was influenced by the shared	No/very minor concerns	No/very minor concerns	Moderate concerns Moderate concerns regarding adequacy.	No/very minor concerns	Moderate confidence Very minor concerns regarding	Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	nature of decision-making. Caregivers and patients consulted older family members when deciding to consent to LP, in some cases to share responsibility and avoid being blamed. Even when the patient was sufficiently well to make their own medical decisions family consensus may have overruled patient wishes, especially if too much time passed between consent and procedure completion.	Very minor concerns regarding methodological limitations because 1 study supporting the finding lacked a reflexivity statement. However, this limitation was assessed as not having a significant influence on the finding.	The finding reflected data from the single contributing study, hence there were no concerns regarding coherence.	Only 1 study contributed to the finding, offering moderately rich data that was rather large in quantity. Considering the finding was rather descriptive, it was concluded that there were moderate concerns about data adequacy even though only 1 study contributed to the finding.	No concerns regarding relevance because the finding reflected factors influencing the uptake of health-care services.	methodological limitations: No reflexivity, No concerns regarding coherence. Moderate concerns regarding adequacy: 1 study with moderately rich data. No concerns regarding relevance.	
11	**Patients' values driving LP consent**	Moderate concerns	No/very minor concerns	Moderate concerns	No/very minor concerns	Low confidence	Elafros et al. 2022 *(21)*
	Patients identified several factors influencing their decision to consent to LP. Trust in physicians and confidence in their technical abilities facilitated the acceptance of the procedure. The desire for diagnostic clarity and appropriate treatment also served as a	Moderate concerns regarding methodological limitations. The 1 contributing study did not provide sufficient data on the relationship between the researcher and participants.	The finding fully reflected data from the single contributing study, hence there were no concerns regarding coherence.	Moderate concerns regarding adequacy. Only 1 study contributed to the finding, offering moderately rich data. Considering the finding was rather descriptive, it was concluded that there	No concerns regarding relevance because the finding reflected factors influencing the uptake of health-care services.	Moderate concerns regarding methodological limitations: No reflexivity statement. No concerns regarding coherence. Moderate concerns regarding adequacy: 1 study with	

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	justification for LP, with some viewing the procedure as a way to potentially reduce the length of hospital stays. Concern over the patient's health and disease progression further motivated families to agree, typically later in the illness course.	Considering that the finding reflected participants' attitudes towards health-care services, this limitation was judged to have potentially influenced the finding.		were moderate concerns about data adequacy even though only 1 study contributed to the finding.		moderately rich but descriptive data. No concerns regarding relevance.	
12	**Systemic and operational barriers in health-care organization** Reports among HCWs highlighted several issues related to the organization of health-care services. These included poor hospital logistics, lack of sterility, risk of iatrogenic infections, time constraints and the requirement for a CT scan prior to performing a LP. Additionally, some HCWs addressed the lack of expertise and knowledge about contraindications of LP among doctors, with	Moderate concerns Moderate concerns regarding methodological limitations because all 3 studies contributing to the finding lacked reflexivity statements. Considering the finding described views of HCWs on health-care organization, lack of reflexivity could have potentially	No/very minor concerns The finding fully reflected data from the single contributing study, hence there were no concerns regarding coherence.	Minor concerns Minor concerns regarding adequacy because 1 of 3 contributing studies offered moderately rich data, while 2 others provided thin data. Additionally, 2 studies offered information only about drug availability.	No/very minor concerns No concerns regarding relevance because the finding reflected factors influencing the provision of health-care services.	Moderate confidence Moderate concerns regarding methodological limitations: No reflexivity, concerns about data analysis and potential recall bias. No concerns regarding coherence. Minor concerns regarding adequacy: 1 study with moderately rich data, 2 studies with thin	Desmond et al. 2013 *(11)*; Colombini et al. 2009 *(20)*; Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	some citing it as a reason they would be hesitant to undergo or perform the procedure. Drug supply shortages were also noted in both epidemic and non-epidemic settings. In epidemic settings, it was reported that HCWs were often unaware of official guidelines regarding different payment schedules, which led to increased out-of-pocket expenses for medications despite official government policy.	influenced the finding. In 1 study, it was unclear whether recall bias could have been introduced. Another study did not provide sufficient information about data analysis. However, these limitations were judged to have had minimal effect on the finding.				data. No concerns regarding relevance.	
13	**Community apprehensions influencing HCW's decision making** HCWs reported that community apprehensions influenced their decision to refer patients for LP. HCWs were reluctant to perform LPs on terminally ill patients due to concerns that if the patient died shortly after, others might perceive the	Moderate concerns Moderate concerns regarding methodological limitations. The 1 contributing study did not provide sufficient data on the relationship between the researcher and HCWs. Considering	No/very minor concerns The finding fully reflected data from the single contributing study, hence there were no concerns regarding coherence.	Moderate concerns Moderate concerns regarding adequacy. Only 1 study contributed to the finding, offering relatively thin data. Considering the finding was rather descriptive, it was concluded that there	No/very minor concerns No concerns regarding relevance because the finding reflected factors influencing the provision of health-care services by HCWs.	Low confidence Moderate concerns regarding methodological limitations: No reflexivity statement, which might have influenced HCWs' replies. No concerns regarding coherence. Moderate concerns	Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	procedure as the cause of death. While caregivers were often more willing to consent to LPs later in the admission, HCWs believed that at this stage the procedure would no longer have a meaningful impact on patient outcomes.	that the finding reflected the factors influencing the provision of the health-care service, this limitation was judged to have potentially influenced the finding.		were moderate concerns about data adequacy even though only 1 study contributed to the finding.		regarding adequacy: Only 1 study with thin data. No concerns regarding relevance.	
14	**Consent practices facilitating LP delivery** First, consent was provided only verbally as it was the norm for LP in this area. By omitting written consent, HCWs believed they were preventing patients from having misconceptions about the procedure. While consent was obtained only verbally, the LP refusal was formally documented in medical records. Second, HCWs prioritized patient care over the consent process to save time. While some entirely skipped the	Moderate concerns Moderate concerns regarding methodological limitations. The study did not provide information about the relationship between researcher and participants. As the finding reflected a rather sensitive topic of consent practices reported by HCWs themselves, this limitation was judged to have	No/very minor concerns No concerns regarding coherence. The finding fully reflected the range of consent practices reported in the study.	Minor concerns Minor concerns regarding adequacy. One study contributed to the finding, offering data that were moderately rich and sufficiently large in quantity.	No/very minor concerns No concerns regarding coherence because the finding encompassed experiences with and facilitators of provision of health-care services for meningitis.	Moderate confidence Moderate concerns regarding methodological limitations: As the finding reflected consent practices reported by HCWs themselves, lack of reflexivity was judged to have potentially influenced the finding. No/very minor concerns regarding coherence. Minor concerns	Elafros et al. 2022 *(21)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	consent process, others modified it to obtain consent more rapidly: They recalled manipulating (i.e. minimizing or omitting) risks of LP during the consent process to reduce the probability of LP refusal. Finally, HCWs believed that by clearly explaining the purpose of LP and effectively communicating with patients they were more likely to obtain consent.	potentially influenced the finding.				regarding adequacy: 1 study contributed to the finding, offering data that were moderately rich and sufficiently large in quantity. No/very minor concerns regarding relevance.	
Post-hospitalization – HICs							
15	**Multifaceted impact of meningitis on physical, mental and social well-being** Meningitis survivors and their carers reported disabling physical and mental health sequelae of meningitis, causing daily frustration and limitations in social activities. Among some of the cited sequelae were	Moderate concerns Moderate concerns regarding methodological limitations. In 2 of the 3 studies that contributed to the finding, recall bias could have been introduced due to the time between the	Minor concerns Minor concerns regarding coherence. While the finding was generally coherent with the underlying data, it reflected general patterns and not the full range of experiences with meningitis sequelae.	No/very minor concerns No concerns regarding adequacy. Three studies contributed to the finding: 2 offered rich data and 1 offered moderately rich data.	Serious concerns Indirect relevance. Serious concerns regarding relevance. The finding did not reflect experiences of end-users with rehabilitation services but with	Low confidence Moderate concerns regarding methodological limitations: Potential recall bias in 2 studies, which was judged to have had minimal impact on the finding. Concerns about study design,	Scanferla et al. 2021 *(15);* Scanferla et al. 2020 *(23)*; Erickson et al. 2001 *(26)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	limb loss, hearing and vision impairment, paralysis, depression, memory impairment in adults and developmental delay in children. Additionally, meningitis survivors highlighted the impact of these sequelae on their social and personal activities and life perspectives. Some patients had to change career, education and family plans, while others reported social isolation and changes in personal motivation. Rehabilitation was an additional source of daily psychological distress, especially when patients were involved in long periods of rehabilitation.	acute episode of meningitis and the interview. Recall bias was judged to have had minimal impact on the finding, as it reflected potentially more recent events of dealing with meningitis after-effects and not the acute episode. One study did not provide sufficient details on study design and reflexivity, raising concerns about the methodological quality of the provided qualitative data.	Additionally, the finding mostly focused on data from adult patients but included little data on parental and childhood experiences.		meningitis sequelae in general.	reflexivity and ethical approval in 1 study, which raised concerns about the quality of the provided qualitative data. Minor concerns regarding coherence: Generally coherent, but mostly reflected major patterns in the underlying data. No/very minor concerns regarding adequacy. Serious concerns regarding relevance: Indirect relevance; did not reflect experience with health-care services but meningitis sequelae in general.	
16	**Long-term psychological impact of hospitalization** Some patients had traumatic experiences and developed phobias related to medical	Moderate concerns Moderate concerns regarding methodological	Minor concerns Minor concerns regarding coherence. While the finding was	No/very minor concerns Very minor concerns regarding adequacy.	No/very minor concerns Direct relevance. The finding described	Moderate confidence Moderate concerns regarding methodological	Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*;

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	procedures, personnel or the hospital environment following their hospitalization. In some cases these fears persisted long after their recovery. The psychological impact of meningitis hospitalization also manifested in distress and feelings of helplessness and depression among both survivors and their caregivers.	limitations. In 4 of the 6 studies that contributed to the finding, recall bias could have been introduced due to the time between the acute episode of meningitis and the interview. In 1 study this period was not reported. The 2 studies did not report the relationship between the researcher and participants, 1 of which also did not provide sufficient details on data analysis. Overall, these methodological limitations could potentially have influenced the finding, so it was concluded that there were moderate	coherent with the underlying data, it reflected general patterns and not the full range of emotions, phobias and depressive symptoms experienced by patients and caregivers.	Together, 6 studies provided moderately rich and consistent data.	experience with health-care services and the impact of their provision.	limitations: Potential recall bias in 4 studies, no reflexivity statement in 2 studies and insufficient information about data analysis in 1 study. Minor concerns regarding coherence: The finding lacked specific descriptions of psychological changes. Very minor concerns regarding adequacy: The overall richness of data was considered to be moderate. No/very minor concerns regarding relevance.	Wisemantel et al. 2018 *(18);* Scanferla et al. 2020 *(23)*; Kupst et al. 1983 *(24)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		concerns about methodology.					
17	**Parental concerns about potential consequences of meningitis** Caregivers of children who had survived meningitis were concerned about potential long-term consequences of the illness. Some parents questioned if their child's health, development and behaviour were normal or if any abnormalities could be treated as after-effects of meningitis. Others were anxious about their child's future and well-being in general.	Minor concerns Minor concerns regarding methodological limitations. In 2 of the 4 studies that contributed to the finding, recall bias could have been introduced due to the time between the acute episode of meningitis and the interview. In 1 study this period was not reported. Recall bias was judged to have a minimal impact on the finding, as it reflected potentially more recent events of dealing with meningitis consequences and not the acute	No/very minor concerns No concerns regarding coherence. The finding fully reflected the underlying data.	Moderate concerns Moderate concerns regarding adequacy. Four studies contributed to the finding: All offered relatively superficial data, with 1 providing a large quantity of data.	Moderate concerns Moderate concerns regarding relevance. While the finding hinted at a lack of support from aftercare services, it explicitly covered only the experience of caregiving for a child with meningitis sequelae.	Low confidence Minor concerns regarding methodological limitations: Potential recall bias in 3 studies, which was judged to have minimally influenced the finding. Insufficient data on reflexivity in 2 studies and on data analysis in 1. These limitations were judged unlikely to have influenced the finding. No/very minor concerns regarding coherence. Moderate concerns regarding adequacy: All 4 studies offered thin data but 1 provided data from a	Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18);* Kupst et al. 1983 *(24)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		episode. The relationship between the researcher and participants was not sufficiently reported in the 2 studies. Additionally, 1 study did not provide sufficient details about data analysis, raising concerns about this methodological aspect. It was concluded that these limitations were unlikely to have influenced the finding.				large sample (n = 244). Moderate concerns regarding relevance: The finding mostly reflected general experience with caregiving and not health-care services.	
18	**Need for care continuity, education and support** Caregivers emphasized the need for prolonged care, support and education regarding meningitis sequelae. Parents wanted reassurance from HCWs about their child's medical	Moderate concerns Moderate concerns regarding methodological limitations. In 3 of the 5 studies that contributed to the finding, recall bias	No/very minor concerns No concerns regarding coherence. The finding completely reflected	No/very minor concerns Very minor concerns regarding adequacy. Out of 5 studies, 1 provided very rich data, another provided moderately	Moderate concerns Indirect relevance. The finding was not directly related to the values and experiences with health-care services. However, it offered	Low confidence Moderate concerns regarding methodological limitations: Potential recall bias in 3 studies, no reflexivity statement in 2	Clark et al. 2013 *(10)*; Haines 2005 *(14)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	condition and highlighted the importance of follow-up appointments, additional medical tests and specialist assessments to evaluate potential sequelae and identify any special needs. Furthermore, some caregivers reported a lack of knowledge about meningitis sequelae and expressed a desire for more information. Additionally, parents noted feeling overwhelmed and distressed following the diagnosis and indicated a need for psychological support after their child's discharge.	could have been introduced due to the time between the acute episode of meningitis and the interview. In 1 study this period was not reported. The 2 studies did not report the relationship between the researcher and participants, 1 of which also did not provide sufficient details on data analysis. Overall, these methodological limitations were judged to have potentially influenced the finding, so it was concluded that there were moderate concerns regarding methodology.	the range of the underlying data.	rich data and 3 other studies provided only thin data. However, the overall richness of data was assessed as high.	information about experiences with meningitis sequelae in general.	studies and insufficient information about data analysis in 1 study. No concerns regarding coherence. Very minor concerns regarding adequacy. and Moderate concerns regarding relevance: The finding was not directly related to the values and experiences with health-care services, but it offered information about experiences with meningitis sequelae in general.	et al. 2018 *(18)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
19	**Perceptions of quality of aftercare for meningitis sequelae** Parents of children with meningitis sequelae had contrasting experiences with aftercare services. Some parents were unhappy with the provided care and reported inadequate customization of prosthetic limbs and orthopaedic devices. Carers also noted poor communication between different members of the aftercare process and different anticipated goals of rehabilitation, which delayed timely and sufficient care. On the other hand, when parents were satisfied with the provided rehabilitation services, aftercare was tailored and suitable for their child's needs. Effective communication and listening to parents' expectations of the process were seen to	Moderate concerns Moderate concerns regarding methodological limitations. One study that contributed to the finding did not provide any information on reflexivity. As the finding reflected experiences with and attitudes towards health-care services, this limitation was judged to have potentially influenced the finding.	No/very minor concerns No concerns regarding coherence. The finding fully reflected the underlying data.	Minor concerns Minor concerns regarding adequacy. Only 1 study contributed to the finding, offering moderately rich data. Given that the finding was exploratory and rather superficial, it was concluded that there were minor concerns regarding adequacy.	No/very minor concerns Direct relevance. No concerns regarding relevance. The finding answered the review question by providing data on caregivers' experience with aftercare services.	Moderate confidence Moderate concerns regarding methodological limitations: No data to judge if reflexivity was adequate, which could have influenced the finding. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study offered rich data, which was considered adequate for a descriptive finding. No/very minor concerns regarding relevance.	Clark et al. 2013 *(10)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	play a crucial role in good care.						
20	**Lack of appreciation for less apparent sequelae of meningitis** A lack of recognition and understanding of the less visible psychosocial and cognitive after-effects of meningitis hindered parental ability to access support services, particularly in educational settings. Young age acted as an additional barrier to gaining access to aftercare because of difficulty testing young children, misconceptions about the needs of disabled children and challenges in predicting cognitive after-effects at the time of discharge.	No/very minor concerns Very minor concerns regarding methodological limitations. One study that contributed to the finding did not report the relationship between the researcher and participants. However, this limitation was judged as unlikely to have influenced the finding.	No/very minor concerns No concerns regarding coherence. The finding completely reflected the range of the underlying data.	Moderate concerns Moderate concerns regarding adequacy because only 1 study provided relatively thin data. Given the descriptive nature of the finding it was concluded that there were moderate concerns regarding adequacy.	Minor concerns Minor concerns regarding relevance. While the finding did not directly describe the experiences of caregivers with health-care services, it provided information about potential barriers that made it difficult to gain access to health-care services for patients with meningitis sequelae.	Moderate confidence Very minor concerns regarding methodological limitations: No reflexivity statement in 1 study. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 1 study with relatively thin data. Minor concerns regarding relevance: While the finding did not directly describe the experiences with health-care services, it provided information about potential barriers to gaining access for	Clark et al. 2013 *(10)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
						patients with meningitis sequelae.	
21	**Systemic and organizational barriers to aftercare** Parents of childhood meningitis survivors reported difficulties with accessing and navigating aftercare services, including disability living allowance and social care, and expressed a need for support. Carers cited factors such as lack of staff, lack of communication between different members of the process, restricted budget and complex bureaucratic procedures as barriers to timely, sufficient and tailored rehabilitation. Additionally, they emphasized the limited inclusion criteria, which posed significant barriers for young children and those with cognitive or psychological sequelae.	Minor concerns Minor concerns regarding methodological limitations. In 1 of the 3 studies that contributed to the finding, recall bias could have been introduced due to the time between the acute episode of meningitis and the interview. In 1 study this period was not reported. The relationship between the researcher and participants was not sufficiently reported in 1 study. These limitations were judged to have had a minimal impact on the finding, as it	No/very minor concerns No concerns regarding coherence. The finding fully reflected the underlying data.	Minor concerns Minor concerns regarding adequacy. Three studies contributed to the finding: 2 offered thin data and 1 offered rich data. Due to the descriptive and superficial nature of the finding it was concluded that the data was sufficient and there were minor concerns regarding limitations.	No/very minor concerns Direct relevance. No concerns regarding relevance. The finding answered the review question by providing insights into barriers to meningitis rehabilitation services.	High confidence Minor concerns regarding methodological limitations: Potential recall bias in 2 of the 3 studies and no reflexivity in 1. These limitations were unlikely to have influenced the finding, given its more generic scope. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study offered rich data and 2 offered thin data. The data were judged as adequate as the finding was descriptive. No/very	Clark et al. 2013 *(10)*; Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	Impairments in these children were sometimes borderline and less apparent and aftercare services failed to recognize the link between meningitis and such non-physical sequelae, further complicating access to rehabilitation.	reflected potentially more recent events during rehabilitation and not the acute episode. Additionally, the study that may have involved recall bias contributed only thin data.				minor concerns regarding relevance.	
22	**Third parties as facilitators of meningitis sequelae aftercare** Parents placed a high value on tailored care suitable for their child's needs. School was seen as having a special role to play in providing accessible, long-term and timely follow-up care. Additionally, parents reported the active involvement of a consultant and multidisciplinary team meetings including parents, school staff and health visitors as factors that helped overcome difficulties in accessing aftercare.	No/very minor concerns Very minor concerns regarding methodological limitations. One study that contributed to the finding did not report the relationship between the researcher and participants. However, this limitation was judged as unlikely to have	No/very minor concerns No concerns regarding coherence. The finding completely reflected the range of the underlying data.	Moderate concerns Moderate concerns regarding adequacy because only 1 study provided relatively thin data. Given the descriptive nature of the finding it was concluded that there were moderate concerns regarding adequacy.	Minor concerns Minor concerns regarding relevance. While the finding did not directly describe the experiences of caregivers with health-care services, it provided information about potential factors that improved access to health-care services for patients with meningitis sequelae.	Moderate confidence Very minor concerns regarding methodological limitations: No reflexivity statement in 1 study. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 1 study with relatively thin data. Minor concerns regarding relevance: While the finding did not directly describe the experiences with	Clark et al. 2013 *(10)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		influenced the finding.				health-care services, it provided information about potential facilitators to gaining access for patients with meningitis sequelae.	
Pre-hospitalization – HICs							
23	**Need for awareness and comprehensive knowledge about meningitis** Patients and caregivers had little or no prior knowledge about meningitis etiology and symptoms before the diagnosis. Once meningitis was diagnosed, people expressed a strong desire for more information about the disease, often consulting the internet or contacting associations to fill in the gaps. Parents and carers highlighted the need for better public education and awareness campaigns to	No/very minor concerns Very minor concerns regarding methodological limitations. In 3 of the 4 studies that contributed to the finding, recall bias could have been introduced due to the time between the meningitis case and participation in the study. In 1 study this period could not be identified. Additionally, there	No/very minor concerns Very minor concerns regarding coherence. While some parents were aware of several symptoms of meningitis, their overall knowledge was still considered insufficient.	No/very minor concerns No concerns about adequacy. Four studies contributed to the finding: 1 offered rich data and the others together provided rich data. Given that the finding was descriptive and that 1 study offered comprehensive data, it was concluded that there were no	Serious concerns Indirect relevance. Serious concerns regarding relevance. The finding did not reflect the experiences of end-users with health-care services but with meningitis in general.	Low confidence Very minor concerns regarding methodological limitations: Concerns about reflexivity, data analysis and recall bias. Very minor concerns regarding coherence. No concerns regarding adequacy. Serious concerns regarding relevance: Indirect relevance; does not reflect experience with health-care services	Scanferla et al. 2021 *(15)*; Sweeney et al. 2013 *(16)*; Wisemantel et al. 2018 *(18);* Scanferla et al. 2020 *(23)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	enable people to recognize the signs of meningitis.	were concerns regarding reflexivity and data analysis in 1 study, as these aspects were not sufficiently reported. However, these limitations were judged unlikely to have influenced the finding as it encompassed more general concepts around meningitis rather than individual factors.		concerns regarding adequacy.		but meningitis in general.	
24	**Parental emotional reactions during initial stages of meningitis** Prior to hospitalization, parents experienced complex emotions ranging from anger and disbelief to fear and a sense of loss of control. Parents revealed they experienced immense fear in the face of a serious disease, which sometimes	Moderate concerns Moderate concerns regarding methodological limitations. In 1 of the 3 contributing studies, recall bias could have been introduced due to the time between the acute episode of	No/very minor concerns No concerns regarding coherence. The finding fully reflected the supporting data.	Minor concerns Three studies contributed to the finding, together offering moderately rich data. Given the descriptive nature of the finding, it was concluded that there	Moderate concerns Indirect relevance. Moderate concerns regarding relevance. Overall, the finding focused on emotional experiences of caregivers before hospitalization. However, it provided	Low confidence Moderate concerns regarding methodological limitations: Potential recall bias in 1 study could have affected the finding. No/very minor concerns regarding coherence. Minor concerns	Haines 2005 *(14)*; Neill et al. 2022 *(22)*; Kupst et al. 1983 *(24)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	led to denial of the illness. The fear was exacerbated by the sense of helplessness and loss of control over their child's condition. Feelings of anger and disbelief occurred when parents failed to get the expected confirmation of their concerns and appropriate support during their first contact with health-care services. Transportation to the health-care facility was another source of emotional burden during the initial stages of the illness. Parents were stressed when they were excluded from accompanying their child, but understanding the rationale behind it and involvement of a team of health specialists helped to ease the stress.	meningitis and the interview. Considering the finding reflected caregivers' emotional experiences prior to hospitalization, the potential recall bias could have affected the finding. Additionally, 2 of the 3 studies did not provide sufficient information on the relationship between the researcher and participants. Lack of reflexivity was judged as unlikely to have influenced the finding as is did not cover direct experiences with health-care services.		were minor concerns regarding adequacy.	some data on experiences with transportation to health-care facilities and contact with health-care services, hence partially answering the review question.	regarding adequacy: 3 studies together offered moderately rich data, which was considered sufficient given that the finding was descriptive. Moderate concerns regarding relevance: The finding provided little data on experiences of caregivers with health-care services before hospitalization.	
25	**Parental intuition and recognition of illness**	Moderate concerns	No/very minor concerns	Minor concerns	Minor concerns	Moderate confidence	Brennan et al. 2003 *(8)*; Haines 2005 *(14)*;

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	Intuition motivated parents to seek medical attention even when the symptoms did not immediately suggest meningitis. They recognized the overall deterioration of their child's health based on subtle changes in behaviour or physical condition.	Moderate concerns regarding methodological limitations. In 2 of the 4 studies that contributed to the finding, recall bias could have been introduced due to the time between the meningitis case and participation in the study. Considering that the finding reflected caregivers' memories before hospitalization, the potential recall bias could have affected the finding. Additionally, there were concerns regarding reflexivity in 3 out of 4 studies, as well as about data analysis in 1 study, as these aspects were not sufficiently reported. However, these limitations	Very minor concerns about coherence because 1 study did not directly state that parental intuition stimulated help-seeking behaviour. However, this limitation was judged unlikely to have decreased confidence in the finding.	Minor concerns regarding adequacy. Four studies contributed to the finding, together offering moderately rich data. Due to the descriptive nature of the finding it was concluded that there were minor concerns about adequacy.	Indirect relevance. Even though the data did not reflect experiences with health-care services in general, the finding described the patterns of help-seeking behaviour that potentially influenced the uptake of these services, so it was concluded that there were minor concerns about relevance.	Moderate concerns regarding methodological limitations: Concerns about recall bias, reflexivity and data analysis. Very minor concerns regarding coherence: 1 study did not explicitly state that intuition stimulated help-seeking. Minor concerns regarding adequacy: Moderately rich data, however the finding was rather descriptive. Minor concerns regarding relevance: The finding was indirectly related to the uptake of health-care services.	Wisemantel et al. 2018 *(18);* Neill et al. 2022 *(22)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		were judged unlikely to have influenced the finding.					
26	**Many masks of meningitis clinical presentation** General practitioners reported having limited experience diagnosing meningitis and meningococcal disease, which can present with diverse clinical manifestations and pose diagnostic challenges. Symptoms such as a non-blanching purpuric rash, neck pain and rapid disease progression increased the certainty of a meningitis diagnosis. Conversely, non-specific symptoms were often less apparent to HCWs and could mislead the diagnostic process. Despite the uncertainty in the diagnosis of meningitis, doctors acknowledged that atypical clinical	Serious concerns Serious concerns regarding methodological limitations. In 1 of the 2 contributing studies recall bias could have been introduced due to the time between treating a meningitis case and the interview. Additionally, 1 study did not provide sufficient information on the relationship between the researcher and participants. Given that the finding reflected the experiences of HCWs with provision of	Minor concerns Minor concerns regarding coherence. While the finding was generally consistent with the underlying data, it reflected the major trends in doctors' experiences with different symptoms of meningitis. However, sometimes doctors had opposing experiences with some symptoms (e.g. purpuric rash).	No/very minor concerns No concerns regarding adequacy. Two studies contributed to the finding: 1 offered rich data and the other offered thin data. Given that the finding was descriptive and 1 study offered comprehensive data, it was concluded that there were no concerns regarding adequacy.	No/very minor concerns Direct relevance. No concerns regarding relevance. The finding directly answered the review question by providing insights into HCWs' experiences with diagnosing meningitis.	Low confidence Serious concerns regarding methodological limitations: Potential recall bias in 1 study and lack of reflexivity in the other study, which could potentially have influenced the finding. Minor concerns regarding coherence: The finding did not reflect some minor opposing data but provided data on major trends in medical practice. No/very minor concerns regarding adequacy. No/very	Brennan et al. 2003 *(8)*; Granier et al. undefined *(12)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	presentations might indicate a more serious underlying illness, prompting them to hospitalize such patients. Additional symptoms that led to the admission of these complex cases included lethargy, decreased mobility, altered consciousness and mental state, pallor, cyanosis and abnormal crying.	medical care and provided rather detailed information, these limitations were judged to have potentially influenced the finding.				minor concerns regarding relevance.	
27	**Role of context and parental input in clinical decision-making** General practitioners (GPs) noted that parental anxiety significantly influenced their clinical decision-making, particularly when they had an established relationship with the family. Some parents expressed fear of meningitis that, according to HCWs, emerged as a result of the prevalence of awareness campaigns. GPs recognized that while these fears were sometimes	Moderate concerns Moderate concerns regarding methodological limitations. One of the 2 contributing studies did not provide enough information on the relationship between the researcher and participants. Given that the finding reflected HCWs' experiences with the provision of medical	Minor concerns Minor concerns regarding coherence. While several GPs noted that parental fear of meningitis is disproportionate, only 1 stated that awareness campaigns are reasonable.	No/very minor concerns No concerns about adequacy. Both studies contributing to the finding provided very rich data.	No/very minor concerns Direct relevance. The finding described the views and experiences of HCWs with the provision of health-care services.	Moderate confidence Moderate concerns regarding methodological limitations: Concerns about reflexivity, recall bias and ethics. Minor concerns regarding coherence: Several parts of the finding were supported only by 1 citation. No concerns regarding adequacy.	Brennan et al. 2003 *(8)*; Granier et al. 1998 *(12)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	disproportionate, awareness campaigns are still needed due to the severity of meningitis. Parental concerns sometimes served as facilitators for further clinical evaluation, with some parents directly prompting GPs to reconsider their initial assessments.	care, lack of reflexivity could have significantly influenced the finding. Additionally, in 1 of the 2 contributing studies recall bias could have been introduced due to the time between the acute episode of meningitis and the interview, which limited confidence in the provided data. Furthermore, 1 study did not explicitly describe ethical issues.				No concerns regarding relevance.	
28	**Intuitive and evidence-based practice** GPs revealed that in general practice they rely much more on experience and intuition rather than evidence and logic. GPs acknowledged the utility of guidelines but expressed scepticism about	Serious concerns Serious concerns regarding methodological limitations. Two of the 3 contributing studies did not provide enough	No/very minor concerns No concerns regarding coherence. The finding fully supported the underlying data.	Minor concerns Minor concerns regarding adequacy. Three studies contributed to the finding: 1 offered rich data and 2 offered thin data.	No/very minor concerns No concerns regarding relevance. The finding directly answered the review question by providing insights	Low confidence Serious concerns regarding methodological limitations: No reflexivity in 2 studies and potential recall bias in 1, which	Brennan et al. 2003 *(8)*; Granier et al. 1998 *(12)*; Jarvinen et al. 2005 *(25)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	their application and noted challenges in keeping up with updates. They stressed that guidelines can undermine individualized and personal patient care and interfere with the more intuitive approach to diagnosis, which was deemed more helpful in cases of unusual clinical presentation. Moreover, GPs stated their priority was to identify a serious illness – where intuition was a key factor – rather than to make a definitive diagnosis. When identifying a serious illness, GPs often recognized the overall poor condition, changes in usual behaviour of patients and so-called puzzling findings, rather than specific signs and symptoms.	information on the relationship between the researcher and participants. Given that the finding reflected HCWs' experiences with provision of medical care, lack of reflexivity could significantly influence the finding. In 1 of the studies recall bias could have been introduced due to the time between treating meningitis cases and the interview, which limited confidence in the provided data. Additionally, 1 of the studies was a mixed-method study and did not provide enough information on qualitative data collection and analysis. However, this study		Due to the descriptive nature of the finding and comprehensive information from 1 study, it was concluded that there were minor concerns regarding adequacy.	into HCWs' experiences with diagnosing meningitis.	could have significantly influenced the finding. Concerns about qualitative data collection and analysis in 1 study. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study offered rich and comprehensive data, while the other 2 offered thin data. No/very minor concerns regarding relevance.	

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		contributed minimal data to the finding.					
29	**Sociocultural factors influencing help-seeking behaviour** Caregivers expressed hesitancy in seeking assistance due to concerns about the potential misuse or overuse of health-care resources, particularly when uncertain about the severity of the illness. This reluctance to overutilize the health-care system, along with other parental responsibilities, ultimately delayed their decision to seek medical attention.	Moderate concerns Moderate concerns regarding methodological limitations. In 1 study contributing to the finding, recall bias could have been introduced due to the time between treating meningitis cases and the interview, which limited confidence in the provided data. Additionally, the study did not provide enough information on the relationship between the researcher and participants.	No/very minor concerns No concerns about coherence. The finding completely reflected the range of the underlying data.	Serious concerns Serious concerns regarding adequacy because only 1 study contributed to the finding, offering thin data.	Minor concerns Indirect relevance. Even though the data was not explicitly related to the utilization of health-care services, the finding described the patterns of help-seeking behaviour that potentially influenced the uptake of these services, so it was concluded that there were minor concerns about relevance.	Low confidence Moderate concerns regarding methodological limitations: Potential recall bias and no reflexivity. No concerns regarding coherence. Serious concerns regarding adequacy: 1 study offering thin data. Minor concerns regarding relevance: The finding was indirectly related to the uptake of health-care services.	Neill et al. 2022 *(22)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
30	**Systemic and operational barriers in health-care organization** HCWs in primary care settings reported not being confident with lack of experience treating meningitis, thus they were more focused on getting the child hospitalized as early as possible rather than starting treatment on their own. The primary source of concern was lack of experience with administering parenteral antibiotics and potential difficulties with intravenous access. Additionally, GPs revealed that treatment could have been delayed due to advice or disapproval from clinical or prescription consultants and lack of immediate access to antibiotics.	Serious concerns Serious concerns regarding methodological limitations. Neither of the contributing studies provided enough information on the relationship between the researcher and participants. Given that the finding reflected HCWs' experiences with provision of medical care, lack of reflexivity could have significantly influenced the finding. Additionally, 1 of the studies was a mixed-method study and did not provide enough information on qualitative data	No/very minor concerns No concerns regarding coherence. The finding fully reflected the underlying data.	Serious concerns Serious concerns regarding adequacy. Two studies contributed to the finding, offering thin data. While 1 of the studies provided some details and primary data to support the statements, the other lacked explanation.	No/very minor concerns Direct relevance. No concerns regarding relevance. The finding reflected the experiences of GPs with providing care for patients with meningitis and barriers to provision, which answered the review question.	Very low confidence Serious concerns regarding methodological limitations: No reflexivity in 2 studies, which could have significantly influenced the finding. Concerns about qualitative data collection and analysis in 1 study. No/very minor concerns regarding coherence. Serious concerns regarding adequacy: 2 studies offered thin data, 1 of which did not provide any details behind the data. No/very minor concerns regarding relevance.	Brennan et al. 2003 *(8)*; Jarvinen et al. 2005 *(25)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		collection and analysis. However, this study contributed minimal data to the finding.					
31	**Factors influencing pre-hospital antibiotic treatment initiation** GPs were more likely to administer antibiotics pre-hospital when they were confident in their diagnosis. In cases with less certainty, the presence of severe symptoms sometimes motivated GPs to take action. However, some GPs were hesitant to initiate treatment without definitive signs, preferring to wait until the diagnosis was clear. The presence of a non-blanching rash was identified as one of the most reliable indicators that led to the initiation of antibiotic treatment.	Moderate concerns Moderate concerns regarding methodological limitations. In 1 of the 2 contributing studies, recall bias could have been introduced due to the time between treating a meningitis case and the interview, which could impact the responses of HCWs. Additionally, 1 study did not provide sufficient information on the relationship between the researcher and participants, but this	No/very minor concerns No concerns about coherence. The finding completely reflected the range of the underlying data.	Moderate concerns Moderate concerns regarding adequacy because only 2 studies contributed to the finding, offering relatively thin data. Given the finding is rather descriptive, it was concluded that there were no concerns regarding adequacy.	No/very minor concerns Direct relevance. The finding provided information directly related to the provision of health-care services.	Low confidence Moderate concerns regarding methodological limitations: In 1 study, potential recall bias could have been introduced. No concerns regarding coherence. Moderate concerns regarding adequacy: Only 2 studies contributed to the finding, offering relatively thin data. No concerns regarding relevance.	Brennan et al. 2003 *(8)*; Granier et al. 1998 *(12)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		limitation was judged unlikely to have influenced the finding.					
Pre-hospitalization – LMICs							
32	**Knowledge and perceptions of meningitis** Community members perceived meningitis as a dangerous disease typically presenting with stiff neck and seizures. Participants acknowledged that meningitis can result in death and disability, which was particularly frightening in relation to children due to the potential loss of productivity and income in the future. Despite previous educational efforts, communities' knowledge about the causes of meningitis was limited and centred around spiritual or supernatural influence rather than modern medical	No/very minor concerns Very minor concerns regarding methodological limitations. A reflexivity statement was not provided in any of the 4 studies that contributed to the finding. Additionally, 1 study did not provide sufficient details on data analysis and 1 study did not report the time between the acute episode and the interview. However, these limitations were	Moderate concerns Moderate concerns regarding coherence. Overall, the included studies were consistent with the finding. However, the finding captured only the most dominant patterns, while the data, especially on the known symptoms and sequelae of meningitis, were more varied.	No/very minor concerns Very minor concerns regarding adequacy. Four studies contributed to the finding: 2 offered rich data and 2 offered moderately rich data. Additionally, there were sufficiently large quantities of data in all of the studies.	Serious concerns Serious concerns regarding relevance. Despite providing data on meningitis in general, the finding did not address experiences with health-care services.	Low confidence Very minor concerns regarding methodological limitations. Moderate concerns regarding coherence: The finding captured only the most dominant patterns, while the data were more varied. Very minor concerns regarding adequacy. Serious concerns regarding relevance: The finding reflected experiences with meningitis in general,	Adedini et al. 2021 *(9)*; Desmond et al. 2013 *(11)*; Mahmoud et al. 2022 *(17);* Colombini et al. 2009 *(20)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	information. Some participants additionally referred to direct contact with an ill person, specific weather conditions and foods that were associated with meningitis.	judged to have had minimal effects on the finding.				not with health-care services.	
33	**Conflict and convergence between biomedical and traditional treatment** Many caregivers and patients showed a preference for biomedical treatment in managing meningitis, particularly after realizing the limitations of traditional healing methods. Caregivers and patients emphasized that the hospital was the preferred option for treatment due to doctors' expertise, despite maintaining spiritual beliefs about the disease's origins. However, other end-users favoured traditional medicine. Some of them expressed doubt about the	Moderate concerns Moderate concerns regarding methodological limitations. Two of the supporting studies did not clearly state the relationship between the researchers and participants. This limitation was judged to have potentially influenced the finding since it was related to preferences for treatment type.	Minor concerns The finding reflected the complexity and variation of the data regarding the preferred treatment of meningitis. However, there were minor concerns regarding coherence because 1 of the studies demonstrated the experience of caregivers and the community only, not the patients.	Moderate concerns Moderate concerns regarding adequacy because 1 of the 2 studies offered rich data, while the other provided only thin data.	No/very minor concerns Minor concerns about relevance because although both studies provided information about end-users' values regarding meningitis treatment, 1 of the 2 studies provided thin data.	Low confidence Moderate concerns regarding methodological limitations: No reflexivity statement in 2 studies. Minor concerns regarding coherence: 1 of 2 studies did not provide information about the values of patients, while the other offered data from both patients and caregivers. Moderate concerns regarding adequacy: 1 study offered rich data, while the other	Adedini et al. 2021 *(9)*; Mahmoud et al. 2022 *(17)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	medical diagnosis of meningitis, attributing their illness to curses, dreams or old age.					provided only thin data. No/very minor concerns regarding relevance: 1 study provided only thin data about end-users' values on meningitis treatment.	
34	**Sociocultural factors influencing health-seeking behaviour** Health-seeking behaviour was largely influenced by sociocultural norms established in communities. In a hierarchical society, patients and caregivers, especially women, usually sought validation of disease severity from senior and often male family or community members. In contrast to men, many women had limited or no formal education and were unemployed, which constrained their capacity to	Minor concerns Minor concerns regarding methodological limitations. A reflexivity statement was not provided in 4 of the 5 studies that contributed to the finding. Lack of reflexivity was judged to have had a potential influence on the finding, as it encompassed views on preferred treatment. However, the main focus of the	Moderate concerns Moderate concerns regarding coherence. All studies generally supported at least 1 of the aspects of the finding. However, the finding captured only the most dominant patterns, leaving out contrasting patterns related to gender inequalities.	No/very minor concerns Very minor concerns regarding adequacy. Five studies contributed to the finding: 2 studies provided rich data, 2 provided moderately rich data and 1 study provided thin data. The quantity of data was sufficiently large.	No/very minor concerns No concerns regarding relevance. The finding did not specifically address experiences with health-care services; however it described values and underlying causes of behaviour that may be considered a barrier to the uptake of these services.	Moderate confidence Minor concerns regarding methodological limitations: Lack of reflexivity in 4 studies, which could have influenced the finding. Moderate concerns regarding coherence: The finding captured only the most dominant patterns, leaving out contrasting patterns related to gender inequalities. No/very minor concerns	Adedini et al. 2021 *(9)*; Desmond et al. 2013 *(11)*; Omoleke et al. 2018 *(13);* Mahmoud et al. 2022 *(17)*; Colombini et al. 2009 *(20)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	make independent decisions. Confirmation of disease severity was essential to warrant funding. However, it was commonly recognized only when the disease interfered with a patient's social activity, delaying timely care. Treatment preferences were also driven by the widespread perception among patients, carers of adult and paediatric patients, and community members that meningitis, when it was believed to be due to supernatural causes, should be treated with Islamic or traditional methods. Families consulted traditional healers despite acknowledging the effectiveness of conventional medicine and its availability, particularly to discern if the disease had supernatural origins.	finding was the underlying reason for the preferred treatment, hence it was concluded that the influence would have been minimal. Additionally, 1 study did not provide sufficient details on data analysis and 1 study did not report the time between the acute episode and the interview. However, this limitation was judged to have had minimal effects on the finding.				regarding adequacy. No concerns regarding relevance.	

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
35	**Initial response regarding preferred treatment** The initial response to disease signs in caregivers and patients involved self-medication and alternative treatment. Several families reported administering medications such as paracetamol to alleviate fever or headaches during the early stages of the illness. Caregivers also frequently mentioned favouring alternative medicine, including the help of prayers, traditional healers and soothsayers, rather than orthodox care. This preference was associated with the prevailing reliance on supernatural explanations for the illness and was particularly evident among older patients and caregiver groups that belonged to rural communities. Some caregivers also clarified that	Moderate concerns Moderate concerns regarding methodological limitations. In 3 out of 4 studies, the relationship between the researchers and participants was not specified. Since the data described attitudes towards preferred treatment, this limitation could have potentially influenced the finding. Additionally, in 1 study it was unclear whether the research design was appropriate to address the aims. Another study did not contain rich information about data analysis.	Minor concerns Minor concerns regarding coherence because the finding was more focused on alternative medicine than on self-medication. However, even though the finding missed some details from studies, overall data from the studies about self-medication was relatively superficial, so it was concluded that there were only minor concerns about coherence.	No/very minor concerns Very minor concerns regarding adequacy as 3 out of 4 studies offered rich data, while 1 study provided information only about self-medication as an initial response (thin data).	No/very minor concerns No concerns about relevance; all studies provided information about the end-users' values and experiences with meningitis treatment.	Moderate confidence Moderate concerns regarding methodological limitations: No reflexivity in 3 out of 4 studies, 1 study lacked information about data analysis and in 1 study it was unclear whether the research design was appropriate to address the aims. Minor concerns regarding coherence: 3 studies reported both alternative medicine and self-medication as an initial response, while the other only reported self-medication. Very minor concerns regarding adequacy.	Adedini et al. 2021 *(9)*; Desmond et al. 2013 *(11)*; Omoleke et al. 2018 *(13);* Colombini et al. 2009 *(20)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	the reasons for favouring alternative medicine were the shorter waiting period, lower cost and less severe illness. Patronage of government hospitals was considered the last resort when the illness became severe and not amenable to alternative care.					No concerns regarding relevance.	
36	**Lack of awareness and alertness to meningitis symptoms delays timely care** Community members, patients and caregivers often underestimated meningitis symptoms, attributing them to more familiar causes such as malaria or traditional illnesses which were usually treated at home. Some non-specific symptoms, including severe headache, body weakness and loss of appetite, were not considered a real illness, which was associated with	No/very minor concerns Very minor concerns regarding methodological limitations. None of the 3 contributing studies provided data on the relationship between the researcher and participants. Additionally, 1 study did not report the time between the interview and the acute episode of	No/very minor concerns No concerns regarding coherence. The finding completely reflected the range of the underlying data.	Minor concerns Minor concerns regarding adequacy. Three studies contributed to the finding: 1 offered moderately rich data and 2 offered thin data. However, due to the descriptive nature of the finding, the underlying data were considered adequate and raised minor concerns.	No/very minor concerns No concerns regarding relevance. The finding did not specifically address experiences with health-care services; however they described an underlying cause of behaviour that may have been a barrier to the uptake of these services.	High confidence No/very minor concerns regarding methodological limitations. No/very minor concerns regarding coherence. Minor concerns regarding adequacy: 1 study offered moderately rich data and 2 offered thin data. Data were considered adequate (minor concerns) for a descriptive finding. No/very minor	Desmond et al. 2013 *(11)*; Mahmoud et al. 2022 *(17);* Griffiths et al. 2012 *(19)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	the delay in timely help-seeking.	meningitis. However, these limitations were judged to have had a minimal influence on the finding.				concerns regarding relevance.	
37	**Financial barriers to health care** Patients and caregivers delayed seeking treatment due to the financial burden associated with health care. These financial constraints included not only direct costs of medical services but also transportation to health facilities. Some families reported having to borrow money to cover health-care expenses. In some cases, these financial limitations motivated them to seek alternative medicine before pursuing hospital care.	No/very minor concerns Very minor concerns regarding methodology because 2 of the 3 studies did not explicitly state the relationship between the researchers and participants (no reflexivity statement), and 1 study did not clearly justify the research design. These limitations, however, were assessed as not having influenced the finding.	No/very minor concerns No concerns regarding coherence.	Minor concerns Minor concerns regarding adequacy because, of 3 studies, 1 offered rich data while the other 2 together offered thin data.	Minor concerns Minor concerns regarding relevance. While all 3 studies provided data relevant to the research question, 1 of the studies only focused on caregivers, while the other 2 offered information about both patients and caregivers.	Moderate confidence Very minor concerns regarding methodological limitations: No reflexivity statement in 2 studies. No concerns regarding coherence. Minor concerns regarding adequacy: 1 study with rich data and 2 studies with thin data. Minor concerns regarding relevance: 1 study only focused on the experiences of caregivers.	Desmond et al. 2013 *(11)*; Omoleke et al. 2018 *(13);* Griffiths et al. 2012 *(19)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
38	**Impact of perceived health service quality on health-seeking behaviour** Both patients and HCWs reported poor organization of health-care services with long waiting times, presumptive diagnosis without examination, verbal mistreatment and lack of follow-up guidance. The perceived suboptimal quality of care prompted patients to avoid hospitals and seek medical advice from alternative service providers.	Moderate concerns Moderate concerns regarding methodological limitations. One of the 2 contributing studies did not provide sufficient data on the relationship between the researcher and participants. Considering that the finding reflected participant experiences with and attitudes towards health-care services, this limitation was judged to have potentially influenced the finding. Additionally, recall bias could have been introduced, which was not	No/very minor concerns The finding fully reflected data from 1 of the 2 contributing studies. Besides long waiting times, another study also reported higher costs of care in governmental hospitals. However, this aspect was not considered to have reflected the quality of health services, hence it was judged not to have impacted coherence.	Moderate concerns Moderate concerns regarding adequacy. Two studies contributed to the finding and both offered relatively thin data. Considering the finding was rather descriptive, it was concluded that there were moderate concerns about data adequacy.	No/very minor concerns No concerns regarding relevance. The finding reflected end-users' experiences with health-care services.	Low confidence Moderate concerns regarding methodological limitations: No reflexivity statement in 1 contributing study, which could have potentially influenced the finding. No/very minor concerns regarding coherence. Moderate concerns regarding adequacy: 2 studies offered thin data. No/very minor concerns regarding relevance.	Desmond et al. 2013 *(11)*; Omoleke et al. 2018 *(13)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
		expected to influence the finding.					
39	**Lack of early recognition** Caregivers reported not recognizing the early symptoms of meningitis and only seeking help in health-care facilities when the disease had progressed. Prior experience with meningitis helped raise suspicion earlier.	No/very minor concerns Very minor concerns regarding methodological limitations. A reflexivity statement was not provided in either of the studies that contributed to the finding. Additionally, in 1 study it was unclear whether the research design was appropriate to address the aims. However, these limitations were judged to have had a minimal effect on the finding.	Minor concerns Minor concerns regarding coherence because 1 of the 2 studies contributed fully to the finding, while the other study only offered data regarding delayed help-seeking behaviour.	Serious concerns Serious concerns regarding adequacy because the overall richness and quantity of the data were low. Both studies provided thin data.	Minor concerns Minor concerns regarding relevance. Even though the finding did not specifically address experiences with health-care services, it described a reason that the uptake of these services might have been delayed.	Very low confidence No/very minor concerns regarding methodological limitations. Minor concerns regarding coherence: 1 study supported all aspects of the finding while the other only a single aspect of the finding. Serious concerns regarding adequacy: Overall richness and quantity of data were relatively low. Minor concerns regarding relevance: The finding provided information about one barrier to the uptake of health-care services.	Adedini et al. 2021 *(9)*; Desmond et al. 2013 *(11)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
40	**Disease severity initiates help-seeking behaviour** The key factor that encouraged caregivers to seek help at conventional health-care facilities was recognition of disease severity rather than recognition of specific signs and symptoms of meningitis. Indicators of severity, such as social life disruption, severe weakness, loss of appetite and the inability to work, were among the cited reasons driving individuals to seek help.	No/very minor concerns Very minor concerns regarding methodological limitations. One study did not clarify the time between meningitis onset and the interview, raising concerns regarding potential recall bias. Additionally, the relationship between the researcher and participants was unclear in this study. However, it was unlikely that these limitations affected participants' responses.	Moderate concerns Moderate concerns regarding coherence. The finding generally supported the underlying data from 2 studies, reflecting initiation of help-seeking in conventional health-care facilities following recognition of disease severity. However, 1 study did not specifically state that disease severity was judged by any specific factor. Additionally, the finding did not cover cases when help-seeking at conventional health-care facilities was initiated following failed attempts to control the disease	Moderate concerns Moderate concerns regarding adequacy. Two studies contributed to the finding: 1 offered moderately rich data and the other offered thin data. However, the descriptive finding relied mostly on the moderately rich data provided in 1 study, so it was concluded that there were moderate concerns regarding adequacy.	No/very minor concerns No concerns regarding relevance. The finding reflected acceptability of conventional health-care services among end-users and factors influencing the uptake of these services, therefore there were no concerns regarding relevance.	Moderate confidence No/very minor concerns regarding methodological limitations. Moderate concerns regarding coherence: 1 study reported cases when help-seeking at conventional health-care facilities was initiated following failed attempts to control the disease with alternative medicine. However, the finding did not cover such cases. Moderate concerns regarding adequacy: 1 study on which this finding mostly relied offered moderately rich data. One of the contributing studies offered thin data. No/very minor	Desmond et al. 2013 *(11)*; Omoleke et al. 2018 *(13)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
			with alternative medicine.			concerns regarding relevance.	
Sequelae – LMICs							
41	**Multifaceted impact of meningitis on physical, mental and social well-being** Patients emphasized the long-term effects of meningitis on their physical, mental and social well-being. Older patients and caregivers of children reported a range of complications, including cardiovascular problems, paralysis, hearing and vision impairments, cognitive decline and psychological changes. Meningitis sequelae significantly disrupted social activities and reduced the level of independence.	No/very minor concerns No concerns regarding methodology. Neither study explicitly stated the relationship between the researchers and participants. These limitations, however, were assessed as not having had an influence on the finding.	Moderate concerns Moderate concerns regarding coherence because the finding lacked several of the conditions reported by end-users after acute meningitis.	Minor concerns Minor concerns regarding adequacy. Two studies contributed to the finding: 1 offered relatively thin data and 1 offered moderately rich data. Considering the finding was rather descriptive, it was concluded that there were moderate concerns about data adequacy.	Serious concerns Serious concerns regarding relevance. Despite providing data on meningitis sequelae in general, the finding did not address experiences with health-care services.	Very low confidence No/very minor concerns regarding methodological limitations: No reflexivity in 2 studies. Moderate concerns regarding coherence: The finding left out several reported aspects. Minor concerns regarding adequacy: 1 study offered relatively thin data and the other moderately rich data. Serious concerns regarding relevance: The finding reflected experiences with meningitis sequelae	Griffiths et al. 2012 *(19)*; Mahmoud et al. 2022 *(17)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
						in general, not with health-care services.	
42	**Experiences with providing care for meningitis sequelae** Aftercare for family members with meningitis sequelae was associated with some practical and psychological challenges. Carers reported the necessity to balance work commitments and caregiving responsibilities. Those caregivers who continued to work struggled to provide consistent and sufficient care, while others had to abandon their jobs to commit to care for their loved ones. Additionally, a single caregiver reported hiring specialized personnel to look after a child with sequelae, which put a financial strain on the family. Psychologically, caring for older parents was perceived	No/very minor concerns Very minor concerns regarding methodological limitations. Two contributing studies did not provide enough information on the relationship between the researcher and participants. However, this limitation was judged to have had a minimal effect on the finding.	No/very minor concerns No concerns regarding coherence. The finding fully reflected the data from the 2 contributing studies.	Moderate concerns Moderate concerns regarding adequacy. Two studies contributed to the finding: 1 offered moderately rich data and the other offered thin data. Moreover, psychological burden of caregiving was reflected only in 1 study and supported by relatively thin data. Considering the finding was rather descriptive, it was concluded that there were moderate concerns about data adequacy.	Serious concerns Serious concerns regarding relevance because the finding reflected the general experiences with caregiving for people with meningitis sequelae and not experiences with rehabilitation services.	Low confidence No/very minor concerns regarding methodological limitations. No/very minor concerns regarding coherence. Moderate concerns regarding adequacy: Of the 2 contributing studies, 1 offered moderately rich data and 1 offered thin data; also, the psychological burden of caregiving was only reflected in 1 study and supported by relatively thin data. Serious concerns regarding relevance: The finding reflected general experiences with caregiving and	Mahmoud et al. 2022 *(17);* Griffiths et al. 2012 *(19)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	as a rewarding experience by some participants, but as a stressful experience by others. Psychological stress was induced by the feelings of isolation, frustration with taking care of older family members and fear of economic instability.					not experiences with rehabilitation services.	
43	**Balancing marital and domestic responsibilities and caregiving** Female caregivers faced challenges with balancing marital and domestic responsibilities while caring for ailing parents. Some women noted that marriage distanced them from their parental homes, complicating their ability for caregiving. In contrast, men were reported to have greater availability to provide care for relatives with meningitis sequelae.	No/very minor concerns Very minor concerns regarding methodological limitations. One study that contributed to the finding did not provide a reflexivity statement. However, this limitation was judged to have had a minimal effect on the finding.	No/very minor concerns The finding fully reflected data from the single contributing study, hence there were no concerns regarding coherence.	Serious concerns Serious concerns regarding adequacy. Only 1 study contributed to the finding, offering relatively thin data.	Serious concerns Serious concerns regarding relevance. Despite providing data on meningitis sequelae in general, the finding did not address experiences with health-care services.	Very low confidence Very minor concerns regarding methodological limitations: No reflexivity, No concerns regarding coherence. Serious concerns regarding adequacy: 1 study with thin data. Serious concerns regarding relevance: The finding reflected experiences with meningitis sequelae	Mahmoud et al. 2022 *(17)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
						in general, not with health-care services.	
44	**Preference for home care over institutionalization** Most caregivers were sceptical about the benefits of professional aftercare services and feared that institutional care could further weaken the health of their loved one. This led to a belief that care should ideally be managed at home within the family.	Moderate concerns Moderate concerns regarding methodological limitations. The study that contributed to the finding did not explicitly report the relationship between the researcher and participants. Considering the finding addressed views on health-care services, it was concluded that this limitation could have influenced the finding.	No/very minor concerns As the finding was based on 1 study and reflected all of the relevant data, there were no concerns regarding coherence.	Moderate concerns Moderate concerns regarding adequacy. One study contributed to the finding, offering relatively thin data. Considering the finding was rather descriptive, it was concluded that there were moderate concerns about data adequacy.	No/very minor concerns The finding reflected a barrier to rehabilitation services, therefore there were no concerns regarding relevance.	Moderate confidence Moderate concerns regarding methodological limitations: Concerns regarding reflexivity and potential recall bias, which could have affected the finding. No/very minor concerns regarding coherence. Moderate concerns regarding adequacy: 1 study contributed to the finding, offering relatively thin data. No/very minor concerns regarding relevance.	Mahmoud et al. 2022 *(17)*
45	**Financial burden as a barrier to aftercare services uptake**	No/very minor concerns	No/very minor concerns	Moderate concerns	No/very minor concerns	Moderate confidence	Griffiths et al. 2012 *(19)*

No.	Theme Summary of findings	Methodological limitations	Coherence	Adequacy	Relevance	GRADE-CERQual assessment of confidence	References
	Financial factors were a barrier to accessing aftercare services for children and adults who had experienced meningitis. Caregivers reported that the high costs associated with transportation, hospital consultations and medical devices, such as hearing aids, contributed to the discontinuation of aftercare.	Very minor concerns regarding methodology because the study did not explicitly state the relationship between the researchers and participants. This limitation, however, was assessed as not having had an influence on the finding.	The finding fully reflected data from the single contributing study, hence there were no concerns regarding coherence.	Moderate concerns regarding adequacy. Only 1 study contributed to the finding, offering relatively thin data. Considering the finding was rather descriptive, it was concluded that there were moderate concerns about data adequacy, even though only 1 study contributed to the finding.	No concerns regarding relevance because the finding reflected factors influencing the uptake of health-care services.	Very minor concerns regarding methodological limitations: No reflexivity, No concerns regarding coherence. Moderate concerns regarding adequacy: 1 study with relatively thin data. No concerns regarding relevance.	

GP: general practitioner; HCW: health-care worker; ICU: intensive care unit; LP: lumbar puncture.

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Appendix WB.I.A1

Search strategy used to identify primary studies

Table WB.I.A1.1 Database: Embase (Elsevier) (https://www.embase.com/#advancedSearch/), searched on 13 February 2024

No.	Searches	Results
1	('meningitis'/exp OR (meningiti* OR (Meningococc* NEAR/3 (infection* OR disease*))):ti,ab)	152 502
2	bacterial meningitis'/de OR 'epidemic meningitis'/exp OR 'Escherichia coli meningitis'/exp OR 'group B streptococcal meningitis'/exp OR 'Haemophilus meningitis'/exp OR 'leptospiral meningitis'/exp OR 'Listeria meningitis'/exp OR 'Lyme meningitis'/exp OR 'pneumococcal meningitis'/exp OR 'fungal meningitis'/exp OR 'HIV-associated meningitis'/exp OR 'parasitic meningitis'/exp OR 'virus meningitis'/exp OR 'aseptic meningitis'/exp OR 'Staphylococcus aureus'/exp OR 'Staphylococcus'/exp OR 'Enterobacteriaceae'/exp OR 'Streptococcus agalactiae'/exp OR 'Streptococcus pyogenes'/exp OR 'Enterovirus'/exp OR 'Herpesviridae'/exp OR 'herpes virus infection'/exp OR 'Simplexvirus'/exp OR 'Flavivirus'/exp OR 'West Nile virus'/exp OR 'Togaviridae'/exp OR 'Mumps'/exp OR 'Mumps virus'/exp OR 'Orthomyxoviridae'/exp OR 'HIV'/exp OR 'Adenoviridae'/exp OR 'Rubella'/exp OR 'Lymphocytic Choriomeningitis'/exp OR 'Rickettsiales'/exp OR 'Spirochaetales'/exp OR 'Leptospira'/exp OR 'Brucella'/exp OR 'Treponema pallidum'/exp OR 'Coxiella'/exp OR 'Mycoplasma'/exp OR 'Naegleria'/exp OR 'Angiostrongylus'/exp OR 'Coccidioides'/exp OR 'Candida'/exp OR 'Histoplasma'/exp OR 'Blastomyces'/exp OR 'Aspergillus'/exp OR 'Syphilis'/exp OR 'Lyme Disease'/exp OR 'Scrub Typhus'/exp OR ((Bacterial OR bacteraemia OR Viral OR Fungal OR Aseptic OR Parasitic OR community-acquired OR Acute OR fulminat* OR Fulminant OR Sudden-onset) NEAR/5 (meningiti*)):ti,ab,kw,de OR (infectious-meningiti* OR Meningococc* OR Neisseria-meningit* OR N-Meningitidis OR Pneumococc* OR S-pneumoniae* OR Haemophilus-influenzae OR Listeri* OR L-monocytogenes OR Staphylococc* OR Staph-aureus OR Enterobacter* OR Enterococc* OR Escherichia-coli OR E-coli OR Streptococc* OR S-agalactiae* OR S-pyogenes OR Enterovir* OR Coxsackieviruses OR Herpesviridae OR Herpesvirus* OR herpes-virus* OR Varicella-zoster OR flavi-virus* OR Japanese-encephal* OR Tick-borne-encephal* OR Powassan-virus* OR West-Nile-virus OR Togaviridae OR Toga-virus* OR Togavir* OR equine-encephal* OR Bunyavirus* OR crosse-encephal* OR Toscana-virus* OR Reovirus* OR tick-fever* OR paramyxovir* OR Mumps OR morbillivirus* OR parainfluenza* OR Orthomyxovir* OR Influenza OR HIV OR human-immuno-deficienc* OR Adenoviridae OR adenovirus* OR Arenavir* OR Choriomeningit* OR LCMV OR Rickettsi* OR Orientia-spp OR Ehrlichia-spp OR spirochet* OR Borrelia-spp OR B-burgdorferi OR leptospir* OR Treponema-pallidum OR Brucell* OR Coxiella OR Mycoplasma OR spirillum* OR Naegleria OR angiostrongyl* OR Trichinella-spiralis* OR Candida OR Coccidioid* OR	2 793 298

	Histoplasm* OR Blastomyc* OR Sporothrix* OR Aspergill* OR Lyme OR Syphili* OR Scrub-Typhus OR tsutsugamushi):ti,ab,kw,de	
3	#1 AND #2	101 270
4	qualitative research'/exp OR 'qualitative analysis'/exp OR 'semi structured interview'/exp OR 'grounded theory'/exp OR 'thematic analysis'/exp OR 'observational method'/exp OR 'constant comparative method'/exp OR 'participant observation'/exp OR 'narrative'/exp OR 'field study'/exp OR 'audiovisual recording'/exp OR 'focus group'/exp OR 'interview'/exp OR 'attitude'/exp OR ((experiences OR qualitative OR interview* OR focus-group* OR semi-structured OR semistructured OR phenomenol* OR ethnograph* OR grounded-theory OR grounded-study OR grounded-analysis OR grounded-analyses OR life-story OR life-stories OR content-analysis OR thematic-analysis OR thematic-analyses OR content-analys* OR narrative-analysis OR fieldwork OR field-work OR ((decriptive OR field) NEAR/3 (study)) OR key-informant* OR investigative OR theme* OR Thematic OR participant-observation* OR group-discussion*) OR (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide*) NEAR/5 (discussion* or questionnaire* OR survey*))):ti,ab	2 264 113
5	#3 AND #4	2 307

Table WB.I.A1.2 Database: MEDLINE (OVID), 1946 to January Week 5 2024, searched on 14 February 2024

No.	Searches	Results
1	Meningitis/ OR meningit*.mp. OR ((meningococc*) ADJ3 (infection* OR disease*))	77 047
2	Meningitis, Bacterial/ OR Meningitis, Escherichia coli/ OR Meningitis, Haemophilus/ OR Meningitis, Listeria/ OR Meningitis, Meningococcal/ OR Meningococcal Infections/ OR Meningitis, Pneumococcal/ OR Meningitis, Fungal/ OR Meningitis, Aseptic/ OR Meningitis, Viral/ OR ((Bacterial OR Viral OR Fungal OR Aseptic OR Parasitic OR community-acquired OR Acute OR fulminat* OR Fulminant OR Sudden-onset) ADJ5 (meningiti*)).ti,ab,kw,kf OR (infectious-meningiti* OR Meningococc* OR Neisseria-meningit* OR N-Meningitidis OR Pneumococc* OR S-pneumoniae* OR Haemophilus-influenzae OR Listeri* OR L-monocytogenes OR Staphylococc* OR Staph-aureus OR Enterobacter* OR Enterococc* OR Escherichia-coli OR E-coli OR Streptococc* OR S-agalactiae* OR S-pyogenes OR Enterovir* OR Coxsackieviruses OR Herpesviridae OR Herpesvirus* OR herpes-virus* OR Varicella-zoster OR flavi-virus* OR Japanese-encephal* OR Tick-borne-encephal* OR Powassan-virus* OR West-Nile-virus OR Togaviridae OR Toga-virus* OR Togavir* OR equine-encephal* OR Bunyavirus* OR crosse-encephal* OR Toscana-virus* OR Reovirus* OR tick-fever* OR paramyxovir* OR Mumps OR morbillivirus* OR parainfluenza* OR Orthomyxovir* OR Influenza OR HIV OR human-immuno-deficienc* OR Adenoviridae OR adenovirus* OR Arenavir* OR Choriomeningit* OR LCMV OR Rickettsi* OR Orientia-spp OR Ehrlichia-spp OR spirochet* OR Borrelia-spp OR B-burgdorferi OR leptospir* OR Treponema-pallidum OR Brucell* OR Coxiella OR Mycoplasma OR spirillum* OR Naegleria OR angiostrongyl* OR Trichinella-spiralis* OR Candida OR Coccidioid* OR Histoplasm* OR Blastomyc* OR Sporothrix* OR Aspergill* OR Lyme OR Syphili* OR Scrub-Typhus OR tsutsugamushi).ti,ab,kw,kf	1 411 308
3	Qualitative Research/ OR Grounded Theory/ OR Observational Study/ OR Anthropology, Medical/ OR Narrative Medicine/ OR Narration/ OR Sound Recordings/ OR Focus Groups/ OR "Interviews as Topic"/ OR Interview/ OR Personal Narrative/ OR Attitude/ OR "Anecdotes as Topic"/ OR ((experiences OR qualitative OR interview* OR focus-group* OR semi-structured OR semistructured OR phenomenol* OR ethnograph* OR grounded-theory OR grounded-study OR grounded-analysis OR grounded-analyses OR story OR stories OR content-analysis OR thematic-analysis OR thematic-analyses OR content-analys* OR narrative-analysis OR fieldwork OR field-work OR ((decriptive OR field) ADJ3 (study)) OR key-informant* OR investigative OR theme* OR Thematic OR participant-observation* OR group-discussion*) OR (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide*) ADJ5 (discussion* or questionnaire* OR survey*))).ti,ab	1 229 724
4	1 and 2 and 3	889

Table WB.I.A1.3 Database: APA PsycInfo (EBSCOhost) (ebscohost.com), searched on 15 February 2024

No.	Searches	Results	Column1
1	(DE "Meningitis") OR (TX meningiti*) OR TX ((meningococc*) N3 (infection* OR disease*))	1 990	
3	(DE "Qualitative Measures" OR DE "Qualitative Methods" OR DE "Qualitative Methods" OR DE "Focus Group" OR DE "Grounded Theory" OR DE "Interpretative Phenomenological Analysis" OR DE "Narrative Analysis" OR DE "Semi-Structured Interview" OR DE "Thematic Analysis" OR DE "Storytelling" OR DE "Anthropology" OR DE "Ethnography" OR DE "Ethnology" OR DE "Narratives" OR DE "Attitudes" OR DE "Interviews" OR DE "Cognitive Interview" OR DE "Focus Group Interview" OR DE "Psychodiagnostic Interview" OR DE "Semi-Structured Interview") OR (TX (experiences OR qualitative OR interview* OR focus-group* OR semi-structured OR semistructured OR phenomenol* OR ethnograph* OR grounded-theory OR grounded-study OR groundeattituded-analysis OR grounded-analyses OR story OR stories OR content-analysis OR thematic-analysis OR thematic-analyses OR content-analys* OR narrative-analysis OR fieldwork OR field-work OR ((decriptive OR field) N3 (study)) OR key-informant* OR investigative OR theme* OR Thematic OR participant-observation* OR group-discussion*) OR (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide*) N5 (discussion* or questionnaire* OR survey*)))	1 522 896	
4	1 and 2	145	

2	(MH "Meningitis, Bacterial") OR (MM "Anthrax Meningitis") OR (MM "Meningitis, Listeria") OR (MM "Meningitis, Meningococcal") OR (MM "Meningitis, Pneumococcal") OR (MH "Meningitis, Viral") OR (MH "Meningitis, Fungal") OR TX ((Bacterial OR Viral OR Fungal OR Aseptic OR Parasitic OR community-acquired OR Acute OR fulminat* OR Fulminant OR Sudden-onset) N5 (meningiti*)) OR TX (infectious-meningiti* OR Meningococc* OR Neisseria-meningit* OR N-Meningitidis OR Pneumococc* OR S-pneumoniae* OR Haemophilus-influenzae OR Listeri* OR L-monocytogenes OR Staphylococc* OR Staph-aureus OR Enterobacter* OR Enterococc* OR Escherichia-coli OR E-coli OR Streptococc* OR S-agalactiae* OR S-pyogenes OR Enterovir* OR Coxsackieviruses OR Herpesviridae OR Herpesvirus* OR herpes-virus* OR Varicella-zoster OR flavi-virus* OR Japanese-encephal* OR Tick-borne-encephal* OR Powassan-virus* OR West-Nile-virus OR Togaviridae OR Toga-virus* OR Togavir* OR equine-encephal* OR Bunyavirus* OR crosse-encephal* OR Toscana-virus* OR Reovirus* OR tick-fever* OR paramyxovir* OR Mumps OR morbillivirus* OR parainfluenza* OR Orthomyxovir* OR Influenza OR HIV OR human-immuno-deficienc* OR Adenoviridae OR adenovirus* OR Arenavir* OR Choriomeningit* OR LCMV OR Rickettsi* OR Orientia-spp OR Ehrlichia-spp OR spirochet* OR Borrelia-spp OR B-burgdorferi OR leptospir* OR Treponema-pallidum OR Brucell* OR Coxiella OR Mycoplasma OR spirillum* OR Naegleria OR angiostrongyl* OR Trichinella-spiralis* OR Candida OR Coccidioid* OR Histoplasm* OR Blastomyc* OR Sporothrix* OR Aspergill* OR Lyme OR Syphili* OR Scrub-Typhus OR tsutsugamushi)	278 500	NOT USED

Table WB.I.A1.4 Database: CINAHL (EBSCOhost) (ebscohost.com), searched on 14 February 2024

No.	Searches	Results
1	(MH "Meningitis+") OR (TX meningiti*) OR TX ((meningococc*) N3 (infection* OR disease*))	14 720
3	((DE "Qualitative Measures" OR DE "Qualitative Methods" OR DE "Focus Group" OR DE "Grounded Theory" OR DE "Interpretative Phenomenological Analysis" OR DE "Narrative Analysis" OR DE "Semi-Structured Interview" OR DE "Thematic Analysis")) OR (TX (experiences OR qualitative OR interview* OR focus-group* OR semi-structured OR semistructured OR phenomenol* OR ethnograph* OR grounded-theory OR grounded-study OR groundeattituded-analysis OR grounded-analyses OR story OR stories OR content-analysis OR thematic-analysis OR thematic-analyses OR content-analys* OR narrative-analysis OR fieldwork OR field-work OR ((decriptive OR field) N3 (study)) OR key-informant* OR investigative OR theme* OR Thematic OR participant-observation* OR group-discussion*) OR (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide*) N5 (discussion* or questionnaire* OR survey*)))	993 911
4	1 and 2	1390
2	(MH "Meningitis, Bacterial") OR (MM "Anthrax Meningitis") OR (MM "Meningitis, Listeria") OR (MM "Meningitis, Meningococcal") OR (MM "Meningitis, Pneumococcal") OR (MH "Meningitis, Viral") OR (MH "Meningitis, Fungal") OR TX ((Bacterial OR Viral OR Fungal OR Aseptic OR Parasitic OR community-acquired OR Acute OR fulminat* OR Fulminant OR Sudden-onset) N5 (meningiti*)) OR TX (infectious-meningiti* OR Meningococc* OR Neisseria-meningit* OR N-Meningitidis OR Pneumococc* OR S-pneumoniae* OR Haemophilus-influenzae OR Listeri* OR L-monocytogenes OR Staphylococc* OR Staph-aureus OR Enterobacter* OR Enterococc* OR Escherichia-coli OR E-coli OR Streptococc* OR S-agalactiae* OR S-pyogenes OR Enterovir* OR Coxsackieviruses OR Herpesviridae OR Herpesvirus* OR herpes-virus* OR Varicella-zoster OR flavi-virus* OR Japanese-encephal* OR Tick-borne-encephal* OR Powassan-virus* OR West-Nile-virus OR Togaviridae OR Toga-virus* OR Togavir* OR equine-encephal* OR Bunyavirus* OR crosse-encephal* OR Toscana-virus* OR Reovirus* OR tick-fever* OR paramyxovir* OR Mumps OR morbillivirus* OR parainfluenza* OR Orthomyxovir* OR Influenza OR HIV OR human-immuno-deficienc* OR Adenoviridae OR adenovirus* OR Arenavir* OR Choriomeningit* OR LCMV OR Rickettsi* OR Orientia-spp OR Ehrlichia-spp OR spirochet* OR Borrelia-spp OR B-burgdorferi OR leptospir* OR Treponema-pallidum OR Brucell* OR Coxiella OR Mycoplasma OR spirillum* OR Naegleria OR angiostrongyl* OR Trichinella-spiralis* OR Candida OR Coccidioid* OR Histoplasm* OR Blastomyc* OR Sporothrix* OR Aspergill* OR Lyme OR Syphili* OR Scrub-Typhus OR tsutsugamushi)	278 500

Appendix WB.I.A2

Reflexivity statement

The research team acknowledges that subjectivity and context inherently influence the research process. To ensure qualitative research rigour, the team employed a range of strategies aimed at addressing individual perspectives and minimizing bias throughout the study.

The research team responsible for data analysis and interpretation consisted of professionals from diverse backgrounds, including experienced (DM) and early-career quantitative researchers (MA, MP), medical practitioners at various stages of their careers including psychiatrists (KK, ES, MS), and medical students (DB, MK, AM), all contributing to a multidisciplinary approach. Considering that the team had more training in quantitative methods, experienced qualitative researchers (MM, ADG, TJ, ZM, SN) with backgrounds in nursing, psychology and social sciences were consulted at all stages of thematic synthesis, including selecting the data analysis method, coding and theme identification and refinement. By utilizing this multidisciplinary strategy, the team aimed to balance any influence of its members' backgrounds and experiences on the findings, thereby ensuring they both meet high standards in qualitative research and hold practical utility for policy-making.

None of the authors involved in conducting the analysis had direct experience working with individuals affected by meningitis, and all were from high-income countries. While this context could serve as a source of underestimation and underrepresentation of certain aspects of the data, it was reasoned that a lack of prior experience would allow the team to approach the analysis with minimal expectations or assumptions about the values, experiences and factors related to meningitis care. This background may have allowed for a more impartial interpretation of the data from primary studies and minimized potential bias in the study findings. Moreover, lack of prior assumptions influenced the decision to adopt a more flexible, exploratory methodology – thematic synthesis – ensuring that the results were driven by the data itself rather than pre-established frameworks.

II. Economic considerations in the diagnosis and management of acute community-acquired meningitis: a rapid scoping review

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1. Introduction

This rapid scoping review aimed to compile information regarding costs and resource utilization associated with the diagnosis, care, treatment and sequelae management of acute community-acquired meningitis.

2. Methods

2.1 Exclusion criteria for study selection

- Diseases other than acute community-acquired meningitis (including cryptococcal, tuberculous, non-infectious and/or hospital-acquired meningitis)

- Studies evaluating the costs/cost-effectiveness during outbreak response
- Prevention and vaccination programmes
- Studies that lack assessment of costs or resource utilization for managing meningitis cases or those that focus solely on lifetime costs
- Studies without original data or employing purely theoretical approaches were excluded, however theoretical studies using retrospective real-life data for cost-effectiveness assumptions were included
- Case reports and case series.

No restrictions were applied regarding the study year, country's income level or participants' age. Studies containing relevant information on costs and/or resource utilization were included and data were extracted.

At least two reviewers independently performed title, abstract and full-text screening. Conflicts were resolved during online sessions with a third reviewer. Data extraction was performed by a single reviewer with subsequent verification by a second reviewer. No risk-of-bias assessment was undertaken.

Of 2230 studies, 61 met inclusion criteria and were selected for data extraction (49 for cost assessment and 12 for cost-effectiveness assessment). Further details are depicted in Fig. WB.II.1. However, time constraints did not allow for additional screening of grey literature and references of included research papers.

2.2 Data extraction: costing studies and costing studies with effect measures

- First author, year
- Country from which meningitis cases information was obtained
- Level of income (low- and middle-income countries [LMICs]/high-income countries [HICs])
- Study design
- Study period (diagnosis/data collection dates with reported inflation-adjusted cost years)
- Number of participants
- Participant characteristics – age groups: neonates (< 1 month), children (1 month to 18 years), and/or adults (> 18 years); cases in which the main study population consisted of children without a reported lower bound were classified as both neonates and children
- Setting
- Etiology

- Costs (relevant quantitative data; for studies with extensive numerical data, only main costs were reported due to time constraints)
- Other reported resources – length of stay; medication consumption; out-of-pocket costs to familiesout-of-pocket costs to families; number of hospital visits/consultations and other resources where available.
- Notes (additional relevant information).

2.3 Data extraction: costing studies with effect measures only

- Method/resource use/price–policy alternative investigated (aim of the study)
- Intention to minimize cost/maximize quality (specified as stated by the author)
- Benefits/effectiveness (main outcomes of the studies)
- Type of economic data analysis used, if any
- Any relevant associated costs/resources not stated necessary for the implementation of the method/resource use/price–policy alternative.

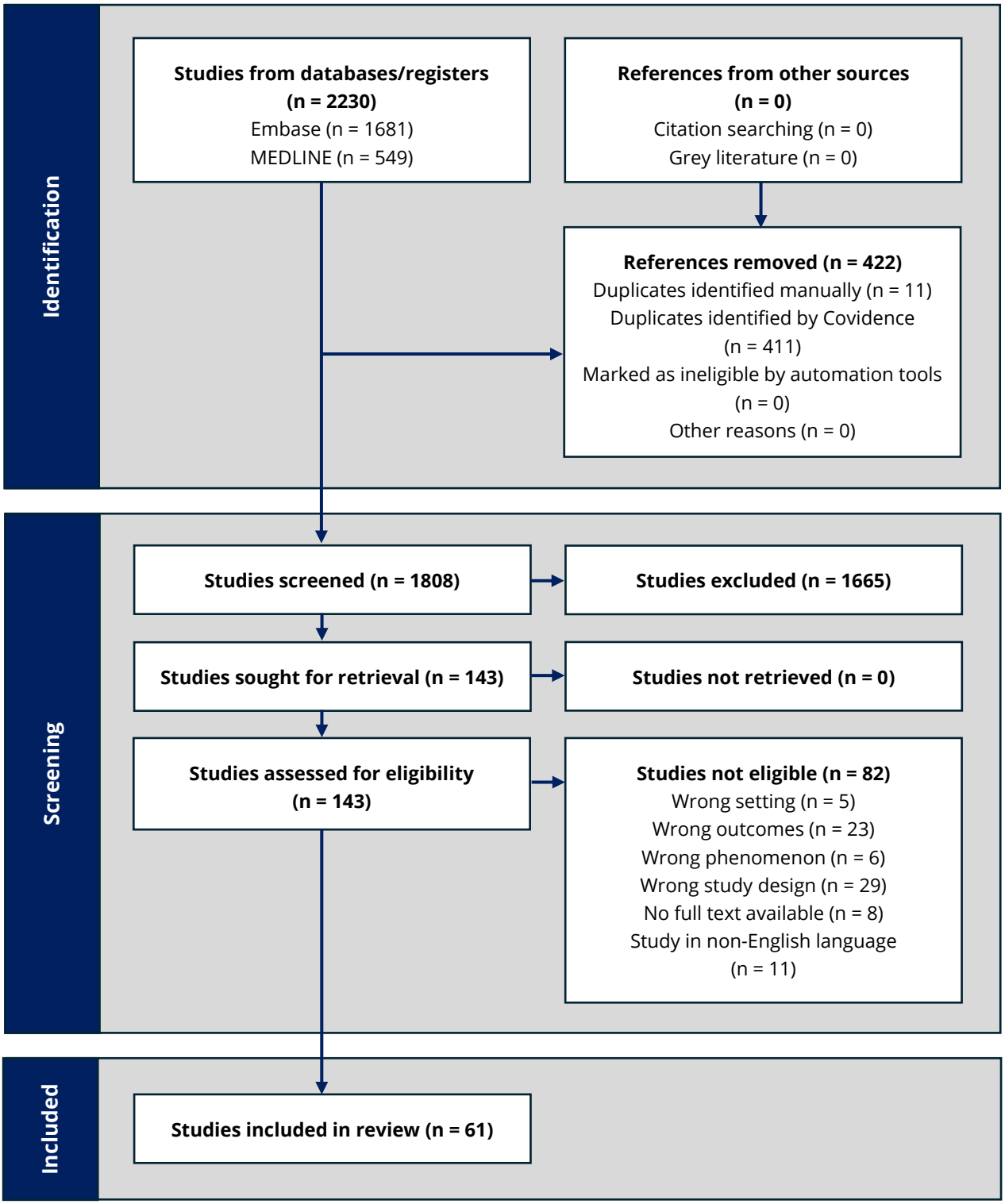
2.4 Compilation of the final tables

Data were categorized by outcome type and income level by country (only for costing studies without effect measures, as costing studies with effect measures included information from HICs only). No assessment of the quality of the evidence was conducted.

3. Results

Overall, 61 studies were included in the review. Twelve studies were conducted in low- and middle-income countries (LMICs) and 49 in high-income countries (HICs). The characteristics of the included studies are reported in Tables WB.II.1–3.

Figure WB.II.1 PRISMA flowchart[3]



[3] PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

3.1 Included studies: Costing studies from LMICs

Table WB.II.1 Costing studies from LMICs

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Liu, 2024 China *(1)*	Multicentre retrospective 2019–2021	918 Neonates, children Hospitalized	Bacterial	The average cost of hospital stay was 21 531 (IQR 24 835) yuan, for confirmed group 35 824 (IQR 438 217), for clinical group 27 768 (IQR 30 446), for probable group 16 209 (IQR 11 228)	The median hospital length of stay (LOS) of all children was 20 (IQR 16) days	In addition, the incidence rate decreased with age. *Escherichia coli* and Group B *Streptococcus agalactiae* (GBS) were the principal pathogens in community-acquired bacterial meningitis (CABM) infant < 3 months (43.3%, 34.1%), and *Streptococcus pneumoniae* was the most common pathogen in children ≥ 3 months (33.9%). In conclusion, the annual incidence and mortality of CABM in children aged 0–14 years in Zhejiang Province were at intermediate and low levels. The distribution of CABM incidence and

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
						pathogen spectrum are different by age; the incidence of abnormal neuroimaging is high; and the economic burden is high.
Adamu, 2022 Nigeria *(2)*	Cross-sectional 2020	53 Neonates, children Hospitalized	Pneumococcal meningitis	All costs converted to US$ using average 2020 conversion rates. Combined costs for Aminu Kano Teaching Hospital (AKTH) and Murtala Muhammed Specialist Hospital (MMSH): • Mean US$ 345.7 (standard deviation [SD] US$ 158.0) • Median US$ 294 (IQR US$ 253–408) Costs by hospital:	Mean length of stay (LOS): AKTH = 6 (SD 1.1) days; MMSH = 7 (SD 4.8) Median LOS: AKTH = 6 (IQR 6–7) days; MMSH = 6 (IQR 5–7)	We conducted 1-way sensitivity analyses of provider costs by varying the source of bed-day costs. Provider costs were sensitive to source of hospital (bed-day) costs. Provider costs were between 38% and 40% lower across all disease categories and between the hospitals when the WHO-CHOICE estimates were used compared with actual hospital admission costs.

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Mean bed-day costs: AKTH = US$ 351 (SD US$ 59); MMSH = US$ 237.2 (SD US$ 161.3) Median bed-day costs: AKTH = US$ 332 (IQR US$ 332–388); MMSH = US$ 199 (IQR US$ 166–233) Mean drug expenses: AKTH = US$ 20 (SD US$ 3); MMSH = US$ 21.5 (SD US$ 7.9) Median drug expenses: AKTH = US$ 20 (IQR US$ 18–22); MMSH= US$ 19 (IQR US$ 17–24) Mean investigation expenses: AKTH = US$ 17 (SD US$ 7); MMSH = US$ 8.6 (SD US$ 1.4) Median investigation expenses: AKTH = US$ 20 (IQR US$ 13–22); MMSH = US$ 8 (IQR US$ 7–10)		

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Mean oxygen and blood transfusion expenses: AKTH = US$ 32 (SD US$ 31); MMSH = US$ 29.6 (SD US$ 19.4) Median oxygen and blood transfusion expenses: AKTH = US$ 34 (IQR US$ 0–40); MMSH = US$ 30 (IQR US$ 20–40) Mean total provider costs: AKTH = US$ 420.0 (SD US$ 80.1); MMSH = US$ 296.9 (SD US$ 117.5) Median total provider costs: AKTH = US$ 407 (IQR US$ 364–449); MMSH = US$ 257 (IQR US$ 225–280) Direct household costs (mean): AKTH = 64.3 (SD 16.8); MMSH = 92.2 (SD 106.6) Direct household costs (median): AKTH = 68.8 (IQR		

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				51–76), MMSH = 71.8 (IQR 58–83) Mean transportation costs: AKTH = 1.1 (SD 2.9); MMSH = 2.9 (SD 4.4) Median transportation costs: AKTH = 0.0 (IQR 0–0); MMSH = 0.0 (IQR 0–6) Mean feeding costs: AKTH = 1.3 (SD 6.1); MMSH = 6.8 (SD 17.8) Median feeding costs: AKTH = 0.0 (IQR 0–0), MMSH = 0.0 (IQR 0–0) Mean user fees: AKTH = 44.3 (SD 6.7); MMSH = 59.2 (SD 94.3) Median user fees: AKTH = 44.3 (IQR 39–50); MMSH = 40.3 (IQR 36–45)		
Chala, 2022	Facility-based cross-sectional	139	Bacterial (confirmed and suspected)	All costs converted to US$ using the 2018 average conversion rate.	Even though patients were negative for bacterial meningitis using the current standard of	Most of the patients, 106 (76.3%) were treated with out-of-pocket payment. The treatment costs for the

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Ethiopia *(3)*	2018	Neonates, children, adults Hospitalized		The total median direct cost of both suspected and confirmed bacterial meningitis: 79 248.02 Br (US$ 2881.75; IQR US$ 2103.1–8765.3). Direct costs were classified as direct medical and direct non-medical costs. A higher proportion, 80.2% (US$ 2311.2; IQR US$ 650.4–4987), of the direct costs were direct medical costs.	diagnosis, they were given a full antibiotic regimen in fear of a false-negative diagnosis arising from self-medication	rest, 21.5% and 2.2%, were covered by community-based health insurance and missionary charity respectively. Considering an accurate method of diagnosis and differentiation, in addition to minimizing unnecessary admissions, an estimated US$ 2867.37 could be saved at an average length of hospital stay of 11 days.
Al-Kumait, 2019 Iraq *(4)*	Descriptive 2017	4 Children Hospitalized	Not relevant (NR)	Antibiotic treatment per 4 patients: $195 (conversion date and currency not specified)	104 ceftriaxone 0.5 g vials with 108 chloramphenicol (1 g) vials were used for 4 patients, duration ≥ 10 days	
Ceyhan, 2018	Single-centre retrospective evaluation of	10	Pneumococcal	All costs converted to € using the 2014 average conversion rate.	NR	

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Türkiye *(5)*	electronic medical records 2013–2014	Children Hospitalized		Direct costs: Mean ± SD € 9299.98 ± 13 762.01 Median (Q1–Q3) of € 3346.38 (€ 941.82–11 700.86) Service cost: Mean ± SD € 6889.99 ± 11 532.51 Median (Q1–Q3) € 1794.41 (€ 648.83–8914.87) Medication cost: Mean ± SD € 1719.31 ± 2698.07 Median (Q1–Q3) € 485.24 (€ 275.35–2068.33) Material cost:		

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Mean ± SD € 690.68 ± 1170.44 Median (Q1–Q3) € 322.84 (€ 24.16–615.96) Total cost: Mean ± SD € 11 772.3 ± 16 688.16		
Usuf, 2016 Gambia *(6)*	Prospective observational cost analysis 2011–2012	29 Children Hospitalized	Bacterial	All costs converted to US$ using the 2010 average conversion rate. Average total provider treatment cost: US$ 131.00 in Basse Health Centre (Basse) and US$ 104.20 at Royal Victoria Teaching Hospital (RVTH)	Average, median, (IQR) out-of-pocket costs to families of children with meningitis: Total US$ 62.5, US$ 30.8 (IQR US$ 9.9–66.9)	
Irurzun-Lopez, 2015	Retrospective cost analysis	Not reported (NR)	Bacterial	All costs converted to US$ using the 2012 average conversion rate.	NR	Resource use and unit cost data were collected through interviews with

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Niger and Chad *(7)*	2012	Children and adults, Outpatient, Hospitalized		This study estimated the costs of existing meningitis surveillance in Niger and Chad. Niger: Health-care facilities accounted for 61% of total costs, followed by laboratories (32%) and Ministry of Health administration (7%). Rural and urban average costs per 100 000 population were US$ 7865 and US$ 2946 for clinics, respectively, and US$ 248 and US$ 1684 for district hospitals, respectively. In Niger, personnel resources contributed the most to the aggregated national cost (US$ 720 600 or 37%), followed by laboratory resources (US$ 374 816 or 19%). When disaggregating by administrative level,		staff at health-care facilities, laboratories, government offices and international partners, and by reviewing financial reports. Sample costs were extrapolated to national level and costs of upgrading to desired standards were estimated. In Niger, the estimated costs of upgrading the current system to operational standards would amount to US$ 183 299, or 9% of the current cost. Laboratory investigation would consume US$ 240 115 159 or 63% of the upgrading cost.

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				cost of personnel resources was also highest at the clinic level (US$ 546 833 or 46%). However, the cost of laboratory resources was highest at the rest of administrative levels, that is at district (US$ 94 966 or 36%), regional (US$ 40 871 or 45%) and central (US$ 240 320 or 49%) levels. Recurrent costs were greater than capital costs (76 and 24%, respectively). Within surveillance functions, laboratory investigation accounted for most costs (US$ 995 047 or 51%), and this was also the case at all administrative levels. Core functions accounted for US$ 1 798 391 or 92% of total costs, while support functions contributed US$ 146 571 or 8%. Cost		

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				per meningitis case varied across administrative levels, from US$ 894 in clinics to US$ 76 at the national hospital. Furthermore, clinics with zero reported cases spent nearly the same as clinics with reported cases (average cost per 100 000 population of US$ 4051 vs US$ 4600). Chad: Mean costs per 100 000 population among districts performing exclusive existing enhanced surveillance (ENS), partial case-based surveillance (CBS) and exclusive CBS were US$ 3228, US$ 3593 and US$ 7449, respectively. The estimated incremental costs per year of having a national CBS system that		

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				adheres to operational standards would amount to US$ 605 017, equivalent to a 179% increase in current costs. With such an upgrade, total costs would be approximately US$ 943 072 per year, equivalent to US$ 7449 per 100 000 population.		
Le, 2014 Viet Nam *(8)*	Prospective survey 2012, estimated in 2012	15 Children, outpatient Hospitalized	Not specified	All costs converted to US$ using the 2012 average conversion rate. The mean total direct medical cost (DMC) of treating a case of meningitis was US$ 300; mean pre-admission cost was US$ 12 (n = 14; SD US$ 28) for meningitis patients. Mean user fees amounted to US$ 153 (n = 15; SD US$ 193) for meningitis.	NR	While the *Haemophilus influenzae* type b (Hib) vaccine was introduced into the Expanded Programme on Immunization (EPI) in 2010, pneumococcal and meningococcal vaccines were still only available in the private sector. Given the high household out-of-pocket costs of pneumonia and meningitis in relation to overall monthly expenditure and the negative health impact of both diseases on children,

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Mean total direct non-medical costs (DNMC) was US$ 156 for meningitis. Excluding indirect costs (IC), mean out-of-pocket cost was US$ 367 (n = 10; SD US$ 430) for a meningitis case. Adding IC, mean household costs amounted to US$ 534 (n = 10; SD US$ 678) for meningitis. When omitting IC, mean costs for treating a pneumonia and meningitis case was US$ 560 (n = 10; SD US$ 617). When including IC, mean costs from societal perspective was US$ 727 (n = 10; SD US$ 865) for a meningitis case. The median cost was US$ 466.		these findings indicate the need to re-evaluate the effectiveness of health insurance policy for children < 6 years old such that out- of-pocket costs are contained. Lower out-of-pocket costs may lead to more access to health care, which would definitely contribute to a reduction of child morbidity and mortality in Viet Nam.

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Griffiths, 2012 Senegal *(9)*	Prospective cohort study 2001–2007, converted to 2010 (US$)	66 Neonates, children, outpatient Hospitalized	Hib meningitis (n = 24, 36%), pneumococcal meningitis (n = 22, 33%), meningococcal meningitis (n = 11, 17%)	All costs converted to US$ using the 2010 average conversion rate. The mean costs per patient amounted to US$ 1293 (range: US$ 105–2572. The mean costs of pre-hospitalization consultation fees and medication were US$ 68 Hospital fees and drugs comprised 71% of total costs, transport 14%, other costs 10% and pre-hospitalization 5% The mean costs per hospitalized day US$ 51 (range US$ 1–161); the mean cost per visit US$ 27	The average LOS was 20 days (range: 5–60 days). During the acute episode, 70% of the children were taken to at least 1 other health-care provider before being admitted to the study hospital. Two families sought help at 3 places, 10 visited 2 different providers and 32 went to 1 other provider before coming to the hospital. Forty-six children (88%) attended the follow-up visits at specialty outpatient clinics (other families couldn't attend these due to transport expenses).	

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				(range US$ 0–72), with transport costs comprising on average 20% (mean transport costs per visit were US$ 7.15 [range US$ 0–23]) Mean meningitis episode costs (n = 47): US$ 1441 (SD 1158) Mean outpatient costs were US$ 86 per child (range: US$ 0–315) during the year of the meningitis episode and US$ 189 (range: US$ 5–753) among the 46 children receiving consultations over the study period Mean total re-hospitalization costs (n = 10): US$ 1293 (SD 794)	The mean number of consultations per child was 2.55 during the same year as the episode, 1.81 1 year later, 0.43 2 years later, 0.09 3 years later and 0.06 4 years later	

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Anh, 2010 Viet Nam *(10)*	Incidence-based cost-of-illness analysis 2005–2006, converted to 2006	76 Children Hospitalized	Pneumococcal (suspected/probable bacterial/ definite) meningitis	All costs converted US$ using the 2006 average conversion rate. Costs for suspected meningitis: drug US$ 20.03 (SD 29.05); laboratory US$ 8.82 (SD 16.72); hotel US$ 14.75 (SD10.08); total US$ 43.61 (SD 41.38) Costs for probable bacterial meningitis*:* drug US$ 71.86 (SD 36.26); laboratory US$ 19.62 (SD 5.44); hotel US$ 29.41 (SD 16.61); total US$ 120.89 (SD 52.45) Costs for definite meningitis: drug US$ 106.16 (SD 86.41); laboratory US$ 30.1 (SD 43.84); hotel US$ 27.7 (SD	Mean LOS (total) 6.42 days (SD 4.61) Mean LOS (suspected meningitis) 6.64 days (SD 4.61) Mean LOS (probable bacterial meningitis) 6.60 days (SD 5.55) Mean LOS (definite meningitis) 3.40 days (SD 3.05) Resource-consumption patterns in the study hospital: costs of materials (54%), labour (28%) and capital (18%)	Hotel cost denotes costs of room, meal and routine nursing care in inpatient ward. To explore the co-factors affecting the treatment costs, a multiple regression analysis was conducted using age, days of hospitalization and diagnosis as independent variables. All, except days of hospitalization, had significant effects on cost. The costs of all disease groups were inversely related to age – as the age of patients increased, costs decreased. When diagnosis and age-groups were compared, the average treatment cost of meningitis ranged from US$ 25 to US$ 190.

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				4.8); total US$ 163.95 (SD 133.22) Costs for all meningitis: drug US$ 29.11 (42.3); laboratory US$ 10.93 (SD 19.49); hotel US$ 16.57 (SD 11.23); total US$ 56.61 (SD 61.4) Of 48 antibiotics used for treating the study patients, ceftriaxone, cefotaxime and cefuroxime were the most expensive drugs (38%, 29% and 16% of all the drug costs in the study, respectively)		
Hussain, 2006 Pakistan *(11)*	Activity-based costing analysis 2000–2001	24 Neonates, children, outpatient	NA	All costs converted US$ using the 2001 average conversion rate. An average cost for treatment of meningitis	NR	

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
		Hospitalized		cases US$ 674.70. For hospitalized care, the health system spent an average of $ 2043 for meningitis Cost break-out: Inpatient cost per episode of illness in 1 of the centres: Salary of medical personnel 4%, salary of support staff 0%, salary of administrative staff 0.01%, capital costs 42%, utilities 13%, maintenance 5%, supplies 14%, drugs 18%, radiograph 0%, lab 0.37%, other costs 4%		
Ayieko, 2009 Kenya *(12)*	Prospective and retrospective cost analysis 2004–2005	102 Neonates, children	NR	All costs converted US$ using the 2005 average conversion rate. Mean drug costs:	Average length of stay (days): National hospital 12.8 Provincial hospital 11.7 Mission hospital 11.8	

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
		Hospitalized		National hospital US$ 24.33 Provincial hospital US$ 18.41 Mission hospital US$ 44.03 Mean cost of investigations: National hospital US$ 36.95 Provincial hospital US$ 13.29 Mission hospital US$ 44.85 Mean bed-day cost: National hospital US$ 223.37 Provincial hospital US$ 157.71 Mission hospital US$ 112.71		

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Mean health-sector cost per patient (excluding pre-admission costs, caretaker time and transport costs, but including revenues generated from user fees): National hospital US$ 284.64 (SD US$ 239.38) Provincial hospital US$ 189.41 (SD US$ 141.58) Mission hospital US$ 201.59 (SD US$ 126.41) Median health-sector cost (excluding pre-admission costs, caretaker time and transport costs, but including revenues generated from user fees):	

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				National hospital US$ 222.60 (IQR US$ 159.68–317.06) Provincial hospital US$ 165.31 (IQR US$ 126.24–237.23) Mission hospital US$ 162.00 (IQR US$ 115.16–248.14) At the national hospital the mean treatment costs of meningitis were US$ 290.42. At the other 2 hospitals where children with meningitis were seen the mean treatment costs were US$ 189.41 and US$ 205.74 per case		
Bilyk, 2019 Ukraine *(13)*	Retrospective analysis	184 Neonates, children	Bacterial (Meningococcal meningitis)	All costs converted to US$ using the 2018 average conversion rate.	Average LOS (14.0 ± 7) bed-days	

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
	2009–2016, converted to 2018	Hospitalized		The total cost of treatment for 184 patients was US$ 25 173.59 (US$ 136.81/per patient)		
Farooqui, 2022 Qatar *(14)*	Cross-sectional study July 2017 – June 2018	~1 13 823 households: 64 552 in rural areas, 49 271 from urban areas Outpatient, hospitalized	NR	Average per episode out-of-pocket expense (OOPE): Acute meningitis Medical ₹ 5367 (standard error [SE] ₹ 821.8) Average share of household expenditure incurred on childhood infections (age 0–5 years) in outpatient and hospitalization: Acute meningitis OOPE share on outpatient with 15 days recall (95% confidence interval [CI]): 7.0% (5.6–8.3%) OOPE share on hospitalization with 365	Average per episode OOPE: Acute meningitis Non-medical ₹ 914 (SE ₹ 95.7) Total ₹ 6281 (SE ₹ 869.3) Public ₹ 1938 (SE ₹ 302.8) Private ₹ 9313 (SE ₹ 1434.1)	

First author, year Country	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				days recall (95% CI): 4.7% (3.5–6.1%)		

CABM: community-acquired bacterial meningitis; CBS: case-based surveillance; DMC: direct medical costs; DNMC: direct non-medical costs; ENS: existing enhanced surveillance; EPI: Expanded Programme on Immunization; GBS: *Streptococcus agalactiae*; Hib: *Haemophilus influenzae* type b; IC: indirect costs; IQR: interquartile range; LOS: length of stay; NR: not reported; SD: standard deviation.

3.2 Included studies: Costing studies from HICs

Table WB.II.2 Costing studies from HICs

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Gil-Prieto, 2023 Spain *(15)*	Retrospective study 2016–2020	Not reported (NR) Adults Hospitalized	Pneumococcal	Mean cost per hospitalization for pneumococcal meningitis of € 12 608 (95% CI € 12 107–13 109) Estimated total cost of hospitalizations per year for pneumococcal meningitis € 4.4 million	Average length of stay (LOS) was 12.72 days (95% CI 12.67–12.80)	
Huang, 2022 France *(16)*	Retrospective cohort study 2014–2016, cost converted to € 2018	790 Neonates, children and adults	Meningococcal meningitis	Cost of the index hospitalization: Mean = €12 103; median = € 7425	Mean LOS 11.5 days (SD 9.2), median LOS 9 days (IQR 7–13) 174 (22%) of patients required mechanical ventilation, 141 (17.8%) filing/use of catecholamine, 20 (5.9%) dialysis for acute	Costs for follow-up and sequelae were reported as well, however septicaemia, septicaemia with meningitis and unspecified or other type of invasive meningococcal disease (IMD) were included in

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
		Hospitalized, intensive care unit (ICU)			kidney injury, 31 (3.9%) were transferred to a rehabilitation centre after discharge	these costs as well as meningitis itself
Adil, 2021 United States of America (USA) *(17)*	Retrospective cohort study 2008–2015, Costs adjusted to 2017 US dollars	1632 Neonates and children Outpatient, hospitalized	Bacterial: Haemophilus 58 (3.6%), Leptospira 1 (0.1%), meningococcus 56 (3.4%), Gram-negative, not more specifically classified 232 (14.2%), Salmonella 4 (0.2%), Staphylococcus/ methicillin-resistant *Staphylococcus aureus* (MRSA) 134 (8.2%), streptococcus 536 (32.8%), *Treponema pallidum* 3 (0.2%), *Mycobacterium tuberculosis* 21 (1.3%), unspecified 494 (30.3%), more	Cumulative total costs (inpatient/outpatient service costs + outpatient medicines) 0–90 days: US$ 56 569; 1 year post-diagnosis US$ 66 398; 2 years post-diagnosis US$ 75 162	Procedures (90 days after the index date, n = 1412): Only craniotomy/craniectomy 38 (2.7%); only lumbar puncture (LP) (diagnostic) 564 (39.9%); only LP (therapeutic) 45 (3.2%); only incision/drainage of intracranial or extracranial collections 68 (4.8%); only internal/external ventricular catheters 175 (12.4%); have at least 1 of the 5 procedures above 755 (53.5%) Initial admission LOS (days from admission to discharge, n = 1632): Mean 22.5 (SD 30.4); median	Discharge disposition for initial admission: Died 62 (3.8%); home 1315 (80.6%); hospice home/medical facility 2 (0.1%); other 253 (15.5%) Summary of results of regression analysis: Sex, age and Gram staining were not significantly associated with cost. For the community-acquired group, the total cost significantly decreased 91–365 days post-diagnosis compared to the first 90 days after diagnosis when accounting for covariates. The average total cost in the 91–365-day period

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
			than 1 specific 93 (5.7%)		14.0; Q1–Q3 6.0–23.0; range 0.0–405.0 Days from bacterial meningitis (BM) diagnosis to discharge (n = 1632): Mean 22.4 (SD 30.5); median 14.0; Q1–Q3 6.0–23.0; range 0.0–405.0	post-diagnosis was 29% of that from the first 90 days.
Cannon, 2021 New Zealand *(18)*	Economic impact assessment 2005–2014, costs converted to NZ dollars 2015	256 Neonates, children and adults Hospitalized	Streptococcal meningitis	Weighted inpatient separation cost $NZ 13 073	Average LOS (days) 13.4	
Darbà, 2021 Spain *(19)*	Retrospective multicentre study 2008–2017	3394 Adults	Pneumococcal	The mean hospital admission cost for all pneumococcal infections was € 5676 per patient, and € 104.2 million annually for all registered	LOS (hospitalization) for pneumococcal meningitis: mean 18.6 days, median 14 days (SD 10)	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
		Outpatient, hospitalized		patients. For meningitis patients it was € 11 934. Mean admission cost € 11 934 Mean cost of urgent admission € 11 850 Mean cost of scheduled admission € 13 327 Mean cost of an initial admission € 11 419 Mean cost of a readmission € 11 855 Mean cost of admissions < 22 days € 9549 Mean cost of admissions > 22 days € 21 163 Mean admission cost, patients < 65 years € 11 294		

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Mean admission cost, patients > 65 years € 13 096		
Hsieh, 2021 Taiwan, China *(20)*	Population-based epidemiological study 2000–2013	7561 Children Hospitalized	Bacterial, *Streptococcus pneumoniae* was the most frequent causative pathogen, accounting for 7.2% and 1.9% of episodes in the steroid group and non-steroid group, respectively, followed by *Haemophilus influenzae* (4% and 0.6%) and *E. coli* (0.7% and 0.3%), other Streptococci (6% and 3%), Pseudomonas species (0.09% and 0.08%), Salmonella species (0.1% and 0.02%), other Gram-	The medical cost of hospitalization, median) was (NT$ 77 941 (IQR NT$ 26 647–237 540) and NT$ 26 653 (IQR NT$ 14 287–53 421) in the steroid and non-steroid groups, respectively	The median length of hospital stay (days) was 13 (range 6–27) and 6 (range 4–10) days in the steroid and non-steroid groups, respectively	The fatality rates were 7.9% (167/2122) in the steroid group and 1.7% (100/5961) in the non-steroid group during hospitalization. The fatality rates were 13.7% (290/2122) and 3.3% (198/5961) in the steroid and non-steroid groups, respectively, during the 1-year follow-up period. The hazard ratios (relative to the non-steroid group) of the in-hospital and 1-year fatality rates were 2.6 (95% CI: 2.0–3.3; $P < 0.0001$) and 4.13 (95% CI: 3.4–5.0; $P < 0.0001$) in the multivariate Cox model after adjustment for both age and sex, respectively.

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
			negative bacilli (2.5% and 1.3%), MRSA (0.5% and 0.2%), other Staphylococci (0.05% and 0%), *Neisseria meningitidis* (0% and 0.02%), *Listeria monocytogenes* (0.3% and 0.05%), anaerobic pathogens (0.3% and 0.05%)			
Weil-Olivier, 2021 France *(21)*	Case–control cost-of-illness study 2012–2017, costs converted to € 2019	3532 Adults Hospitalized	*N. meningitidis*	Mean per capita cost of the index hospitalization for IMD was € 11 256 The mean costs of the index stay increased with age, from € 9637 (CI € 9202–10 072) for cases under age 25 years to € 12 635 (CI € 11 526–13 744) for cases aged 25–	The mean duration of the index hospitalization was 14.8 days	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				49 years and € 14 165 (CI € 13 365–14 965) for cases aged 60 years or older. The mean cost was: € 9393 (CI € 9029–9757) in cases without sequelae; € 14 469 (CI € 13 352–15 586) in cases with a single sequela; and € 22 537 (CI € 20 564–24 510) in 298 cases with multiple sequelae. Costs accrued during the year following the index date in the total population: Total mean per capita costs were more than twice as high for cases (€ 6564) than for controls (€ 2890). Total costs also increased		

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				with the number of sequelae from € 4254 in cases who recovered from the index IMD without any sequelae to € 20 096 in those with multiple sequelae. The mean cost of the index hospitalization in the subgroup of cases followed for 5 years was € 9912. Total mean per capita costs during the first year after the index event were € 17 358. After the first year following the index event, total mean per capita costs in cases descended to a plateau between € 2000 and € 3500 per year.		

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Cailleaux, 2020 France *(22)*	Prospective observational study 2016–2017	130 Adults NR	Bacterial and viral: *L. monocytogenes*, *N. meningitidis*, cytomegalovirus, enterovirus, herpes simplex virus (HSV) 1 and 2, varicella-zoster virus (VZV), human herpes virus 6 (HHV-6), parechovirus, *E. coli* serotype K1, *H. influenzae*, *L. monocytogenes*, *Streptococcus agalactiae*, *S. pneumoniae*, and *Cryptococcus neoformans/ gatti*	Cost of the multiplex assay € 180 during the study period Mean daily cost of hospitalization during the study period € 1265 in a conventional medicine department € 1710 intensive care unit	NR	
Huang, 2020 Germany *(23)*	Retrospective case-matched cohort study (using an age- and sex-matched control group)	62 Neonates, children and adults	*N. meningitidis*	Mean overall costs of meningitis cases within pre-defined follow-up periods after diagnosis: € 300 (≤ 1 month), € 1671 (1 month to 1 year), € 2001 (1–3 years), € 1978 (3–5	NR	For the analysis of short-term and long-term costs in IMD cases, the follow-up period was stratified into the following periods to account for different length of study follow-up time: ≤ 1

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
	2009–2015, costs converted to € 2016	Outpatient, hospitalized		years) and € 1078 (5–7 years)		month, 1 month to 1 year, 1–3 years, 3–5 years and 5–7 years; < 1 month and 1 month to 1 year was considered a short-term follow-up period and later time periods as a long-term follow-up period
Kitano, 2021 Japan *(24)*	Retrospective analysis combined with a cost–benefit simulation 2017–2019	23 Children Hospitalized	Mostly viral, but also bacterial	The average medical and social costs were ¥ 245 994 (US$ 2236.3) and ¥ 161 270 (US$ 1466.1), the average total cost per 1-day hospital stay was ¥ 29 831 (US$ 271.2)	NR	Cost–benefit analysis was presented. The minimum reduction needed in average LOS for the FilmArray Meningoencephalitis (FAME) test to be cost-beneficial was 0.32–0.86 days per meningitis case
Balada-Llasat, 2019 USA *(25)*	Retrospective cohort study 2011–2014, costs converted to US$ 2015	6665 paediatric patients: 3030 infants (< 1 year old), 3635 children (1–17 years old)	Bacterial, viral (enterovirus, herpes virus, arbovirus), fungal	Costs (mean ± SD) Infants (< 1 year): Total visit cost US$ 12 759 ± 19 330	Costs for cerebrospinal fluid (CSF) tests (2015 US$, mean ± SD [% of children who had the test]) Infants:	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
		Outpatient, hospitalized (91.1% of infants and 76.3% of the children), ICU		Total cost incurred until LP procedure day US$ 2965 ± 2266 ICU-related cost US$ 23 344 ± 26 718 Medication treatment cost US$ 834 ± 1887 Diagnostic laboratory testing cost US$ 825 ± 1104 Meningoencephalitis (ME)-related laboratory tests cost US$ 204 ± 234 Children (1–17 years) Total visit cost US$ 11 119 ± 34 904 Total cost incurred until LP procedure day US$ 3097 ± 3021 ICU-related cost US$ 30 631 ± 76 482	Gram stain US$ 36 ± 26 (84.6%) Glucose US$ 13 ± 12 (64.9%) Protein US$ 16 ± 15 (63.5%) Cell count and differential US$ 28 ± 22 (53%) Bacterial culture US$ 28 ± 18 (54%) Acid-fast bacillus (AFB) culture NA Fungal culture US$ 50 ± 35 (0.7%) Antibody tests US$ 68 ± 48 (0.9%) Any polymerase chain reaction (PCR) test US$ 94 ± 88 (0.6%) Cryptococcal antigen US$ 40 ± 25 (0.2 %) Viral culture US$ 106 ± 155 (8.8 %)	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Medication treatment cost US$ 1771 ± 9965 Diagnostic laboratory testing cost US$ 855 ± 2136 ME-related laboratory tests cost US$ 172 ± 239 Higher mean costs were associated with inpatients and with delayed LP: US$ 20 226–22 774 (LP first day after admission, procedure done within 24 hours after admission) and US$ 24 133–24 624 (inpatient, LP second day after admission, infant/children) When cost was calculated based on ME etiology, infants diagnosed with unknown etiology had the highest associated hospitalization cost of US$ 41 397, followed by	India ink stain US$ 7 ± 10 (0.3 %) Other antigen tests US$ 11 ± 48 (0.4%) Children (1–17 years) Gram stain US$ 33 ± 25 (85.2%) Glucose US$ 13 ± 11 (62.9 %) Protein US$ 14 ± 12 (64.4 %) Cell count and differential US$ 41 ± 49 (51.5%) Bacterial culture US$ 8 ± 20 (53.6 %) AFB culture US$ 40 ± 33 (3.3%) Fungal culture US$ 37 ± 32 (3.6 %)	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				herpes virus (US$ 36 625) and bacterial etiologies (US$ 27 638). For children, herpes virus ME had the highest associated hospitalization cost of US$ 30 906, followed by other viruses (US$ 29 676) and bacterial etiologies (US$ 21 961). The total cost incurred until LP procedure date was highest in the other virus group for infants (US$ 4126) and children (US$ 6413). The highest ICU-related cost was for herpes virus (US$ 46 106) for infants and other virus (US$ 38 485) for children. For infants, the overall medication cost was highest in the herpes virus group (US$ 2792), followed by other virus (US$ 2647) and bacterial groups (US$ 1768). For children,	Antibody tests US$ 69 ± 93 (6.5 %) Any PCR test US$ 88 ± 101 (10.2 %) Cryptococcal antigen US$ 27 ± 15 (0.6%) Viral culture US$ 66 ± 60 (5%) India ink stain US$ 10 ± 7 (1.1%) Other antigen tests US$ 23 ± 24 (0.8%) The median length of hospital stay was greater in both age groups when the LP was performed on the second service day (infants: median 10 days and children 7 days) as compared to 6 days for infants and 4 days for children who received their LP on the first service day	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				the overall medication cost was highest in the other virus group (US$ 4727), followed by herpes virus (US$ 4631) and bacterial groups (US$ 2873). The highest ME-related laboratory test cost was for herpes virus (US$ 501 infants and US$ 463 children) followed by other virus (US$ 474 infant and US$ 247 children.		
Bozzola, 2019 Italy *(26)*	Retrospective analysis 2006–2015	32 Children Hospitalized, ICU	Meningococcal meningitis	The median cost of hospitalization in the acute phase (HAP) was € 12 604 (range € 9203–35 050; mean cost € 14 874). The mean HAP of the 6 patients aged < 1 year was € 17 306, higher than those of the 12 children aged 1–5 years (€ 13 313), the 8 cases aged 5–10 years	Patients had been hospitalized for a mean time of 17 days (range 11–25 days); 14 children required ICU assistance for a mean period of 3 days (range 24–189 hours), which contributed to the increment of the hospitalization costs	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				(€ 15 025) and the 6 patients older than 10 years (€ 14 059). Patients requiring the ICU had higher HAP (€ 17 931) than those hospitalized at the infectious diseases unit (€ 12 496).		
Rampakakis, 2019 Canada *(27)*	Retrospective observational cohort study 1995–2012, costs converted to Can$ 2012	912 Adults Outpatient, Emergency department (ED), hospitalized	Meningococcal meningitis	Mean hospitalization Cost per case Can$ 40 075 (median Can$ 16 927) for IMD cases compared with Can$ 2827 (median Can$ 0) for controls Mean total cost per case during the overall follow-up period Can$ 45 768 –52 631 for IMD cases (median Can$ 20 593–27 462);	Hospitalization was significantly higher among IMD cases even excluding the initial hospitalization for the IMD infection and the 0–30 day period, specifically for 1–6 months (11.2% vs 2.5%), 6–12 months (13.8% vs 6.8%), 12–60 months (16.4% vs 10.9%) and the overall period between 30 days and 60 months (27% vs 14.3%). Acute inpatient care and visits to the intensive care unit and the	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Can$ 5414–11 650 for non-IMD controls (median Can$ 1135–7646) Overall cost for all IMD cases during the study period Can$ 41 740 142–47 999 289 (median Can$ 18 780 907–25 044 979)	emergency room were also significantly higher in the IMD group irrespective of follow-up period examined, while alternative care was only different between groups in the first 6 months of the IMD infection. Medication use was more frequent among IMD cases compared with non-IMD controls, particularly during the acute phase of the disease (4.6% vs 2.3%) but also between 30 days and 60 months (6.8% vs 5.2%). In terms of out-of-hospital outpatient care, visits to the general practitioner's (GP's) office and to a specialist were more frequent among IMD cases compared with controls,

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
					particularly during the acute phase (GP's office: 81.7% vs 28.7%; specialist: 97.9% vs 21.3%) and 1–6 months (GP's office: 72.0% vs 61.8%; specialist: 72.1% vs 48.4%).	
Charalambous, 2018 USA *(28)*	Retrospective cohort study 2000–2012	576 Adults Outpatient, hospitalized	315 (16.35%) coccidioidal meningitis, 146 (7.58%) *Candida* meningitis and 115 (5.97%) *Histoplasma* meningitis	*Coccidioides* meningitis: Average baseline annual cost for a patient 1 year prior to diagnosis US$ 14 287 Average annual expenditure during the year of diagnosis US$ 29 074 Average annual cost over the next 5 years post-diagnosis US$ 10 673	*Coccidioides* meningitis: the length of follow-up ranged from 0.0–11.9 years, with an average follow-up of 2.3 years (SD 2.5). The baseline mean annual LOS was 6.8 days and it peaked during the year of diagnosis (22.7 days), with a subsequent mean of 5 days annually over the next 5 years. Cumulative average LOS of 48.1 days at 5 years after the initial diagnosis year. *Histoplasma*meningitis: The length of follow-up ranged from 0.0–10.9 years, with	The study contains costs and resource use on criptococcal meningitis, which was not added to the extraction table

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Cumulative total cost over 5 years US$ 82 439 *Histoplasma* meningitis: Mean annual hospital cost for patients 1 year prior to diagnosis US$ 15 512 Mean annual cost during the year of diagnosis US$ 23 799 Mean annual cost over the next 5 years post-diagnosis US$ 12 252 Cumulative total cost over 5 years US$ 78 609 *Candida* meningitis: Baseline mean annual hospital cost for a patient 1	an average follow-up of 2.6 years (SD 2.6). The mean annual length of hospital stay 1 year prior to diagnosis (baseline) was approximately 3.9 days. Average annual LOS peaked during the first diagnosis year (39.3 days), subsequently averaging 2.1 days annually over the next 5 years. Cumulative average LOS was 49.8 days at 5 years after the initial diagnosis year. *Candida* meningitis: The length of follow-up ranged from 0–7.7 years, with an average follow-up of 1.5years (SD 1.7). The baseline mean annual LOS 1 year prior to diagnosis was 31.6 days. The average annual LOS peaked during the first diagnosis year	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				year prior to diagnosis US$ 38 929 Mean annual cost during the year of diagnosis US$ 51 304 Mean annual cost over the next 5 years post-diagnosis US$ 10 500 Cumulative total cost over 5 years US$ 103 803.	(60.9 days) and averaged 3.6 days annually over the next 5 years. Cumulative average LOS was 79.0 at 5 years after the initial diagnosis year.	
Gustafsson, 2018 Denmark *(29)*	National registry-based, matched control study 1997–2015, converted to 2015 US$	Primary target study population: 6495 Children and adults Primary target study population:	*N. meningitidis*	The differences in actual costs between cases and controls were most profound in the baseline year (case: US$ 3834; control: US$ 1742) and especially in the first year after the meningococcal diagnosis (case: US$ 16 641; control: US$ 1426). Hospital	The average attributable costs per patient were highest in the first year after the meningococcal diagnosis (US$ 18 920 for the primary study population and US$ 16 169 for the secondary study population) and negative in the following years. The negative costs in years 2–4	Exhaustive data for costs can be found in the text of the article. However, it was not extracted due to the amount. The "cost" section reports the main characteristics. Average direct costs were estimated as the average actual costs among patients with meningococcal disease in a

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
		2165 cases and 4330 controls Secondary target study population: 1788 Secondary target study population (those who had an identifiable sibling with ≤ 5 years' age difference): 894 cases and 894 sibling controls Outpatient, hospitalized		admission costs were the main driver in the first year after diagnosis (89%). In both the primary and secondary study populations, the adult patients (i.e. patients aged 20–25 years or 25+ years at the time of the meningococcal diagnosis) had the highest average costs following their diagnosis. These groups were followed by the rather large group of adolescents, aged 15–19 years, with an average actual cost per patient in the first year of US$ 16 335. However, the costs in year 1 relative to the baseline year were approximately 10 times higher for the age group 11–19 years, whereas the	after diagnosis were associated with the observed high average actual costs among cases in the baseline year, which may be explained by more prior comorbidities in the meningococcal population compared with controls (data not shown).	given year minus the average actual costs among controls in the same year. Average total costs were defined as the average actual costs in year after the diagnosis minus the average actual costs in the baseline year. The average attributable costs were estimated by applying a difference-in-difference approach, where the average total costs among individuals in the control groups were subtracted from the average total costs among patients with meningococcal disease.

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				equivalent relative increases in the age groups 20–25 years and 25+ years were approximately 5 and 3, respectively. The average direct costs for cases were highest the first year after the meningococcal diagnosis (primary study population: US$ 15 215; secondary study population: US$ 13 833). In the 2nd, 3rd, 4th and 5th years after the diagnosis, the costs were all lower than the costs in the baseline year. Based on the data in this study, a conservative estimate of this burden, on the one hand, showed that the total costs added up to slightly more than US$ 1.5 million per year in 2017,		

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				increasing to slightly more than US$ 1.7 million per year in 2060, including losses due to premature deaths. A higher and less conservative estimate, on the other hand, shows that the total costs added up to slightly less than US$ 4.1 million per year in 2017 and slightly more than US$ 4.6 million per year in 2060, including losses due to premature deaths.		
Soucek, 2017 USA *(30)*	Retrospective cohort study 2015	33 Adults Hospitalized	Bacterial, viral	Median cost of antimicrobial treatment in the standard-of-care (SOC) group was US$ 63.43 (US$ 2.04–388.71) per patient treatment course. If testing was performed using the BioFire FAME, the median cost of antimicrobial treatment US$ 24.70 (US$ 0–206.98).	Median length of stay in days, (range) 8.1 (1.65–28.8) Empiric therapy, n (%) Beta-lactam 25 (76%) Vancomycin 23 (70%) Ampicillin 6 (18%) Other antibiotic 4 (12%) Acyclovir 21 (64%)	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				When including the cost of diagnostic testing, the median cost per patient using the SOC was US$ 239.63 (US$ 178.24–564.91) per treatment course vs US$ 239.14 (US$ 214.44–421.42) if testing was performed using the BioFire FAME.		
Gil-Prieto, 2016 Spain *(31)*	Retrospective epidemiological study utilizing national hospital discharge data 2011	NR Adults Hospitalized	Pneumococcal	Pneumococcal meningitis for people aged ≥ 18: € 13 286;18–64: € 12 884; ≥ 65: € 13 880	NR	
Baldo, 2015 Italy *(32)*	Retrospective observational study using secondary data analysis	225 Neonates, children and adults	Pneumococcal	An average cost was € 8239 per patient	Mean hospital stay (days) 16.9 ± 16.2	The estimated incidence of *S. pneumoniae*-related hospital admissions was 0.9/100 000 for meningitis

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	2008–2012	Hospitalized				
Wang, 2014 Australia *(33)*	Retrospective study 2000–2011, converted to $A 2011	26 Children Hospitalized	*N. meningitidis*	Inpatient costs per patient during acute hospitalization $A 10 924.5 ($A 8722.3–14 042.5)	LOS (days) per patient during acute hospitalization Mean 7.1 (5.7–10.1)	
Wu, 2014 Taiwan, China *(34)*	Retrospective analysis 2002–2009, converted to NT$ 2009	6 in 2010, total not specified Adults Hospitalized	*S. pneumoniae*	Direct cost per case: Age: 50–64, NT$ 273 293; 65–74, NT$ 193 528; 75–84, NT$ 344 621; > 85, NT$ 203 359	NR	
Nigrovic, 2013 USA *(35)*	Retrospective multicentre cross-sectional study	10 329 visits, suspected viral meningitis 7618, viral meningitis	Viral meningitis	Overall cost per child US$ 5363 (IQR US$ 3967–7444) Total costs for children aged < 3 years were higher than those for children aged > 3 years (median of	Median LOS: 2 days (IQR 1–3 days) for children aged ≥ 3 years; and median LOS: 2 days (IQR 2–3 days) for children aged < 3 years; 1837 children (24%) had cranial computed	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
	2005–2011, converted to US$ 2011	Neonates and children Outpatient, ED, hospitalized		US$ 5429, IQR US$ 4050–7377 for children aged < 3 years vs US$ 4536, IQR US$ 2748–6771 for children aged > 3 years) The median cost per child with viral meningitis was ~US$ 4000 higher for hospitalized children compared with those discharged from the ED (US$ 1371, IQR US$ 984–1825 for discharged patients)	tomography (CT) scan performed: 1457 (43%) for children aged ≥ 3 years, 267 (19%) for children aged 61 days to 3 years, 113 (4%) for children aged ≤ 60 days; 6472 children (85%) were treated with parenteral antibiotics: third-generation cephalosporins (n = 6141, 95%), ampicillin (n = 2569, 40%) and vancomycin (n = 1539, 24%); 2329 (68%) for children aged ≥ 3 years, 1329 (96%) for children aged 61 days to 3 years, 2814 (99%) for children aged ≤ 60 days; 1611 children (21%) were treated with acyclovir: 326 (10%) for children aged ≥ 3 years, 242 (18%) for children aged 61 days to 3 years, 1043 (37%) for children aged ≤ 60 days; 341 children (4%) were	

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					treated with corticosteroids: 248 (7%) for children aged ≥ 3 years, 58 (4%) for children aged 61 days to 3 years, 35 (1%) for children aged ≤ 60 days Viral testing (viral antibody unspecified; other specified viral culture; other specified meningitis bacteria; or viruses, unspecified) was performed in 1825 children (24%): 751 (22%) for children aged ≥ 3 years, 375 (27%) for children aged 61 days to 3 years, 699 (25%) for children aged ≤ 60 days. LPs performed in the ED (n/% of all ED visits/% with viral meningitis [study year]):	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
					17 878/1.20%/8.1% (2005); 18 052/1.09%/6.5% (2006); 20 817/1.04%/5.5% (2007); 19 901/0.91%/6% (2008); 19 538/0.72%/5.2% (2009); 17 248/0.67%/5.6% (2010); 16 900/0.63%/4% (2011)	
Davis, 2011 USA *(36)*	Retrospective analysis 2000–2007, converted to US$ 2009	1536 (895 Nationwide Inpatient Sample (NIS); 504 Perspective Comparative Database (PCD); 137 LifeLink) Neonates, children and adults Hospitalized, ICU	Meningococcal	Meningococcal meningitis Facility costs US$ 17 085 Repeat hospitalizations US$ 9827 Emergency room visits US$ 190 Physician office visits US$ 782 Lab orders US$ 224 Prescription drugs US$ 807 Total costs US$ 56 202	Meningococcal meningitis Non-facility costs US$ 23 110 Skilled nursing facility care US$ 449 Other outpatient/ancillary care US$ 3729 LOS in the NIS and PCD: 8.4 days and 8.8 days, respectively ICU: 1.8 days	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Davis, 2011 USA *(37)*	Retrospective cohort case–control analysis 2006, converted to US$ 2009	424 Neonates, children and adults Hospitalized	Meningococcal	Approximate costs: Age category (years) All admissions US$ 20 000 < 1 US$ 28 000 1–4 US$ 11 000 5–10 US$ 18 000 11–18 US$ 18 000 19–20 US$ 26 000	Adjusted mean length of stay (range) All admissions 6.19 days (5.7–6.68) By age < 1 year: 8.03 days (6.48–9.58) 1–4 years: 4.92 days (4.42–5.42) 5–10 years: 5.60 days (4.64–6.56) 11–18 years: 5.93 days (5.53–6.33) 19–20 years: 7.68 days (6.23–9.13)	
Davis, 2011 USA *(38)*	Retrospective analysis	173 Adults, children	*N. meningitidis*	Overall unadjusted health-care costs were approximately twice as high for patients with complicated IMD compared with patients	NR	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
	1998–2008, adjusted to US$ 2009	Outpatient, hospitalized, ICU		with uncomplicated IMD (mean: US$ 77 216 [US$ 134 323] vs US$ 40 726 [SD: US$ 110 374]). In comparison to patients with uncomplicated IMD, patients with complicated IMD had significantly higher inpatient costs (mean: US$65 013 [SD US$ 122 510] vs US$ 34 015 [SD US$ 98 880]) and total number of inpatient days observed during the follow-up period.		
Karve, 2011 USA *(39)*	Longitudinal retrospective cohort analysis 1997–2009, converted to US$ 2009	343 Adults Not specified	*N. meningitidis*	Overall unadjusted health-care costs were more than 3 times higher for patients with complicated IMD compared with patients with uncomplicated IMD (mean: US$ 99 743 [SD US$ 172 815] vs US$ 31 839 [SD	NR	This study provides previously unavailable information on the increased health-care utilization and associated costs observed among IMD patients with serious sequelae. Increasing the rates of or access to

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				US$ 32 177]; *P* < 0.001). Inpatient hospitalizations were the largest cost driver for both groups. In comparison with patients with uncomplicated IMD, patients with complicated IMD had significantly higher inpatient costs (mean [SD]: US$ 74 879 [US$ 155 443] vs US$ 24 299 [US$ 28 741]; *P* < 0.001) and higher total number of inpatient days observed during follow-up (mean: 25.6 days [SD 42.3 days] vs 8.1 days [SD 11.3 days]; *P* < 0.001). Compared with patients without an IMD- related sequelae, patients with at least 1 IMD-related sequelae had 50% more inpatient admissions during follow-up (incidence rate ratio: 1.5; 95% CI 1.3–1.9; *P* < 0.001), which		vaccination across all age groups should help lower the incidence of IMD, thereby reducing morbidity and mortality and subsequently lowering the economic and clinical burden exerted by IMD survivors on the USA's health-care system. The data also provide needed information on the prevalence of specific sequelae among patients with IMD. The study findings therefore may serve as a useful resource for policy-makers and researchers in designing and conducting cost-effectiveness analysis of vaccination programmes.

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				resulted in US$ 46 808 (95% CI US$ 42 442-$51 174; *P* < 0.001) in additional associated costs. 3.1 times higher (incidence rate ratio: 3.1; 95% CI 2.4–4.0; *P* < 0.001), with US$ 9372 (95% CI US$ 8426–10 317; *P* < 0.001) in additional associated costs. After adjusting for covariates, the predicted all-cause costs per patient during the 12-month follow-up period remained approximately 3 times higher for patients with complicated IMD compared with patients with uncomplicated IMD (mean: US$ 96 825 [95% CI US$ 88 659–104 993] vs US$ 32 414 [95% CI US$ 30 825–34 003]). Finally, the risk of rehospitalization following		

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				discharge after the initial IMD admission was higher among patients with complicated IMD (hazard ratio 1.7; 95% CI 1.0–2.7; P = 0.34) compared with patients with uncomplicated IMD (tabular data available upon request).		
Mongelluzzo, 2010 USA *(40)*	Retrospective cohort study 2001–2006	2319 Children Hospitalized	269 children had meningococcal meningitis and 470 children had pneumococcal meningitis	Median charges per hospital ranged from US$ 20 158 to $53 823 Comparison of total hospital charges by complication type: No complication (n = 1745) US$ 27 110 (US$ 15 823–48 307) Systemic (n = 423) US$ 66 690 (US$ 39 546–136 756)	The median LOS was 9 days (IQR 6–15 days) Comparison of LOS in days by complication type: 5% of children had a LOS > 42 days No complication (n = 1745) 9 days (IQR 6–14 days) Systemic (n = 423) 14 days (IQR 9–23 days) Focal infection (n = 95) 13 days (IQR 9–28 days)	In multivariate analyses, the presence of systemic conditions, associated focal infections or both conditions was independently associated with significantly higher total in-hospital charges. When conditions were considered individually, bone and joint infections (213% increase; 95% CI 113–260%), endocarditis (108% increase; 95% CI 23–258%), and pneumonia (107% increase; 95% CI 58–

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Focal infection (n = 95) US$58 016 (US$ 29 056–125 813) Both (n = 56) US$ 130 744 (US$ 62 397–299 288) Costs adjusted for age category, race, sex, vancomycin receipt and adjuvant corticosteroid therapy: Systemic US$ 136 (US$ 108–269) Focal infection US$ 118 (US$ 77–168) Both US$ 351 (US$ 237–503)	Both (n = 56) 21.5 days (IQR 12–45 days) LOS in days adjusted for age category, race, sex, vancomycin receipt and adjuvant corticosteroid therapy: Systemic 72 days (IQR 51–96 days) Focal infection 78 days (IQR 40–126 days) Both 211 days (IQR 142–303 days)	171%) were associated with the highest increases in total hospital charges. Systemic inflammatory response syndrome (SIRS) and mastoiditis were not associated with higher hospital charges. In multivariate analyses, the presence of systemic conditions, associated focal infections or both conditions was independently associated with a significantly longer LOS. Endocarditis (152% increase; 95% CI 60–300%) and pneumonia (136% increase; 95% CI 85–201%) were associated with the greatest adjusted increases in LOS; only mastoiditis was not associated with an increased LOS compared

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
						with those without complications.
Clarke, 2009 USA *(41)*	Retrospective analysis 1988–2004	545 Neonates, children and adults Hospitalized	Bacterial (*N. meningitidis*: 122 [30.4%] were found to be serogroup B, 113 [28.2%] were serogroup C, 93 [23.2%] were serogroup Y, 15 [3.7% were serogroup W-135, and 1 [0.3%] was serogroup X; 57 [14.2%] were not able to be grouped)	Total hospital charges > US$ 1.7 million Mean hospital charges were US$ 37 724 (median US$ 18 393, range US$ 776–269 367)	NR	
O'Brien, 2006 USA *(42)*	Retrospective analysis 1999–2001, converted to US$ 2003	751 Neonates, children and adults ED, hospitalized	*N. meningitidis*	Cost of stay: Fatal cases Mean US$ 17 113 Median US$ 11 180 Nonfatal cases:	Mean LOS (days): Fatal cases 2.5 Nonfatal cases 7.7	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Mean US$ 17 394 Median US$ 12 145		
King, 2004 Australia *(43)*	Population-based retrospective study 1990–2000, indexed to $A 2000	94 Neonates and children Hospitalized and ICU	Pneumococcal meningitis	Average cost per patient in 1996 was $A 11 316. Average cost per patient in 1997 was $A 7229. Average cost per patient in 1998 was $A 15 052. Average cost per patient in 1999 was $A 41 221. Average cost per patient in 2000 was $A 23 035.Average cost per patient in total between 1996 and 2000 was $A 19 878.	The median duration of initial hospital admission was 11.6 days (range 1.5 hours to 68.7 days)	This report demonstrates the difficulties of diagnosis of pneumococcal meningitis and provides evidence of high resource requirement in affected children during their acute hospital admissions, with ICU stays for almost half. Their hospital admissions are long and expensive. There are frequent in-patient complications including nosocomially-acquired infections. Mortality is high at 8.5% with significant persistent morbidity in 26.6%. Now that the option of vaccination and prevention of invasive pneumococcal disease exists, and as antibiotic resistance continues to rise in

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
						Australia, prevention is a better option than treatment.
Khetsuriani, 2003 USA *(44)*	Retrospective national data analysis 1988–1999	865 058 (hospitalizations) Children and adults Hospitalized	Viral 434 195 (50.2%) Bacterial 200 234 (23.1%) Fungal 80 325 (9.3%) Unspecified 157 138 (18.2%)	NR	Average hospital stay of 9.4 days (SE 0.35; median, 4 days)	Using the National Hospital Discharge Survey (NHDS) data, there was an estimated average of 72 000 meningitis-associated hospitalizations per year between 1988 and 1999. The largest proportion of these, just over 50%, can be attributed to viral meningitis, with an estimated average of 36 000 hospitalizations and 175 000 hospital days each year.
Petit, 2003 Canada *(45)*	Retrospective population-based analysis	63 Children	Pneumococcal meningitis	Unitary costs per child (excluding costs of permanent sequelae): To health system Can$ 10 281	NR	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
	1997–1998, converted to Can$ 2000	Hospitalized		To families Can$ 1424 To society Can$ 11 705 The economic burden (excluding costs of sequelae): Costs to health system Can$ 649 000 Costs to families Can$ 97 000 Costs to society Can$ 746 000		
Pichichero, 1998 USA *(46)*	Prospective multicentre study 1994	2 Children Outpatient	Aseptic meningitis associated with enterovirus	Diagnosis (number of patients): Physician office visit for diagnosis n = 2 Physician office visit before diagnosis n = 0 Second physician visits after diagnosis n = 1 (50%)	Indirect costs: Physician office visit US$ 22 Emergency department visit US$ 44 Physician return visit US$ 22 Sick-child care US$ 95 Adolescent lost wages US$ 0	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
				Emergency department visit n = 2 (100%) Complete blood count n = 1 (50%) Radiographs n = 1 (50%) Symptomatic prescription n = 1 (50%) Antibiotics n = 1 (50%) Over-the-counter prescribed n = 1 (50%) Average direct costs/case US$ 771	Parent lost wages US$ 176 Grand total US$ 422	
Bent III, 1994 USA *(47)*	Retrospective analysis 1986–1991	470 Neonates and children Hospitalized	Bacterial: Hib, pneumococcal, streptococcal, and staphylococcal meningitis	Average cost per day was US$ 940	Average LOS was 12 days	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
Froehlich, 1991 USA *(48)*	Retrospective observational study 1987	105: Bacterial meningitis 58; aseptic meningitis 47 Outpatient, hospitalized	Bacterial *H. influenzae* (37 cases), *S. pneumoniae* (10 cases) *N. meningitidis* (5 cases), *S. agalactiae* (3 cases), *E. coli* (2 cases), and group D streptococcus (1 cases) Aseptic meningitis included both viral meningitis (41 cases) and meningitis of unspecified cause (4 cases)	The mean charges for aseptic meningitis and bacterial meningitis were US$ 2534 and US$ 6499, respectively Total charges for each admission correlated with the length of stay; however, daily charges were similar for patients in each category (US$ 713 for bacterial meningitis, US$ 721 for aseptic meningitis)	LOS in the hospital was 10.5 days	
DeAngelis, 1983	Observational retrospective	47: bacterial meningitis 7;	Bacterial	The average cost of hospitalization for infants admitted for the year 1979–1980 was US$ 2130	Mean hospitalization LOS (range)	

First author, year Country/area of conduct	Study design Study period	No. of participants Population Setting	Etiology	Costs	Other reported resources	Notes
USA *(49)*	1978–1981	aseptic meningitis 40 Hospitalized		per infant, with a range from US$ 1480 for those with aseptic meningitis to US$ 6345 for those with bacterial meningitis. On average, 25.6% of the bill was for diagnostic studies and 8.3% was for paediatricians' fees.	Bacterial meningitis 19.0 days (15–28) Aseptic meningitis 19.0 days (3–16)	

AFB: acid-fast bacillus; BM: bacterial meningitis; CI: confidence interval; CSF: cerebrospinal fluid; ED: emergency department; FAME: FilmArray® Meningoencephalitis; GP: general practitioner; HAP: hospitalization in the acute phase; HHV-6: human herpes virus 6; HSV: herpes simplex virus; ICU: intensive care unit; IMD: invasive meningococcal disease; IQR: interquartile range; LOS: length of stay; ME: meningoencephalitis; MRSA: Staphylococcus aureus; NHDS: National Hospital Discharge Survey; NIS: Nationwide Inpatient Sample; NR: not reported; OOPE: out-of-pocket expense; PCD: Perspective Comparative Database; PCR: polymerase chain reaction; SE: standard error; SIRS: systemic inflammatory response syndrome; SOC: standard-of-care.

3.3 Included studies: Costing studies with effect measures

Table WB.II.3 Costing studies with effect measures

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
Acuña, 2022, Chile HIC *(50)*	Analytical observational study, using a retrospective cohort for prior to the intervention and a prospective cohort for post-intervention period	409: 297 pre-intervention; 112 post-intervention Neonates and children Outpatient, ED, hospitalized, ICU	*Streptococcus pneumoniae* *Neisseria meningitidis* *Streptococcus agalactiae* *Escherichia coli* *Staphylococcus epidermis* *Staphylococcus aureus* *Streptococcus parasanguinis* *Enterococcus faecalis*	The FilmArray Meningoencephalitis (FAME) panel; the study's objective was to compare the etiological identification and hospitalization costs among patients with suspected central	Quality (greater sensitivity in identifying the etiology of central nervous system [CNS] infections)	The increase in positive identification of the etiology in CNS infections. Under age 6 months the cerebrospinal fluid (CSF) positivity increased significantly from 2.6 to 28.1% when the use of	Only descriptive statistics were used	The unit cost of this diagnostic technique (FAME) averaged US$ 191 per sample	NR	There was no significant difference in the use of antibiotics upon admission to the hospital, but there was a difference in the use of antivirals, with a greater use recorded in the post-	Each patient in whom a CNS infection was suspected routinely underwent a lumbar puncture (LP), from which 3 samples were obtained Testing costs were not

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
	2016–2018, converted to US$ 2021		*Streptococcus pyogenes* Enterovirus Parechovirus Herpes implex virus (HSV)1 Varicella-zoster virus (VZV) Cytomegalovirus (CMV) Human herpes virus 6 (HHV-6) *Haemophilus influenzae*	nervous system (CNS) infection before and after the use of FAME		FAMEs was incorporated. This was also observed when only CSF with altered cytology was analysed (9.7 and 42.3%). Older than 6 months the CSF positivity was 5.9% to 20.8%, CSF with altered cytology 8.8% to 23.1%. The use of FAME was available 24 hours a day				intervention period Pre-intervention/ post-intervention Use of antibiotic on admission 187 (63.4%)/68 (61.3%) Use of antivirals on admission 30	analysed due to standardized hospital protocols in suspected CNS infection; all patients received the same laboratory exploration, so it is not a variable ICU admission criteria were based on the Paediatric Index of

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
						during business and non-business hours, and the processing of samples took only 65 minutes. Routine real-time polymerase chain reaction (PCR) is processed only during business hours, and the response time is up to 48 hours.				(10.1%)/28 (25.0%) CT scan performed 64 (21.5%)/38 (33.9%) Remote neural monitoring (RNM) performed 33 (11.1%)/21 (18.7%) Electroencep halogram (EEG) performed 74	Mortality (PIM) The most frequent discharge diagnoses in the post-intervention period were CNS infections, seizures and epilepsy (all related to the CNS), unlike the diagnoses from the pre-intervention period, which were most

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
						The difference in total bed-days (intensive care unit [ICU]/basic bed) was not statistically significant, which is demonstrated in a marginal difference in costs. However, a significant difference in ICU bed-days was found in favour of the use of FAME.				(24.9%)/44 (39.3%). 297 pre-intervention and 112 post-intervention	frequently fever without an identified source and infection

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
						Number of basic bed-days: Pre-intervention: number of tests = 1908 Total cost US$ 106 848 for public health insurance bed-day; US$ 1 267 200 private bed-day cost (average costs of Chilean private				Pre-intervention: 85.5% required hospitalization (ICU 14.8%, median days ICU 3.5 days) Post-intervention: 92.7% required hospitalization (ICU 28.6%, median days ICU 2 days) In both groups, the	In the pre-intervention period, the molecular results showed a viral etiology in 3.4% of the CSF samples analysed; however, in the post-intervention period, positivity increased to 16.07%, identifying viruses with $P < 0.05$

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
						health institutions) Post-intervention: number of tests = 613 Total cost US$ 34 328 for public health insurance bed-day; US$ 392 320 private bed-day cost (average costs of Chilean private health institutions)				median paediatric index of mortality (PIM) score was 1.2 (IQR 0.6–2.8)	The overall positivity (any positive microbiologic al test) was 9.4% in the pre-intervention period and 26.8% in the post-intervention period ($P < 0.001$)

First author, year Study period Country Level of income	Study design	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
						Costs savings US$ 72 540 for public health insurance bed-day; US$ 874 880 private bed-day cost (average costs of Chilean private health institutions) Number of ICU bed-days: Pre-intervention:					

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						number of tests = 686 Total cost US$ 166 698 for public health insurance bed-day; US$ 699 720 private bed-day cost (average costs of Chilean private health institutions) Post-intervention:					

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						number of tests = 125 Total cost US$ 30 375 for public health insurance bed-day; US$ 127 500 private bed-day cost (average costs of Chilean private health institutions) Costs savings US$ 136 323 for public health insurance bed-					

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						day; US$ 572 220 private bed-day cost (average costs of Chilean private health institutions) Use bed-days per patient Basic bed-days: Pre-intervention: number of tests = 7.5					

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						Total cost US$ 420 for public health insurance bed-day; US$ 4800 private bed-day cost (average costs of Chilean private health institutions) Post-intervention: number of tests = 5.8 Total cost US$ 325 for					

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						public health insurance bed-day; US$ 3712 private bed-day cost (average costs of Chilean private health institutions) Costs savings US$ 95 for public health insurance bed-day; US$ 1088 private bed-day cost (average costs of Chilean private health institutions)					

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						ICU bed-days: Pre-intervention: number of tests = 15.5 Total cost US$ 3767 for public health insurance bed-day, US$ 15 810 private bed-day cost (average costs of Chilean private					

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						health institutions) Post-intervention: number of tests = 3.5 Total cost US$ 851 for public health insurance bed-day, US$ 3570 private bed-day cost (average costs of Chilean private health institutions)					

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						Costs savings US$ 2916 for public health insurance bed-day, US$ 12 240 private bed-day cost (average costs of Chilean private health institutions)					
Morrison, 2022, USA HIC *(51)*	Retrospective cross-sectional study 2017–2019	202 Adults Hospitalized, ICU	HSV VZV Enterovirus Cryptococcus VDRL	The appropriateness of initial CSF laboratory testing	Cost	Infectious disease consult prior to LP and meningitis indication for LP were independently associated with	Only descriptive statistics were used for these costs	NR	NR	Total number of CSF tests: 324 (non-ICU n = 90), 200 (ICU n = 38)	Inappropriate CSF laboratory testing was defined as any initial CSF test ordered outside of

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			CMV Epstein-Barr virus Toxoplasma AFB culture Fungal culture Lyme serology West Nile serology JC virus			a reduction in inappropriate CSF test orders: adjOR 0.28, 95% CI and adjOR 0.18 Cost analysis for excessive meningitis testing per patient was US$ 229.50 (153–382.50) and US$ 382.50 (229.50–535.50) in non-ICU and ICU, respectively				Number of excessive tests: 324 (100% non-ICU), 200 (100% ICU) Number of inadequate tests: 0 (0%, non-ICU), 0 (0%, ICU)	algorithm criteria prior to results of CSF fluid analysis Electronic medical record decision support to cancel molecular tests for patients with ≤ 10 white blood cells count (WBCs) in CSF analysis may be a helpful strategy to

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											mitigate unnecessary test ordering and false positive tests in this population. Some of the costs and resources were not included as these were only attributable to patients with documentation of both meningitis

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											and encephalitis
Alghounaim, 2020 Canada HIC *(52)*	Single-center model-based analysis of a retrospective cohort 2013–2017, converted to Can$ 2018	153 Neonates and children Patient with suspected enterovirus (EV) meningitis in the observed cohort of children with send-out testing to those of the simulated cohort of children using	*S. pneumoniae* *N. meningitidis* *S. agalactiae* *E. coli* *Staphylococcus epidermis* *S. aureus* *S. parasanguinis* *E. faecalis* *S. pyogenes* Enterovirus Parechovirus HSV1 VZV Cytomegalovirus (CMV)	Performing EV PCR testing of CSF locally compared to sending specimens to a reference laboratory	Cost	Same-day turnaround time (TAT) would decrease mean LOS by 0.50 days and intravenous antimicrobial duration by 0.67 days Same-day TAT for EV CSF PCR would save Can$ 342.83 per patient tested for suspected EV	Economic sensitivity analyses of the estimated mean differences in LOS and duration of antimicrobial use	NR	Capital costs for implementing in-hospital testing (i.e. acquisition of new instruments/ platforms) were not included	Median LOS was 5 days (IQR 3–12); most patients (86%) received intravenous antibiotics and 39% received intravenous acyclovir, with mean durations of 5.72 and 4.45 days, respectively	Blood and CSF specimens for EV PCR testing were forwarded to the reference lab (CHU Sainte-Justine, Montreal, Quebec, Canada) every working day at 08:00. Specimens received after 08:00 Friday

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		retrospective data Day centre, hospitalized, ICU	HHV-6 *H. influenzae* HSV VZV Enterovirus Cryptococcus VDRL CMV Epstein-Barr virus Toxoplasma AFB culture Fungal culture Lyme serology West Nile serology JC virus			infection (Can$ 13 113.42 annually) EV CSF PCR+ patients, estimated reductions in LOS, and antimicrobial duration were 1.75 and 2.32 days, respectively In sensitivity analyses, savings varied between Can$ 483.83 per patient to				Mean TAT for EV CSF PCR was 6.26 days	through Sunday were frozen at -70 °C and sent on the following Monday

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						Can$ 217.83 per patient when the cost per test ranged between Can$ 34 and Can$ 300, respectively, assuming test performance was the same between different assays Savings increased if testing was limited to patients with CSF pleocytosis (Can$ 555.44					

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						per patient) or to infants aged < 60 days (Can$ 571.00 per patient) Savings decreased to Can$ 90.73 per patient if test TAT was extended to 48 hours					
Cailleaux, 2020 France	Single-centre prospective observational study 2016–2017	130 Adults Hospitalized, ICU (n = 8,	Enterovirus (n = 12) VZV (n = 7) HSV-2 (n = 6)	Impact of a commercial multiplex PCR assay (FAME) on the management of patients with	Both	Multiplex PCR meningitis/encephalitis results were positive in 33 (25%) of patients; direct examination	Medico-economic evaluation of potential impact of systematic use of the meningitis/en	Unitary cost of the multiplex assay (€ 180 during the study period), the hospitalizati	Cost of unnecessary imaging and biological tests that were used without PCR	Seventy-three patients (56%) received at least 1 intravenous anti-infective agent for	Patients had a suspicion of meningitis or encephalitis and a confirmed

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HIC *(22)*		6%), ED (n = 55, 42%)	*L. monocytogenes* (n = 3) *C. neoformans/ gattii* (n = 2) *H. influenzae*, HHV-6 and HSV-1, n = 1 patient each	suspected meningitis or encephalitis, in terms of time to diagnosis, antimicrobial agents use, duration of hospitalization and costs		and bacterial culture were positive in 4 (3%) and 8 (6%) of patients, respectively	cephalitis panel multiplex PCR assay for patients suspected of meningitis	on stay and the mean daily cost of hospitalization during the study period (€ 1265 in a conventional medicine department and € 1710 in ICU)	were not included	suspected CNS infection, mostly aciclovir (n = 58, 44%), amoxicillin (n = 34, 26%) and/or a third-generation cephalosporin (n = 26, 22%)	biological meningitis
						Compared with routine CSF tests, multiplex PCR meningitis/encephalitis testing was estimated to			Cost of anti-infective treatment, their monitoring, the adverse events and human	Median length of hospital stay was 6 days	Joint validation was conducted by a microbiologist and an infectious

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						have reduced time to diagnosis by a mean of 3.3 days (± 1.6 days) in patients with microbiological documentation, compared with routine tests Multiplex PCR meningitis/encephalitis allowed an early diagnosis of *L. monocytogenes* meningitis (diagnosis			resources were also not included		disease specialist, tested with biological tests (direct examination with WBCs, protein and glucose levels, Gram stain, cultures on standard media and meningitis/encephalitis panel multiplex PCR assay, and, FAME

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						delay, 1 hour), whereas diagnosis delay would have been at least 48 hours by routine tests (i.e. CSF direct examination was negative, and CSF culture was positive after 48 hours incubation) A diagnosis of *H. influenzae* meningitis would have been undocumented without					Due to its single-centre design, the findings may not be generalizable, especially for the comparison of time to diagnosis with routine tests, as the turnaround times may differ largely from one site to another due to pre-analytical (e.g. distance from the

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						multiplex PCR meningitis/ encephalitis panel, as CSF direct examination and culture returned negative The use of multiplex PCR meningitis/ encephalitis test during a year in the hospital was associated with a reduced cost of € 49 000 through decreased					clinical department to the laboratory in charge of CSF tests, permanent access to a 24/7 molecular biology platform) and post-analytical factors (working hours in the lab, transmission of results to the

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						duration of hospital stay, at the expense of € 22 958 (multiplex PCR tests acquisition cost), for the 130 patients enrolled (overall saving of € 26 242 (49 000–22 958) or € 201 per patient) Earlier discontinuation of empiric anti-infective drugs in 42 patients					physicians in charge)

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						(32%), a reduced hospital stay in 23 patients (18%), resulting in an estimated reduction of 82 hospital days overall					
Fulton, 2020, USA HIC *(53)*	Exploratory analysis using a retrospective cohort 2010–2014, converted to US$ 2014	23933 Neonates, children and adults Age (n): < 1 year n = 2836;	NR	Advanced diagnostic testing for patients hospitalized with meningitis	Cost	Expenditures that could be impacted by an advanced diagnostic test, as amounts paid are usually significantly lower than charges. The break-even	Statistical analysis of patient subgroups expenditures according to the type of spending	Inpatient expenditures: General floor (n = 23 933) mean US$ 24 814 (SD US$ 67 162)	NR	Mean LOS per hospitalization (not per episode, which may include 2 or more hospitalizations) for patients with	A patient who had 2 or more hospitalizations with meningitis during a 180-day period was counted as 1 episode (16% of the

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		1–4 years n = 488; 5–19 years n = 3193; 20–44 years n = 9499; 45–64 years n = 7917 Male 11 485, Female 12 448 Hospitalized, ICU (n = 5894), outpatient (n = 18 600)				percentage reduction of the mean remaining health-care expenditures 5 days after the subgroup-defining event for patients hospitalized with meningitis (as the probability of the test changing care increases, the percentage reduction in mean remaining expenditures		ICU (n = 5138) mean US$ 4804 (SD US$ 28 541) Physician services (n = 22 846) mean US$ 1554 (SD US$ 2616) Prescription drugs (n = 17 440) mean US$ 4335		meningitis was 7.6 days	meningitis episodes) Given that it was not possible to reliably classify whether prescription drugs were related to the episode, only a 7-day look-back period was used for prescription drugs, and all subsequent prescription drug utilization

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						to break even decreases): LOS > 2 days: Remaining health-care expenditures (mean) US$ 18 325 Percentage reduction in mean remaining health-care expenditure needed to break even (with probability of change care): > 100% (1%), > 100% (5%),		(SD US$ 15 478) Diagnostic tests (n = 14 829) mean US$ 1145 (SD US$ 3851) Rehabilitation (n = 316) mean US$ 240 (SD US$ 3249) Subtotal (n = 23 933) mean			during the hospitalization was assumed to be related to the episode. Only a 30-day post-discharge period was used for prescription drugs related to the episode and all prescription drug utilization was assumed to be related

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						> 100% (10%), 73% (15%), 55% (20%)		US$ 36 891 (SD US$ 92 636)			to the episode.
						ICU stay: Remaining health-care expenditures (mean) US$ 34 221		Outpatient expenditures:			The health-care expenditure measure included the amount paid by the insurer plus the amount paid by the patient via cost sharing
						Percentage reduction in mean remaining health-care expenditure needed to break even (with probability of		Before hospitalization (n = 5605) mean US$ 316 (SD US$ 2998)			
								Outpatient hospital visits (n = 3128) mean			ICU expenditures could usually be separated from general

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						change care): > 100% (1%), > 100% (5%), 58% (10%), 39% (15%), 29% (20%) Neurosurgical procedure: Remaining health-care expenditures (mean) US$ 83 337 Percentage reduction in mean remaining health-care expenditure		US$ 269 (SD US$ 2452) Physician visits (n = 7998) mean US$ 59 (SD US$ 134) Physical therapy (n = 324) mean US$ 26 (SD US$ 480) Prescription drugs (n = 13 568) mean			floor expenditures, which was the case for 5138 of the 5894 patients with meningitis who had an ICU stay

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						needed to break even (with probability of change care): > 100% (1%), 48% (5%), 24% (10%), 16% (15%), 12% (20%) HIV-1 or transplant: Remaining health-care expenditures (mean) US$ 83 337 Percentage reduction in		US$ 343 (SD US$ 2292) Subtotal (n = 18 600) mean US$ 1013 (SD US$ 4664) Total (n = 23 933) mean US$ 37 904 (SD US$ 93 138) US$ 2000 advanced			

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						mean remaining health-care expenditure needed to break even (with probability of change care): > 100% (1%), > 100% (5%), 53% (10%), 35% (15%), 27% (20%) Age < 1 year: Remaining health-care expenditures (mean) US$ 35 371		diagnostic test			

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						Percentage reduction in mean remaining health-care expenditure needed to break even (with probability of change care): > 100% (1%), > 100% (5%), 57% (10%), 38% (15%), 28% (20%)					
Posnakoglou, 2020	Prospective cohort study	142: 71 cases (FAME), 71 controls (PCR)	*N. meningitides* serogroup B	Benefits of syndromic testing with FAME panel	Cost	A pathogen was detected in 37/71 (52.1%) of children with	Only descriptive statistics were used	NR	Costs for antibacterial or antiviral medicines or	NR	FAME testing was done in the infectious diseases

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Greece HIC *(54)*	2018–2019	Neonates and children Hospitalized	*S. pneumoniae* *S. agalactiae* *Streptococcus viridans* *H. influenzae* *E. coli* Enterovirus HHV-6 HHV-7 Parechovirus West Nile virus			the use of FAME and in 16/71 (22.5%) in the control group Median (IQR) length of stay in cases and controls with aseptic meningitis was 5 days (4–8) and 8 days (6–10), respectively The median (IQR) duration of antimicrobials			supplementary laboratory exams for the additional hospitalization days were not included in the analysis		laboratory, while single PCRs were sent to reference laboratories, as it was the usual practice in the hospital. FAME was performed according to the manufacturer's protocol and was offered from 08.00–17.00, 5 days/week. The results were

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						in cases and controls were 4 days (2–5.7) and 7 days (5–10), respectively and for acyclovir 3 days (2–4.75) and 5 days (3–9.25), respectively. The median hospitalization cost was calculated in cases and controls to be € 1042 (932–1372) and € 1522 (1302–					available in about 70 minutes on weekdays, whereas samples submitted during the weekend were stored at -20 °C until testing. Five bacterial meningitis cases were diagnosed using FAME (which were culture negative)

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						1742), respectively. The total benefit in hospitalization cost for the group of children who had their CSF tested with FAME (n = 71) was calculated at € 22 834					
Hensey, 2017 Australia	Retrospective analysis 2012–2013	44 29 (69%) received outpatient parenteral	Presumptive bacterial meningitis	Outpatient parenteral antimicrobial therapy	Cost	The median total length of stay was in the other direction for meningitis: 20 days (IQR 14–24) for the	Only descriptive statistics were used	NR	NR	NR	OPAT is delivered by the Hospital-in-the-Home (HITH) service, with trained

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HIC *(55)*		antibiotic therapy (OPAT) following a median of 6 days of inpatient care Neonates and children (aged < 18 years) Outpatient, hospitalized				hospital group compared to 15 days (IQR 10–21) for the home group, with a median of 9 days (IQR 4–14) of treatment via OPAT in the latter In treating the 29 patients who received part of their treatment via OPAT (combined total of 278 days) the cost savings for					paediatric nurses attending the patient's home for scheduled assessments and treatment, administering antimicrobial infusions once or twice daily or via an elastomeric infusion pump, depending on the antibiotic prescribed. This service is medically

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						meningitis were A$ 164 020 over the 2-year period (A$ 222 400 vs A$ 58 380, *P* = 0.0001). If all patients in the hospital group had completed the same proportion of their treatment at home there would have been an additional 191 days via OPAT, with an additional					supervised by a paediatric infectious diseases consultant and paediatric fellow. Patients are discussed between the medical and nursing staff daily, with home or telehealth medical reviews for acute or complex patients.

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						estimated cost saving of A$ 112 690.					
Hagedorn, 2016 USA HIC *(56)*	Cross-sectional 2010–2013	248 Children were stratified by bacterial meningitis score (BMS) into groups that were very low risk (VLR, n = 26) or not very low risk (non-VLR, n = 222)	Bacterial meningitis (only in non-VLR patients) and enteroviral meningitis	Information on the lack of widespread use of the BMS	Both	Exposure and risks inherent to empirical treatment of bacterial meningitis could have been averted if children who qualified as VLR were discharged in accordance with BMS recommendations, rather than admitted	Only descriptive statistics were used	VLR: average hospital charges US$ 17 548.73	NR	ED LOS in hours, median (IQR): 6.1 (5.1–7.3) for non-VLR, 7.5 (6.1–8.9) for VLR, 5.9 (5.2–6.6) for VLR discharges and 6.5 (6.2–6.5) for non-VLR discharges	

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
		Male 148 (60%) Female 100 (40%) ED, hospitalized (n = 219), ICU				The resource utilization metrics demonstrated that the admitted VLR patients spent longer in the ED than either of the other groups and had 2 revisits to the ED within 3 days of discharge but no readmissions. One patient was admitted to the ICU, and, on average, the VLR patients					

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						admitted received 35 hours of antibiotic therapy, with average hospital charges of US$ 17 548.73. VLR patients admitted to the hospital received 82 doses of antibiotics and 188 total doses of all medicines (including antibiotics), underwent 6 imaging					

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						procedures (including 4 brain or neck magnetic resonance imaging tests, 1 computed tomography [CT] scan, and 1 chest radiograph), and suffered 8 intravenous catheter-related complications, 1 adverse drug reaction (red man syndrome attributable to vancomycin) and 1 overdose					

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						(acetaminophen).					
Giulieri, 2014 Switzerland HIC *(57)*	Observational study 2002–2009	59: n = 17 in group A, n = 20 in group B and n = 22 in group C Children and adults aged > 16 years (IQR 21–50); 49% males, 51% females Hospitalized	Aseptic or viral	Rapid detection of enterovirus in CSF by a fully automated PCR assay	Cost	While empirical antibacterial therapy was initiated with similar frequencies in the 3 groups, its duration was significantly shorter in group C (median 0.5 days, IQR 0–0.5, corresponding to a single antibacterial dose, IQR 0–1)	Only descriptive statistics were used	Cost of homemade real-time enterovirus PCR US$ 114; cost of GXEA US$ 121	NR	TAT of molecular assays was highly correlated with hospitalization costs in group C, but not in group B	Patients with AM were subdivided into 3 groups: A. No documented viral etiology (i.e. home-made real-time enterovirus PCR not done or negative, or negative viral culture); B. Enterovirus documented by a positive

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						than in group A (median 1 day, IQR 0–6; *P* = 0.01) and group B (median 1 day, IQR 0–1.9; *P* = 0.03), respectively. The proportion of patients receiving empirical acyclovir was significantly lower in group C (0%) than in groups A (47%) and B (20%), respectively.					home-made real-time enterovirus PCR; C. Enterovirus documented by a positive GXEA

First author, year Study period Country Level of income	Study design	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
						Among patients with positive GeneXpert enterovirus assay (GXEA) (group C), median length of hospitalization was 0.5 days (i.e. 3.5 days shorter than in group A [$P < 0.0001$] and 1.5 days shorter than in group B) Aseptic meningitis (AM) with a positive					

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
						GXEA was associated with a median hospitalization cost of US$ 921 resulting in a median cost reduction of US$ 4537 and US$ 1875, compared to AM without documented viral origin (group A) and AM with positive homemade real-time enterovirus PCR (group B), respectively					

First author, year Country Level of income	Study design Study period	No. of participants Participant charac-teristics Setting	Etiology	Which method/ "resource use"/ price–policy alternative was investigated?	Does it aim to minimize the cost/ maximize the quality?	What are the benefits/ what is the effectiveness?	Which type of economic data analysis was used, if any?	Costs	Were any associated costs and/or resources not stated?	Other reported resources	Notes
Huizing, 2011, Kingdom of the Netherlands HIC *(58)*	Combined retrospective and prospective cohort study (prospective evaluation of the study group and a retrospective analysis for the control group) 2007–2009	36: Retrospective control group (n = 19), prospective study group (n = 17) Neonates and children Hospitalized	Enteroviral meningitis	Rapid enterovirus molecular test	Cost	In the control group, the results were available within 3–7 days, whereas in the study group rapid enterovirus molecular test results were available within 3–24 hours The median LOS was 3.9 days (2.3– 41.0 days) in the historical control group vs 1.9 days (0.8	Only descriptive statistics were used	Mean costs were US$ 2520 (917–16 204) and US$ 1042 (316–4157) for the control and the study group, respectively	The costs of diagnostic tests and antibiotic treatments were left out of the calculation	During daytime, results of rapid PCR tests were available within 3 hours, and during evening and nighttime, results were available the next morning	

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						–10.5 days) in the prospective group; the median duration of antibiotic therapy was also significantly reduced from 3.1 days (1.3–12.8 days) in the control group to 0.8 days (0.5–9.7 days) in the prospective study group Mean costs per patient calculation					

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						showed an average reduction of more than US$ 1450					
Marshall, 1997, USA HIC *(59)*	Theoretical retrospective cohort study 1995	53 Neonates and children Hospitalized	Enteroviral meningitis	Rapid enterovirus molecular test	Cost	Under the conservative assumption that clinicians would discharge afebrile patients with an established viral diagnosis, routinely performing PCR on all infants with CSF pleocytosis would have	Only descriptive statistics were used	US$ 150 (estimated charge) was added per patient for performing PCR Collectively these patients generated US$ 91 689 in charges (US$ 44 289 PCR-	As this was a theoretical study, the real price for the test implementation was not stated	Collectively these patients generated 79 hospital days (36 PCR-positive and 43 PCR-negative)	

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						resulted in total charges of US$ 75 966, a reduction of 17% Under the more liberal assumption that clinicians would discharge PCR-positive patients regardless of fever and assuming that PCR results would be available at 24 hours, charges would have		positive and US$ 47 400 PCR-negative)			

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						been reduced by 35% Total hospital charges of US$ 27 575 would have been reduced by 23–67%					
Maxson, 1994, USA HIC *(60)*	Retrospective cohort study 1990–1993	26: n = 26 with true-positive antigen results were studied (out of 901 for which the test was conducted)	*S. pneumoniae* and *H. influenzae* type b (Hib), *Neisseria (N.) meningitidis* types A, B and C, group B streptococcus	Usefulness of the bacterial antigen study	NR	Of the 26 tests with positive results, 4 affected treatment	Only descriptive statistics were used	The charge for a CSF bacterial antigen panel was US$ 90. The total charge for Gram stain, culture and sensitivity testing was	NR	14 patients were pre-treated with parenterally administered antibiotics before LP, and 5 received oral antibiotic therapy	The overall sensitivity of the bacterial antigen tests was 80.6% and the specificity was 99.9%. The sensitivity and specificity of

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		Neonates and children NR	(GBS) and *E. coli*					US$ 61. A cell count and differential cell count cost US$ 32, and the charge for CSF protein and glucose analysis was US$ 54. Therefore, the charge for these routine studies without the antigen test was US$ 147. Antigen			the bacterial antigen test for *S. pneumoniae* , Hib and *N. meningitidis* were 66% and 100%, 89% and 99%, and 83% and 100%, respectively. The sensitivity and specificity of the bacterial antigen test for GBS were both 100%.

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								testing increases the cost of laboratory analysis of the CSF by 60% per patient.			
						The charges for CSF antigen studies averaged US$ 26 000 per year. The total cost for the true-positives results in this analysis was approximately US$ 730 per year. The				Of the 872 negative CSF antigen test results, 6 were falsely negative (0.6%).	"We believe that the routine use of bacterial antigen testing of the CSF is neither beneficial to patients nor cost-effective."

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						average cost per positive test result that affected the care a patient received was approximately US$ 20 700 for the study period.					

adjOR: adjusted odds ratio; AFB: acid-fast bacillus; AM: aseptic meningitis; CMV: cytomegalovirus; CNS: central nervous system; CSF: cerebrospinal fluid; CT: computed tomography; ED: emergency department; EV: enterovirus; FAME: FilmArray® Meningoencephalitis; GXEA: GeneXpert enterovirus assay; HHV-6: human herpes virus 6; HIC: high-income country; HITH: Hospital-in-the-Home; HSV: herpes simplex virus; ICU: intensive care unit; IQR: interquartile range; ; LMICs: low- and middle-income countries; LP: lumbar puncture; NR: not reported; OPAT: outpatient parenteral antibiotic therapy; PCR: polymerase chain reaction; TAT: turnaround time; VDRL: Venereal Disease Research Laboratory; VLR: very low risk; VZV: varicella-zoster virus; WBC: white blood cell count.

3.4 Excluded studies

Table WB.II.4 Excluded studies and reasons for exclusion

Study	Reason for exclusion
Aberathna et al. 2019 *(61)*	Wrong outcomes
Ajmera et al. 2019 *(62)*	Wrong phenomenon
Akpede et al. 1999 *(63)*	Wrong study design
Alemkere et al. 2019 *(64)*	Wrong study design
Alonso Pérez et al. 2017 *(65)*	Study in non-English language
Altawalbeh et al. 2024 *(66)*	Wrong phenomenon
Antoon et al. 2022 *(67)*	Wrong outcomes
Antoon et al. 2021 *(68)*	Wrong phenomenon
Astengo et al. 2021 *(69)*	Wrong study design
Atal et al. 2020 *(70)*	Wrong study design
Baltussen et al. 2009 *(71)*	Wrong study design
Begue et al. 1998 *(72)*	Study in non-English language
Bimba et al. 2020 *(73)*	Wrong outcomes
Calderón et al. 2014 *(74)*	Study in non-English language
Chacon-Cruz et al. 2022 *(75)*	Wrong outcomes
Chen et al. 2019 *(76)*	Wrong study design
Cheng et al. 2023 *(77)*	Wrong outcomes
Clements et al. 1993 *(78)*	Wrong study design
Colombini et al. 2011 *(79)*	Wrong setting
Colombini et al. 2009 *(80)*	Wrong setting
Colombo 2002 *(81)*	Study in non-English language

Constenla 2007 *(82)*	Wrong study design
Cullinan et al. 1998 *(83)*	Wrong outcomes
DeStoppelaar et al. 1999 *(84)*	Study in non-English language
Dela-Pena et al. 2017 *(85)*	Wrong outcomes
Demiroğlu et al. 2010 *(86)*	Study in non-English language
Dorratoltaj et al. 2018 *(87)*	Wrong setting
Duff et al. 2019 *(88)*	Wrong study design
Duff et al. 2018 *(89)*	Wrong study design
Duke et al. 2003 *(90)*	Wrong outcomes
Durski et al. 2013 *(91)*	Wrong study design
Filippis et al. 2023 *(92)*	Wrong study design
Foradori et al. 2021 *(93)*	Wrong outcomes
Fox-Lewis et al. 2018 *(94)*	Wrong study design
Fukasawa et al. 2017 *(95)*	Wrong study design
Gil Prieto et al. 2010 *(96)*	Study in non-English language
Grattan et al. 2021 *(97)*	Wrong outcomes
Graziani et al. 2003 *(98)*	No full text available
Grizzle et al. 2021 *(99)*	Wrong phenomenon
Hamilton et al. 1999 *(100)*	No full text available
Hegde et al. 2005 *(101)*	Wrong phenomenon
Horváth-Puhó et al. 2021 *(102)*	Wrong study design
Ismail 2022 *(103)*	Wrong outcomes
Ivanova-Markova et al. 2021 *(104)*	Wrong study design
Jacobs et al. 1996 *(105)*	No full text available
Kim et al. 2022 *(106)*	Wrong outcomes

Kiyani et al. 2021 *(107)*	No full text available
Kobayashi et al. 2021 *(108)*	Wrong study design
Li et al. 2023 *(109)*	Wrong outcomes
Liu et al. 2016 *(110)*	No full text available
Lucarevschi et al. 2012 *(111)*	Study in non-English language
Lucioni et al. 2005 *(112)*	Study in non-English language
Messacar et al. 2022 *(113)*	Wrong study design
Moffa et al. 2020 *(114)*	Wrong study design
Moreau et al. 2013 *(115)*	Wrong outcomes
Najamuddin et al. 2017 *(116)*	Wrong outcomes
Ngo Nsoga et al. 2023 *(117)*	Wrong outcomes
Nigrovic et al. 2000 *(118)*	Wrong study design
Novak et al. 2019 *(119)*	Wrong study design
Ołdak et al. 2006 *(120)*	Study in non-English language
Oostenbrink et al. 2003 *(121)*	Wrong study design
Oostenbrink et al. 2002 *(122)*	No full text available
Ouhoummane et al. 2019 *(123)*	Wrong study design
Parasuraman et al. 2001 *(124)*	Wrong study design
Parasuraman et al. 2000 *(125)*	No full text available
Pickering et al. 2018 *(126)*	Wrong study design
Rimawi et al. 2013 *(127)*	Wrong outcomes
Rowland et al. 2000 *(128)*	Wrong phenomenon
Sabayan et al. 2007 *(129)*	Wrong outcomes
Sabbatani et al. 2003 *(130)*	No full text available
Salah et al. 2019 *(131)*	Study in non-English language

San Roman Montero et al. 2009 *(132)*	Wrong outcomes
Saubolle et al. 1987 *(133)*	Wrong outcomes
Scholz et al. 2019 *(134)*	Wrong study design
Shen et al. 2022 *(135)*	Wrong study design
Somda et al. 2010 *(136)*	Wrong setting
Tascini et al. 2023 *(137)*	Wrong outcomes
Wang et al. 2019 *(138)*	Wrong study design
Weycker et al. 2010 *(139)*	Wrong outcomes
Zarabi et al. 2023 *(140)*	Wrong outcomes
Zeevat et al. 2024 *(141)*	Wrong study design
Dure-Samin et al. 1991 *(142)*	Wrong setting

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