NICE National Institute for Health and Care Excellence

NICE guideline

Meningitis (bacterial) and meningococcal septicaemia in under 16s: recognition, diagnosis and management

Clinical guideline

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Your responsibility

The recommendations in this guideline represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, professionals and practitioners are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or the people using their service. It is not mandatory to apply the recommendations, and the guideline does not override the responsibility to make decisions appropriate to the circumstances of the individual, in consultation with them and their families and carers or guardian.

Local commissioners and providers of healthcare have a responsibility to enable the guideline to be applied when individual professionals and people using services wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with complying with those duties.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.

Contents

This guideline is based on QS19.

Introduction

Bacterial meningitis is an infection of the surface of the brain (meninges) by bacteria that have usually travelled there from mucosal surfaces via the bloodstream. In children and young people aged 3 months or older, the most frequent causes of bacterial meningitis include *Neisseria meningitidis* (meningococcus), *Streptococcus pneumoniae* (pneumococcus) and *Haemophilus influenzae* type b (Hib). These organisms occur normally in the upper respiratory tract and can cause invasive disease when acquired by a susceptible person. In neonates (children younger than 28 days), the most common causative organisms are *Streptococcus agalactiae* (Group B streptococcus), *Escherichia coli*, *S pneumoniae* and *Listeria monocytogenes*.

Most *N meningitidis* colonisations are asymptomatic, but occasionally the organism invades the bloodstream to cause disease. Meningococcal disease most commonly presents as bacterial meningitis (15% of cases) or septicaemia (25% of cases), or as a combination of the two syndromes (60% of cases). Meningococcal disease is the leading infectious cause of death in early childhood, making its control a priority for clinical management (as well as public health surveillance and control).

The epidemiology of bacterial meningitis in the UK has changed dramatically in the past two decades following the introduction of vaccines to control Hib, serogroup C meningococcus and some types of pneumococcus. As no vaccine is currently licensed against serogroup B meningococcus, this pathogen is now the most common cause of bacterial meningitis (and septicaemia) in children and young people aged 3 months or older.

This guideline does not consider meningitis associated with tuberculosis (TB), because tuberculous meningitis (or meningeal TB) is covered in Tuberculosis: clinical diagnosis and management of tuberculosis, and measures for its prevention and control (NICE clinical guideline 33). However, some features of the presentation of tuberculous meningitis are indistinguishable from bacterial meningitis.

Under the Health Protection (Notification) Regulations 2010, registered medical practitioners in England have a legal requirement to notify the proper officer of the local authority urgently when they have reasonable grounds for suspecting that a patient has meningitis or meningococcal septicaemia.

Where the evidence supported it, the Guideline Development Group made separate recommendations for the management of different conditions (bacterial meningitis, meningococcal septicaemia, and in some cases, meningococcal disease). Unless otherwise specified, the recommendations refer to all children and young people aged under 16 years. The Guideline Development Group also used the term 'neonate' in some recommendations.

The guideline will assume that prescribers will use a drug's summary of product characteristics (SPC) to inform their decisions for individual patients.

Patient-centred care

This guideline offers best practice advice on the care of children and young people younger than 16 years with bacterial meningitis and meningococcal septicaemia.

Treatment and care should take into account the child's or young person's needs and preferences, as well as those of their parents or carers. Children and young people with bacterial meningitis and meningococcal septicaemia should have the opportunity to make informed decisions about their care and treatment, in partnership with their healthcare professionals, but this depends on their age and capacity to make decisions. Where a child or young person is not old enough or does not have the capacity to make decisions, healthcare professionals should follow the Department of Health's advice on consent and the code of practice that accompanies the Mental Capacity Act. In Wales, healthcare professionals should follow advice on consent from the Welsh Government.

If the patient is under 16, healthcare professionals should follow the guidelines in the Department of Health's Seeking consent: working with children.

Sometimes if a child or young person appears to have a serious illness that could indicate the need for urgent treatment, the medical staff may not have time to fully discuss what is involved in that treatment beforehand.

In an emergency if the person with parental responsibility cannot be contacted, healthcare professionals may give treatment immediately when it is in the child's or young person's best interests.

Good communication between healthcare professionals and children and young people, and their parents and carers, is essential. It should be supported by evidence-based written information tailored to their specific needs. Treatment and care, and information given about it, should be culturally appropriate. Information should also be accessible to people with additional needs such as physical, sensory or learning disabilities, and to people who do not speak or read English.

Care of young people in transition between paediatric and adult services should be planned and managed according to the best practice guidance described in Transition: getting it right for young people.

Adult and paediatric healthcare teams should work jointly to provide assessment and services to young people with bacterial meningitis and meningococcal septicaemia. Diagnosis and

management should be reviewed throughout the transition process, and there should be clarity about who is the lead clinician to ensure continuity of care.

Key priorities for implementation

Symptoms and signs of bacterial meningitis and meningococcal septicaemia

- Consider bacterial meningitis and meningococcal septicaemia in children and young people who present with the symptoms and signs in table 1 (see section 1).
    - Be aware that:
        - some children and young people will present with mostly non-specific symptoms or signs and the conditions may be difficult to distinguish from other less important (viral) infections presenting in this way
        - children and young people with the more specific symptoms and signs are more likely to have bacterial meningitis or meningococcal septicaemia and the symptoms and signs may become more severe and more specific over time.
    - Recognise shock (see table 1, section 1) and manage urgently in secondary care.
- Healthcare professionals should be trained in the recognition and management of meningococcal disease.

Management in the pre-hospital setting

- Primary care healthcare professionals should transfer children and young people with suspected bacterial meningitis or suspected meningococcal septicaemia to secondary care as an emergency by telephoning 999.

Diagnosis in secondary care

Investigation and management in children and young people with petechial rash

- Give intravenous ceftriaxone immediately to children and young people with a petechial rash if any of the following occur at any point during the assessment (these children are at high risk of having meningococcal disease):
    - petechiae start to spread
    - the rash becomes purpuric
    - there are signs of bacterial meningitis (see table 1, section 1)

- there are signs of meningococcal septicaemia (see table 1, section 1)
- the child or young person appears ill to a healthcare professional.

Polymerase chain reaction

- Perform whole blood real-time polymerase chain reaction testing (EDTA[1] sample) for *N meningitidis* to confirm a diagnosis of meningococcal disease.

Lumbar puncture

- In children and young people with suspected meningitis or suspected meningococcal disease, perform a lumbar puncture unless any of the following contraindications are present:
  - signs suggesting raised intracranial pressure
    - reduced or fluctuating level of consciousness (Glasgow Coma Scale score less than 9 or a drop of 3 or more)
    - relative bradycardia and hypertension
    - focal neurological signs
    - abnormal posture or posturing
    - unequal, dilated or poorly responsive pupils
    - papilloedema
    - abnormal 'doll's eye' movements
  - shock (see table 1, section '1: Guidance')
  - extensive or spreading purpura
  - after convulsions until stabilised
  - coagulation abnormalities
    - coagulation results (if obtained) outside the normal range
    - platelet count below 100 x 10^9/litre
    - receiving anticoagulant therapy

- local superficial infection at the lumbar puncture site
- respiratory insufficiency (lumbar puncture is considered to have a high risk of precipitating respiratory failure in the presence of respiratory insufficiency).

Management in secondary care

Fluids for bacterial meningitis

- Do not restrict fluids unless there is evidence of:
  - raised intracranial pressure, **or**
  - increased antidiuretic hormone secretion[2].

Intravenous fluid resuscitation in meningococcal septicaemia

- In children and young people with suspected or confirmed meningococcal septicaemia:
  - if there are signs of shock give an immediate fluid bolus of 20 ml/kg sodium chloride 0.9% over 5–10 minutes. Give the fluid intravenously or via an intraosseous route and reassess the child or young person immediately afterwards
  - if the signs of shock persist, immediately give a second bolus of 20 ml/kg of intravenous or intraosseous sodium chloride 0.9% or human albumin 4.5% solution over 5–10 minutes
  - if the signs of shock still persist after the first 40 ml/kg:
    - immediately give a third bolus of 20 ml/kg of intravenous or intraosseous sodium chloride 0.9% or human albumin 4.5% solution over 5–10 minutes
    - call for anaesthetic assistance for urgent tracheal intubation and mechanical ventilation
    - start treatment with vasoactive drugs
    - be aware that some children and young people may require large volumes of fluid over a short period of time to restore their circulating volume
    - consider giving further fluid boluses at 20 ml/kg of intravenous or intraosseous sodium chloride 0.9% or human albumin 4.5% solution over 5–10 minutes based

on clinical signs and appropriate laboratory investigations including urea and electrolytes

- discuss further management with a paediatric intensivist.

Long-term management

Long-term effects of bacterial meningitis and meningococcal septicaemia

- Offer children and young people with a severe or profound deafness an urgent assessment for cochlear implants as soon as they are fit to undergo testing (further guidance on the use of cochlear implants for severe to profound deafness can be found in Cochlear implants for children and adults with severe to profound deafness [NICE technology appraisal guidance 166]).
- Children and young people should be reviewed by a paediatrician with the results of their hearing test 4–6 weeks after discharge from hospital to discuss morbidities associated with their condition and offered referral to the appropriate services. The following morbidities should be specifically considered:
  - hearing loss (with the child or young person having undergone an urgent assessment for cochlear implants as soon as they are fit)
  - orthopaedic complications (damage to bones and joints)
  - skin complications (including scarring from necrosis)
  - psychosocial problems
  - neurological and developmental problems
  - renal failure.

[1] Ethylenediaminetetraacetic acid.

[2] See National Patient Safety Agency (2007) Patient safety alert 22: Reducing the risk of hyponatraemia when administering intravenous infusions to children.

1 Guidance

The following guidance is based on the best available evidence. The full guideline gives details of the methods and the evidence used to develop the guidance.

This guideline assumes that fever in children younger than 5 years will be managed according to Feverish illness in children (NICE clinical guideline 47) until bacterial meningitis or meningococcal septicaemia is suspected.

1.1 Bacterial meningitis and meningococcal septicaemia in children and young people – symptoms, signs and initial assessment

1.1.1 Consider bacterial meningitis and meningococcal septicaemia in children and young people who present with the symptoms and signs in table 1 (below).

- Be aware that:
  - Recognise shock (see table 1 below) and manage urgently in secondary care.

Table 1 Symptoms and signs of bacterial meningitis and meningococcal septicaemia

Symptom/sign	Bacterial meningitis (meningococcal meningitis and meningitis caused by other bacteria)	Meningococcal disease (meningococcal meningitis and/or meningococcal septicaemia)	Meningococcal septicaemia	Notes
Common non-specific symptoms/signs				
Fever	√	√	√	Not always present, especially in neonates
Vomiting/nausea	√	√	√	
Lethargy	√	√	√	
Irritable/ unsettled	√	√	√	

Ill appearance	√	√	√	
Refusing food/ drink	√	√	√	
Headache	√	√	√	
Muscle ache/ joint pain	√	√	√	
Respiratory symptoms/signs or breathing difficulty	√	√	√	
Less common non-specific symptoms/signs				
Chills/shivering	√	√	√	
Diarrhoea, abdominal pain/ distension	√	√	NK	
Sore throat/ coryza or other ear, nose and throat symptoms/signs	√	√	NK	
More specific symptoms/signs				
Non-blanching rash	√	√	√	Be aware that a rash may be less visible in darker skin tones – check soles of feet, palms of hands and conjunctivae
Stiff neck	√	√	NK	

Altered mental state	√	√	√	Includes confusion, delirium and drowsiness, and impaired consciousness
Capillary refill time more than 2 seconds	NK	√	√	
Unusual skin colour	NK	√	√	
Shock	√	√	√	
Hypotension	NK	√	√	
Leg pain	NK	√	√	
Cold hands/feet	NK	√	√	
Back rigidity	√	√	NK	
Bulging fontanelle	√	√	NK	Only relevant in children aged under 2 years
Photophobia	√	√	X	
Kernig's sign	√	√	X	
Brudzinski's sign	√	√	X	
Unconsciousness	√	√	√	
Toxic/moribund state	√	√	√	
Paresis	√	√	X	
Focal neurological deficit including cranial nerve involvement and abnormal pupils	√	√	X	

Seizures	√	√	X	

Signs of shock

- Capillary refill time more than 2 seconds
- Unusual skin colour
- Tachycardia and/or hypotension
- Respiratory symptoms or breathing difficulty
- Leg pain
- Cold hands/feet
- Toxic/moribund state
- Altered mental state/decreased conscious level
- Poor urine output

√ symptom/sign present

X symptom/sign not present

NK not known if a symptom/sign is present (not reported in the evidence)

1.1.2 Be alert to the possibility of bacterial meningitis or meningococcal septicaemia when assessing children or young people with acute febrile illness.

1.1.3 Healthcare professionals should be aware that classical signs of meningitis (neck stiffness, bulging fontanelle, high-pitched cry) are often absent in infants with bacterial meningitis[3].

1.1.4 Be aware that children and young people with bacterial meningitis commonly present with non-specific symptoms and signs, including fever, vomiting, irritability, and upper respiratory tract symptoms. Some children with bacterial meningitis present with seizures[4].

1.1.5 Consider other non-specific features of the child's or young person's presentation, such as:

- the level of parental or carer concern (particularly compared with previous illness in the child or young person or their family),
- how quickly the illness is progressing, **and**
- clinical judgement of the overall severity of the illness.

1.1.6 In children and young people with suspected bacterial meningitis or meningococcal septicaemia, undertake and record physiological observations of heart rate, respiratory rate, oxygen saturations, blood pressure, temperature, perfusion (capillary refill) and neurological assessment (for example the Alert, Voice, Pain, Unresponsive [AVPU] scale) at least hourly.

1.1.7 Healthcare professionals should be trained in the recognition and management of meningococcal disease.

1.1.8 Notify a proper officer of the local authority urgently on suspicion of meningitis or meningococcal septicaemia. This is a legal requirement under the Health Protection (Notification) Regulations 2010[5][6].

1.1.9 Be aware of 'Guidance for Public Health Management of Meningococcal Disease in the UK' (Health Protection Agency Meningococcus Forum, 2006)[7].

1.2 Pre-hospital management of suspected bacterial meningitis and meningococcal septicaemia

1.2.1 Primary care healthcare professionals should transfer children and young people with suspected bacterial meningitis or suspected meningococcal septicaemia to secondary care as an emergency by telephoning 999.

Suspected bacterial meningitis without non-blanching rash

1.2.2 Transfer children and young people with suspected bacterial meningitis without non-blanching rash directly to secondary care without giving parenteral antibiotics.

1.2.3 If urgent transfer to hospital is not possible (for example, in remote locations or adverse weather conditions), administer antibiotics to children and young people with suspected bacterial meningitis.

Suspected meningococcal disease (meningitis with non-blanching rash or meningococcal septicaemia)

1.2.4 Give parenteral antibiotics (intramuscular or intravenous benzylpenicillin) at the earliest opportunity, either in primary or secondary care, but do not delay urgent transfer to hospital to give the parenteral antibiotics.

1.2.5 Withhold benzylpenicillin only in children and young people who have a clear history of anaphylaxis after a previous dose; a history of a rash following penicillin is not a contraindication.

1.3 Diagnosis in secondary care

1.3.1 Perform a very careful examination for signs of meningitis or septicaemia in children and young people presenting with petechial rashes (see table 1 above).

Investigation and management in children and young people with petechial rash

1.3.2 Give intravenous ceftriaxone immediately to children and young people with a petechial rash if any of the following occur at any point during the assessment (these children are at high risk of having meningococcal disease):

- petechiae start to spread
- the rash becomes purpuric
- there are signs of bacterial meningitis (see table 1 above)
- there are signs of meningococcal septicaemia (see table 1 above)
- the child or young person appears ill to a healthcare professional.

1.3.3 If a child or young person has an unexplained petechial rash and fever (or history of fever) carry out the following investigations:

- full blood count
- C-reactive protein (CRP)
- coagulation screen

- blood culture
- whole-blood polymerase chain reaction (PCR) for *N meningitidis*
- blood glucose
- blood gas.

1.3.4 In a child or young person with an unexplained petechial rash and fever (or history of fever) but none of the high-risk clinical manifestations (see table 1 above):

- Treat with intravenous ceftriaxone immediately if the CRP and/or white blood cell count (especially neutrophil count) is raised, as this indicates an increased risk of having meningococcal disease.
- Be aware that while a normal CRP and normal white blood cell count mean meningococcal disease is less likely, they do not rule it out. The CRP may be normal and the white blood cell count normal or low even in severe meningococcal disease.
- Assess clinical progress by monitoring vital signs (respiratory rate, heart rate, blood pressure, conscious level [Glasgow Coma Scale and/or APVU], temperature), capillary refill time, and oxygen saturations. Carry out observations at least hourly over the next 4–6 hours.
- If doubt remains, treat with antibiotics and admit to hospital.

1.3.5 If the child or young person is assessed as being at low risk of meningococcal disease and is discharged after initial observation, advise parents or carers to return to hospital if the child or young person appears ill to them.

1.3.6 Be aware that in children and young people who present with a non-spreading petechial rash without fever (or history of fever) who do not appear ill to a healthcare professional, meningococcal disease is unlikely, especially if the rash has been present for more than 24 hours. In such cases consider:

- other possible diagnoses
- performing a full blood count and coagulation screen.

Investigation and management in children and young people with suspected bacterial meningitis

1.3.7 In children and young people with suspected bacterial meningitis, perform a CRP and white blood cell count:

- If the CRP and/or white blood cell count is raised and there is a non-specifically abnormal cerebrospinal fluid (CSF) (for example consistent with viral meningitis), treat as bacterial meningitis.
- Be aware that a normal CRP and white blood cell count does not rule out bacterial meningitis.
- Regardless of the CRP and white blood cell count, if no CSF is available for examination or if the CSF findings are uninterpretable, manage as if the diagnosis of meningitis is confirmed.

Polymerase chain reaction (PCR) tests for bacterial meningitis and meningococcal disease

1.3.8 Perform whole blood real-time PCR testing (EDTA[8] sample) for *N meningitidis* to confirm a diagnosis of meningococcal disease.

1.3.9 The PCR blood sample should be taken as soon as possible because early samples are more likely to be positive.

1.3.10 Use PCR testing of blood samples from other hospital laboratories if available, to avoid repeating the test.

1.3.11 Be aware that a negative blood PCR test result for *N meningitidis* does not rule out meningococcal disease.

1.3.12 Submit CSF to the laboratory to hold for PCR testing for *N meningitidis* and *S pneumoniae*, but only perform the PCR testing if the CSF culture is negative.

1.3.13 Be aware that CSF samples taken up to 96 hours after admission to hospital may give useful results.

Skin samples for meningococcal disease

1.3.14 Do not use any of the following techniques when investigating for possible meningococcal disease: skin scrapings, skin biopsies, petechial or purpuric lesion aspirates (obtained with a needle and syringe).

Performing lumbar puncture and interpreting CSF parameters for suspected bacterial meningitis

1.3.15 Perform a lumbar puncture as a primary investigation unless this is contraindicated.

1.3.16 Do not allow lumbar puncture to delay the administration of parenteral antibiotics.

1.3.17 CSF examination should include white blood cell count and examination, total protein and glucose concentrations, Gram stain and microbiological culture. A corresponding laboratory-determined blood glucose concentration should be measured.

1.3.18 In children and young people with suspected meningitis or suspected meningococcal disease, perform a lumbar puncture unless any of the following contraindications are present:

- signs suggesting raised intracranial pressure
  - shock (see table 1 above)
  - extensive or spreading purpura
  - after convulsions until stabilised
  - coagulation abnormalities
    - local superficial infection at the lumbar puncture site
    - respiratory insufficiency (lumbar puncture is considered to have a high risk of precipitating respiratory failure in the presence of respiratory insufficiency).

1.3.19 In children and young people with suspected bacterial meningitis, if contraindications to lumbar puncture exist at presentation consider delaying lumbar puncture until there are no longer contraindications. Delayed lumbar puncture is especially worthwhile if there is diagnostic uncertainty or unsatisfactory clinical progress.

1.3.20 CSF white blood cell counts, total protein and glucose concentrations should be made available within 4 hours to support the decision regarding adjunctive steroid therapy.

1.3.21 Start antibiotic treatment for bacterial meningitis if the CSF white blood cell count is abnormal:

- in neonates at least 20 cells/microlitre (be aware that even if fewer than 20 cells/microlitre, bacterial meningitis should still be considered if other symptoms and signs are present – see table 1 above)
- in older children and young people more than 5 cells/microlitre or more than 1 neutrophil/microlitre, regardless of other CSF variables.

1.3.22 In children and young people with suspected bacterial meningitis, consider alternative diagnoses if the child or young person is significantly ill and has CSF variables within the accepted normal ranges.

1.3.23 Consider herpes simplex encephalitis as an alternative diagnosis.

1.3.24 If CSF white cell count is increased and there is a history suggesting a risk of tuberculous meningitis, evaluate for the diagnosis of tuberculous meningitis in line with Tuberculosis: clinical diagnosis and management of tuberculosis, and measures for its prevention and control (NICE clinical guideline 33).

1.3.25 Perform a repeat lumbar puncture in neonates with:

- persistent or re-emergent fever
- deterioration in clinical condition
- new clinical findings (especially neurological findings) or
- persistently abnormal inflammatory markers.

1.3.26 Do not perform a repeat lumbar puncture in neonates:

- who are receiving the antibiotic treatment appropriate to the causative organism and are making a good clinical recovery
- before stopping antibiotic therapy if they are clinically well.

Cranial computed tomography in suspected bacterial meningitis

1.3.27 Use clinical assessment and not cranial computed tomography (CT), to decide whether it is safe to perform a lumbar puncture. CT is unreliable for identifying raised intracranial pressure.

1.3.28 If a CT scan has been performed, do not perform a lumbar puncture if the CT scan shows radiological evidence of raised intracranial pressure.

1.3.29 In children and young people with a reduced or fluctuating level of consciousness (Glasgow Coma Scale score less than 9 or a drop of 3 or more) or with focal neurological signs, perform a CT scan to detect alternative intracranial pathology.

1.3.30 Do not delay treatment to undertake a CT scan.

1.3.31 Clinically stabilise children and young people before CT scanning.

1.3.32 If performing a CT scan consult an anaesthetist, paediatrician or intensivist.

1.4 Management in secondary care

Antibiotics for suspected bacterial meningitis or meningococcal disease

1.4.1 Treat children and young people aged 3 months or older with suspected bacterial meningitis without delay using intravenous ceftriaxone.

1.4.2 Treat children younger than 3 months with suspected bacterial meningitis without delay using intravenous cefotaxime plus either amoxicillin or ampicillin.

1.4.3 Treat suspected meningococcal disease without delay using intravenous ceftriaxone.

1.4.4 Treat children and young people with suspected bacterial meningitis who have recently travelled outside the UK or have had prolonged or multiple exposure to antibiotics (within the past 3 months) with vancomycin in addition to the above antibiotics.

1.4.5 Where ceftriaxone is used, do not administer it at the same time as calcium-containing infusions. Instead, use cefotaxime[9].

1.4.6 In children younger than 3 months, ceftriaxone may be used as an alternative to cefotaxime (with or without ampicillin or amoxicillin), but be aware that ceftriaxone should not be used in premature babies or in babies with jaundice, hypoalbuminaemia or acidosis as it may exacerbate hyperbilirubinaemia.

1.4.7 If tuberculous meningitis is part of the differential diagnosis use antibiotic treatment appropriate for tuberculous meningitis in line with Tuberculosis (NICE clinical guideline 33) (replaced by Tuberculosis [NICE clinical guideline 117]).

1.4.8 If herpes simplex meningoencephalitis is part of the differential diagnosis give appropriate antiviral treatment.

Treatment for specific infections in confirmed bacterial meningitis

Children and young people aged 3 months or older

1.4.9 Treat *H influenzae* type b meningitis with intravenous ceftriaxone for 10 days in total unless directed otherwise by the results of antibiotic sensitivities.

1.4.10 Treat *S pneumoniae* meningitis with intravenous ceftriaxone for 14 days in total unless directed otherwise by the results of antibiotic sensitivities.

Children younger than 3 months

1.4.11 Treat Group B streptococcal meningitis with intravenous cefotaxime for at least 14 days. If the clinical course is complicated[10] consider extending the duration of treatment and consulting an expert in paediatric infectious diseases.

1.4.12 Treat bacterial meningitis due to *L monocytogenes* with intravenous amoxicillin or ampicillin for 21 days in total, plus gentamicin for at least the first 7 days.

1.4.13 Treat bacterial meningitis due to Gram-negative bacilli with intravenous cefotaxime for at least 21 days unless directed otherwise by the results of antibiotic sensitivities. If the clinical course is complicated[10] consider extending

the duration of treatment and consulting an expert in paediatric infectious diseases.

Treatment of unconfirmed bacterial meningitis

1.4.14 In children and young people aged 3 months or older with unconfirmed, uncomplicated but clinically suspected bacterial meningitis, treat with intravenous ceftriaxone for at least 10 days depending on symptoms and signs and course of the illness.

1.4.15 In children younger than 3 months with unconfirmed but clinically suspected bacterial meningitis, treat with cefotaxime plus either ampicillin or amoxicillin for at least 14 days. If the clinical course is complicated[10], consider extending the duration of treatment and consulting an expert in paediatric infectious diseases.

Meningococcal disease

1.4.16 In children and young people with confirmed meningococcal disease, treat with intravenous ceftriaxone for 7 days in total unless directed otherwise by the results of antibiotic sensitivities.

1.4.17 In children and young people with unconfirmed but clinically suspected meningococcal disease, treat with intravenous ceftriaxone for 7 days in total.

Other aspects of management in bacterial meningitis and meningococcal septicaemia

Metabolic disturbances

1.4.18 In children and young people with suspected or confirmed meningococcal septicaemia, anticipate, monitor and correct the following metabolic disturbances using local or national protocols:

- hypoglycaemia
- acidosis
- hypokalaemia

- hypocalcaemia
- hypomagnesaemia
- anaemia
- coagulopathy.

Seizures

1.4.19 Use local or national protocols for management of seizures in children and young people with suspected bacterial meningitis or meningococcal septicaemia.

Raised intracranial pressure

1.4.20 Use local or national protocols to treat raised intracranial pressure.

Fluid management in suspected or confirmed bacterial meningitis

1.4.21 Assess for all of the following:

- signs of shock (see table 1 above)
- raised intracranial pressure
- signs of dehydration.

Refer to Diarrhoea and vomiting in children (NICE clinical guideline 84) for assessment of shock and dehydration.

1.4.22 If present, correct dehydration using enteral fluids or feeds, or intravenous isotonic fluids (for example, sodium chloride 0.9% with glucose 5% or sodium chloride 0.9% with dextrose 5%).

1.4.23 Do not restrict fluids unless there is evidence of:

- raised intracranial pressure, **or**
- increased antidiuretic hormone secretion[11].

1.4.24 Give full-volume maintenance fluids to avoid hypoglycaemia and maintain electrolyte balance.

1.4.25 Use enteral feeds as maintenance fluid if tolerated.

1.4.26 If intravenous maintenance fluid is required, use isotonic fluids (for example, sodium chloride 0.9% with glucose 5% or sodium chloride 0.9% with dextrose 5%). In neonates, use glucose 10% and added sodium chloride for maintenance.

1.4.27 Monitor fluid administration and urine output to ensure adequate hydration and avoid overhydration.

1.4.28 Monitor electrolytes and blood glucose regularly (at least daily while the child or young person is receiving intravenous fluids).

1.4.29 If there are signs of raised intracranial pressure or evidence of shock, initiate emergency management for these conditions and discuss ongoing fluid management with a paediatric intensivist.

Intravenous fluid resuscitation in meningococcal septicaemia

1.4.30 In children and young people with suspected or confirmed meningococcal septicaemia:

- If there are signs of shock, give an immediate fluid bolus of 20 ml/kg sodium chloride 0.9% over 5–10 minutes. Give the fluid intravenously or via an intraosseous route and reassess the child or young person immediately afterwards.
- If the signs of shock persist, immediately give a second bolus of 20 ml/kg of intravenous or intraosseous sodium chloride 0.9% or human albumin 4.5% solution over 5–10 minutes.
- If the signs of shock still persist after the first 40 ml/kg:
  - discuss further management with a paediatric intensivist.

Vasoactive therapy for shock in meningococcal septicaemia

1.4.31 If shock persists despite fluid resuscitation (more than 40 ml/kg) and treatment with either intravenous adrenaline or intravenous noradrenaline, or both,

consider potential reasons (such as persistent acidosis, incorrect dilution, extravasation) and discuss further management options with a paediatric intensivist.

1.4.32 Use local or national protocols for the administration of vasoactive agents in children and young people with suspected or confirmed bacterial meningitis or meningococcal septicaemia.

Respiratory support in children and young people with suspected or confirmed bacterial meningitis or meningococcal septicaemia

1.4.33 In self-ventilating children and young people with signs of respiratory distress, administer 15-litre face mask oxygen via a reservoir rebreathing mask.

1.4.34 If there is a threatened loss of airway patency, implement airway-opening manoeuvres, and start bag–valve mask ventilation in preparation for tracheal intubation.

1.4.35 A healthcare professional with expertise in paediatric airway management should undertake tracheal intubation.

1.4.36 Be aware that children and young people with suspected or confirmed bacterial meningitis or meningococcal septicaemia are very ill and at grave risk of sudden deterioration during intubation. Anticipate aspiration, pulmonary oedema or worsening shock during intubation. Ensure that they are nil by mouth from admission to hospital and that the following are available before intubation:

- facilities to administer fluid boluses
- appropriate vasoactive drugs
- access to a healthcare professional experienced in the management of critically ill children.

1.4.37 Undertake tracheal intubation and mechanical ventilation for the following indications:

- threatened (for example, loss of gag reflex), or actual loss of airway patency

- the need for any form of assisted ventilation, for example bag–mask ventilation
- clinical observation of increasing work of breathing
- hypoventilation or apnoea
- features of respiratory failure, including:
  - continuing shock following infusion of a total of 40 ml/kg of resuscitation fluid
  - signs of raised intracranial pressure
  - impaired mental status:
    - control of intractable seizures
    - need for stabilisation and management to allow brain imaging or transfer to the paediatric intensive care unit or another hospital.

1.4.38 Use local or national protocols for intubation.

Corticosteroids

Bacterial meningitis

1.4.39 Do not use corticosteroids in children younger than 3 months with suspected or confirmed bacterial meningitis.

1.4.40 Give dexamethasone (0.15 mg/kg to a maximum dose of 10 mg, four times daily for 4 days)[12] for suspected or confirmed bacterial meningitis as soon as possible if lumbar puncture reveals any of the following:

- frankly purulent CSF
- CSF white blood cell count greater than 1000/microlitre
- raised CSF white blood cell count with protein concentration greater than 1 g/litre
- bacteria on Gram stain.

1.4.41 If tuberculous meningitis is in the differential diagnosis, refer to Tuberculosis (NICE clinical guideline 33) (replaced by Tuberculosis [NICE clinical guideline

117]) before administering steroids, because steroids may be harmful if given without antituberculous therapy.

1.4.42 If dexamethasone was not given before or with the first dose of antibiotics, but was indicated, try to administer the first dose within 4 hours of starting antibiotics, but do not start dexamethasone more than 12 hours after starting antibiotics.

1.4.43 After the first dose of dexamethasone discuss the decision to continue dexamethasone with a senior paediatrician.

Meningococcal septicaemia

1.4.44 Do not treat with high-dose corticosteroids (defined as dexamethasone 0.6 mg/kg/day or an equivalent dose of other corticosteroids).

1.4.45 In children and young people with shock that is unresponsive to vasoactive agents, steroid replacement therapy using low-dose corticosteroids (hydrocortisone 25 mg/m^2 four times daily)[12] should be used only when directed by a paediatric intensivist.

Adjunctive therapies

1.4.46 Do not use activated protein C or recombinant bacterial permeability-increasing protein in children and young people with meningococcal septicaemia.

Monitoring for deterioration for meningococcal disease

1.4.47 Monitor children and young people closely after admission to hospital for signs of deterioration (monitor respiration, pulse, blood pressure, oxygen saturation and Glasgow Coma Scale score).

1.4.48 Be aware that children and young people with meningococcal disease can deteriorate rapidly, regardless of the results of any initial assessment of severity.

Retrieval and transfer to tertiary care

1.4.49 Children and young people who need resuscitation should be discussed with a paediatric intensivist as soon as possible.

1.4.50 Transfer of children and young people to tertiary care should be undertaken by an experienced paediatric intensive care retrieval team comprising medical and nursing staff.

1.5 Long-term management

Long-term effects of bacterial meningitis and meningococcal septicaemia

1.5.1 Before discharging children and young people from hospital:

- consider their requirements for follow-up, taking into account potential sensory, neurological, psychosocial, orthopaedic, cutaneous and renal morbidities, **and**
- discuss potential long-term effects of their condition and likely patterns of recovery with the child or young person and their parents or carers, and provide them with opportunities to discuss issues and ask questions.

1.5.2 Offer children and young people and their parents or carers:

- information about and access to further care immediately after discharge, **and**
- contact details of patient support organisations including meningitis charities that can offer support, befriending, in-depth information, advocacy, counselling, and written information to signpost families to further help, **and**
- advice on accessing future care.

1.5.3 Offer a formal audiological assessment as soon as possible, preferably before discharge, within 4 weeks of being fit to test.

1.5.4 Offer children and young people with a severe or profound deafness an urgent assessment for cochlear implants as soon as they are fit to undergo testing (further guidance on the use of cochlear implants for severe to profound deafness can be found in Cochlear implants for children and adults with severe to profound deafness [NICE technology appraisal guidance 166]).

1.5.5 Children and young people should be reviewed by a paediatrician with the results of their hearing test 4–6 weeks after discharge from hospital to discuss morbidities associated with their condition and offered referral to the appropriate services. The following morbidities should be specifically considered:

- hearing loss (with the child or young person having undergone an urgent assessment for cochlear implants as soon as they are fit)
- orthopaedic complications (damage to bones and joints)
- skin complications (including scarring from necrosis)
- psychosocial problems
- neurological and developmental problems
- renal failure.

1.5.6 Inform the child's or young person's GP, health visitor and school nurse (for school-age children and young people) about their bacterial meningitis or meningococcal septicaemia.

1.5.7 Healthcare professionals with responsibility for monitoring the child's or young person's health should be alert to possible late-onset sensory, neurological, orthopaedic and psychosocial effects of bacterial meningitis and meningococcal septicaemia.

Immune testing

1.5.8 Test children and young people for complement deficiency if they have had either:

- more than one episode of meningococcal disease, **or**
- one episode of meningococcal disease caused by serogroups other than B (for example A, C, Y, W135, X, 29E), **or**
- meningococcal disease caused by any serogroup and a history of other recurrent or serious bacterial infections.

1.5.9 Children and young people with recurrent episodes of meningococcal disease should be assessed by a specialist in infectious disease or immunology.

1.5.10 Do not test children and young people for complement deficiency who have had either:

- a single episode of meningococcal disease caused by serogroup B meningococcus, **or**
- unconfirmed meningococcal disease.

1.5.11 Discuss appropriate testing for complement deficiency with local immunology laboratory staff.

1.5.12 If a child or young person who has had meningococcal disease has a family history of meningococcal disease or complement deficiency, test the child or young person for complement deficiency.

1.5.13 If a child or young person who has had meningococcal disease is found to have complement deficiency, test their parents and siblings for complement deficiency.

1.5.14 Refer children and young people with complement deficiency to a healthcare professional with expertise in the management of the condition.

1.5.15 Do not test children and young people for immunoglobulin deficiency if they have had meningococcal disease, unless they have a history suggestive of an immunodeficiency (that is, a history of serious, persistent, unusual, or recurrent infections).

[3] This recommendation is from Feverish illness in children (NICE clinical guideline 47).

[4] See table 2 in Feverish illness in children (NICE clinical guideline 47).

[5] See Legislation.

[6] The Department of Health has issued guidance on health protection legislation which explains the notification requirements. See Health protection legislation guidance 2010

[7] See Health Protection Agency.

[8] Ethylenediaminetetraacetic acid.

[9] See Medicines and Healthcare products Regulatory Agency (2009) Drug Safety Update: Vol. 3 Issue 3.

[10] For example, if there is poor response to antibiotic therapy, effusion or abscess, or concomitant intraventricular haemorrhage in a premature baby.

[11] See National Patient Safety Agency (2007) Patient safety alert 22: Reducing the risk of hyponatraemia when administering intravenous infusions to children.

[12] The dosage given in the recommendation is based on high-quality evidence and is consistent with established clinical practice (see the full guideline for further details). The guideline will assume that prescribers will use a drug's SPC to inform their decisions for individual patients. Dexamethasone does not have UK marketing authorisation for use at the dose specified in the recommendation. Such use is an off-label use. Informed consent should be obtained and documented in line with normal standards in emergency care.

2 Notes on the scope of the guidance

NICE guidelines are developed in accordance with a scope that defines what the guideline will and will not cover. The scope of this guideline is available.

How this guideline was developed

NICE commissioned the National Collaborating Centre for Women's and Children's Health to develop this guideline. The Centre established a Guideline Development Group (see appendix A), which reviewed the evidence and developed the recommendations. An independent Guideline Review Panel oversaw the development of the guideline (see appendix B).

There is more information about how NICE clinical guidelines are developed on the NICE website. See also NICE's How NICE clinical guidelines are developed: an overview for stakeholders, the public and the NHS.

3 Implementation

NICE has developed tools to help organisations implement this guidance.

4 Research recommendations

The Guideline Development Group has made the following recommendations for research, based on its review of evidence, to improve NICE guidance and patient care in the future. The Guideline Development Group's full set of research recommendations is detailed in the full guideline (see section 5).

4.1 Symptoms and signs of bacterial meningitis and meningococcal disease

What are the symptoms and signs of bacterial meningitis and meningococcal disease in children and young people aged under 16 years that differentiate between these conditions and minor self-limiting infections (including those characterised by fever)?

Why this is important

Research is needed from primary and secondary care settings on the diagnostic accuracy of symptoms and signs suggestive of bacterial meningitis and meningococcal disease in children and young people. The research should focus on identifying individual symptoms and signs, or groups of symptoms and signs that are effective as predictors of bacterial meningitis and meningococcal disease. These symptoms and signs should also differentiate effectively between these conditions and minor self-limiting infections. The research should include consideration of the effectiveness of symptoms and signs of acute feverish illness as predictors of meningococcal disease. Consideration should also be given to the age of the child or young person (in terms of the relevance of particular symptoms and signs) and the clinical setting at presentation. Suitable study designs would include diagnostic accuracy studies as well as observational studies (such as case–control studies), and the research could include a systematic review of studies that have already been published.

4.2 Predictive value of blood test results and CSF findings

What are the normal ranges for blood and CSF parameters in children and young people in the UK?

Why this is important

Bacterial meningitis is a rare disease that is not easily distinguishable clinically from aseptic meningitis. It is, however, important to recognise those children who are most likely to have bacterial meningitis to direct appropriate management of the condition and to avoid inappropriate treatment of aseptic meningitis. Since the introduction of vaccines to protect against Hib, meningococcus serogroup C and pneumococcus, no high-quality studies involving previously

healthy children and young people have been conducted in the UK to determine normal ranges for blood test results or CSF findings in bacterial and aseptic meningitis. Such studies are needed to provide reference values to help interpret blood test results and CSF findings in children (especially neonates) and young people with suspected bacterial meningitis.

4.3 Albumin and crystalloid solutions for fluid resuscitation

How effective is albumin 4.5% solution compared with crystalloid saline 0.9% solution for fluid resuscitation in children and young people with septic shock?

Why this is important

There are theoretical reasons why albumin solution may be more effective than crystalloid solution in children and young people with septic shock. However, no clinical studies have evaluated the effectiveness of albumin solution in children and young people with meningococcal disease. Concerns about the safety of colloids such as albumin solution led to a widespread change in clinical practice in the 1990s to using crystalloid solutions, despite a lack of evidence of equivalent effectiveness. Although albumin solution is considerably more expensive than crystalloid solution, a small additional benefit of albumin over crystalloid (one death prevented in more than 14,000 treated cases) would make the use of albumin solution cost effective. Randomised controlled trials are therefore needed to compare the effectiveness of albumin and crystalloid solutions in children and young people with septic shock.

4.4 Adjunctive corticosteroid treatment

What is the effectiveness of corticosteroids as an adjunct to antibiotic treatment in neonates with suspected or confirmed bacterial meningitis?

Why this is important

Neonatal bacterial meningitis is associated with high morbidity, despite the availability of antibiotics that are highly effective against the leading causes of bacterial meningitis in this age group. New approaches to management are needed because there are currently no vaccines to protect against infection from the causative organisms. Corticosteroids are effective as an adjunct to antibiotic treatment in older children with meningitis caused by Hib, and in adults with bacterial meningitis. However, there is insufficient evidence to support a recommendation for adjunctive corticosteroid treatment in neonates. Extrapolation from older age groups would be inappropriate because the spectrum of organisms causing infection in neonates is different, and the impact on the

developing brain of the causative organisms during inflammation may not be the same. A large-scale randomised controlled trial is therefore needed to compare the effectiveness of antibiotic treatment plus corticosteroids with antibiotic treatment alone in neonates with suspected or confirmed bacterial meningitis.

4.5 Steroid replacement treatment

How effective is steroid replacement treatment in children and young people with vasopressor-unresponsive shock caused by septicaemia, including meningococcal septicaemia?

Why this is important

Well-conducted but relatively small randomised controlled trials involving adults only suggest that low-dose corticosteroid replacement treatment may ameliorate haemodynamic failure and inflammatory dysregulation associated with severe sepsis. Such treatment may also improve outcomes following septic shock. Severe sepsis in children and young people differs from that in adults, in that multiple-organ dysfunction is less common in children and young people, and mortality is lower. A randomised controlled trial involving children and young people is needed to evaluate the effectiveness of corticosteroid replacement treatment. Studies involving adults suggest that those with normal adrenal function have worse outcomes if they receive steroids than those with adrenal dysfunction, and so the proposed trial should consider whether testing for adrenal dysfunction before starting steroid replacement treatment improves outcomes.

5 Other versions of this guideline

5.1 Full guideline

The full guideline, Bacterial meningitis and meningococcal septicaemia: management of bacterial meningitis and meningococcal septicaemia in children and young people younger than 16 years in primary and secondary care, contains details of the methods and evidence used to develop the guideline. It is published by the National Collaborating Centre for Women's and Children's Health.

5.2 Quick reference guide

A quick reference guide for healthcare professionals is available.

5.3 Information for the public

NICE has produced information for the public explaining this guideline.

We encourage NHS and voluntary sector organisations to use text from this information in their own materials.

6 Related NICE guidance

Published

- Diarrhoea and vomiting caused by gastroenteritis: diagnosis, assessment and management in children younger than 5 years. NICE clinical guideline 84 (2009).
- Feverish illness in children: assessment and initial management in children younger than 5 years. NICE clinical guideline 47 (2007).
- Tuberculosis. Clinical diagnosis and management of tuberculosis, and measures for its prevention and control. NICE clinical guideline 33 (2006). [Replaced by NICE clinical guideline 117].
- Cochlear implants for children and adults with severe to profound deafness. NICE technology appraisal guidance 166 (2009).

7 Updating the guideline

NICE clinical guidelines are updated so that recommendations take into account important new information. New evidence is checked 3 years after publication, and healthcare professionals and patients are asked for their views; we use this information to decide whether all or part of a guideline needs updating. If important new evidence is published at other times, we may decide to do a more rapid update of some recommendations.

Appendix A: The Guideline Development Group, National Collaborating Centre and NICE project team

Guideline Development Group

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Technical Lead

Annette Mead
Editor

Appendix B: The Guideline Review Panel

The Guideline Review Panel is an independent panel that oversees the development of the guideline and takes responsibility for monitoring adherence to NICE guideline development processes. In particular, the panel ensures that stakeholder comments have been adequately considered and responded to. The panel includes members from the following perspectives: primary care, secondary care, lay, public health and industry.

Aomesh Bhatt
Industry representative

Peter Robb (Chair)
Consultant ENT surgeon, Epsom and St Helier University Hospitals Trust and The Royal Surrey County NHS Trusts

Christine Hine
Consultant in public health, Bristol and South Gloucestershire PCT

John Seddon
Lay representative, Chairman, V.O.I.C.E.S.

Greg Rogers
Primary care representative, Kent

Appendix C: The algorithms

The full guideline contains the algorithms.

Changes after publication

February 2015: we have removed reference to throat swabs from recommendation 1.3.14, to bring the recommendation into line with Public Health England's Guidance on the public health management of meningococcal disease in the UK.

July 2013: minor maintenance

January 2012: minor maintenance

September 2010: a correction has been made to the full version of this guideline, as well as to the NICE version and the Quick Reference Guide.

The hydrocortisone dosage in the recommendation relating to steroid replacement therapy using low-dose corticosteroids in children and young people with shock that is unresponsive to vasoactive agents has been corrected (NICE guideline recommendation 1.4.45). The original recommendation stated:

In children and young people with shock that is unresponsive to vasoactive agents, steroid replacement therapy using low-dose corticosteroids (hydrocortisone 0.25 mg/m^2 four times daily) should be used only when directed by a paediatric intensivist.

The corrected recommendation reads:

In children and young people with shock that is unresponsive to vasoactive agents, steroid replacement therapy using low-dose corticosteroids (hydrocortisone 25 mg/m^2 four times daily) should be used only when directed by a paediatric intensivist.

This web version has been amended to reflect this correction.

July 2010:

Please note that there is an amended version of the Quick Reference Guide (QRG) for the NICE clinical guideline 102, Bacterial meningitis and meningococcal septicaemia guideline, which was published in June 2010. The amended QRG now reflects the action required when meningococcal meningitis is confirmed in children older than 3 months (page 14). The slide set has also been revised.

About this guideline

NICE clinical guidelines are recommendations about the treatment and care of people with specific diseases and conditions in the NHS in England and Wales.

The guideline was developed by the National Collaborating Centre for Women's and Children's Health. The Collaborating Centre worked with a group of healthcare professionals (including consultants, GPs and nurses), patients and carers, and technical staff, who reviewed the evidence and drafted the recommendations. The recommendations were finalised after public consultation.

The methods and processes for developing NICE clinical guidelines are described in The guidelines manual.

We have produced information for the public explaining this guideline. Tools to help you put the guideline into practice and information about the evidence it is based on are also available.

Your responsibility

This guidance represents the view of NICE, which was arrived at after careful consideration of the evidence available. Healthcare professionals are expected to take it fully into account when exercising their clinical judgement. However, the guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer, and informed by the summary of product characteristics of any drugs they are considering.

Implementation of this guidance is the responsibility of local commissioners and/or providers. Commissioners and providers are reminded that it is their responsibility to implement the guidance, in their local context, in light of their duties to avoid unlawful discrimination and to have regard to promoting equality of opportunity. Nothing in this guidance should be interpreted in a way that would be inconsistent with compliance with those duties.

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