LRI Children's Hospital

Management of Bacterial Meningitis in Children

Staff relevant to:	Clinicians working in Leicester Children's Hospital, caring for children or Young People with suspected or confirmed bacterial meningitis.
Team approval date:	November 2024
Version:	V 5
Revision due:	November 2027
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Trust Ref:	C22/2014

Related guidance

Sepsis UHL Childrens Hospital Guideline (D4/2022)

Primary Immunodeficiency - Suspected UHL Childrens Medical Guideline (C4/2015)

Raised Intracranial Pressure UHL Childrens Hospital Guideline(C22/2019)

Lumbar Puncture UHL Childrens Hospital Guideline (C82/2007)

Encephalitis UHL Childrens Medical Guideline (C21/2014)

1. Introduction and Who Guideline applies to

This guideline is intended for the use of clinicians working within the UHL Children's Hospital caring for children presenting with signs and symptoms of meningitis between 0-18 years of age.

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.

Bacterial meningitis in children and young people is associated with considerable mortality and morbidity. In the United Kingdom mortality can range from 2% to 11% and are especially high (about 10%) in neonates. Those who recover from bacterial meningitis can have considerable ongoing morbidities. Prompt treatment is necessary to reduce morbidity and mortality.

Acute Management of Bacterial Meningitis in Children and Young People

Signs and symptoms

Box 1- These can be non-specific, especially in a young child:
Red Flag Combination:
Fever, Headache, altered consciousness.
These can be difficult to detect in babies and young children. See Table on p3/4 for further details and other signs/symptoms.

THINK- could this be Encephalitis or disseminated HSV- refer to Encephalitis guidelines

Check airway,breathing and circulation, signs of shock, or raised Intracranial Pressure (RICP) gain vascular/IO access, ABCDE

Box 2 -Assessment -Call for senior help

Airway -and apply 15 l/min facial O_2
Breathing – support as necessary
Circulation -IV cannula (IO if unable to gain access) - with bloods as below*
-If shocked (tachycardia, cold peripheries, capillary refill >2 seconds)
-Treat with fluid bolus - 20ml/Kg 0.9% Saline, reassess and repeat as necessary. Keep regular measurement of BP
Disability-Check blood sugar, assess conscious level (GCS or AVPU)
-Assess for signs of raised intra-cranial pressure (raised BP, low Heart rate, reduced GCS. See raised ICP guideline C22/2019)
-Assess neurology – cranial nerves, focal signs?
Exposure- Temperature**,** Rashes – e.g. meningococcal

Perform diagnostic tests

Lab Investigations- blood gas (bicarb, base deficit, lactate, blood glucose), Blood culture, BC, U&E, bone profile, clotting, CRP,
Meningococcal and Pneumococcal PCR.
Also take urine MC+S, and bacterial throat swab.

Perform Lumbar puncture, unless contraindicated (See LP Children's guideline C82/2007)

Contraindications for LP
- clinical or radiological signs of RICP-**will need to stabilise to perform CT Head prior to LP Refer to RICP guidelines for signs and management**
- infection at LP site
- Extensive/spreading purpura

Stabilise the following before LP
- Unprotected airway/respiratory compromise
- shock
- uncontrolled seizures
- bleeding risk

DO NOT DELAY ANTIBIOTICS
Give antibiotics within 1HOUR
See page 3 and BNFc

Further management-refer to guidelines below

Sending CSF- Microscopy & Gram stain, culture, sensitivity, HSV, VZV and enterovirus PCR**.** Send 0.5ml in universal containers 1 &3
Chemistry- Glucose, protein. Send 5-10 drops universal container 2 and yellow blood bottle- **Please remember to check serum glucose at time of LP**
Samples must be hand delivered to the lab and microbiology technician to be informed

Recognising bacterial meningitis

Beware that it is a rapidly evolving condition, and may present with non-specific symptoms and signs (and without the red flag combination), particularly in babies and young children. **Strongly suspect bacterial meningitis in people with all the symptoms in the red flag combination. However, bacterial meningitis can be strongly suspected based on clinical assessment, even if these are not present.** Take a history to include: head trauma, immunisation history, medications (including immunosuppression).

Red flag combination	**Notes**
Fever, headache, neck stiffness, and altered level of consciousness or cognition (including confusion or delirium)	Fever and neck stiffness are less common in babies. Headache and neck stiffness are harder to identify in babies and young children.

Other signs and symptoms of Meningitis

Appearance	
Bulging fontanelle	In babies and young children with an open fontanelle.
Fever	Fever, headache, neck stiffness and altered level of consciousness or cognition are the red flag combination for bacterial meningitis. Fever is less common in babies. Ask the child or young person (or their family members or carers) if they have taken antipyretics, because this may make fever harder to identify.
Ill appearance	Ask the child or young person (or their family members or carers) if they have taken antipyretics, because this may make ill appearance harder to identify.
Non-blanching petechial or purpuric rash	Mainly in meningococcal disease (including meningitis) Check all over the body and look for petechiae in the conjunctivae. May be difficult to see on brown, black or tanned skin
Pale, mottled skin or cyanosis	May be difficult to see on brown, black or tanned skin.
Behaviour	
Irritability	Common in babies and young children.
Lethargy	Common in babies and young children.
Reduced feeding	In babies.
Unusual behaviour	For example, the person may be agitated, aggressive or subdued. Ask family members or carers
Weak, high-pitched or continuous cry	In babies.
Cardiovascular	
Early signs of sepsis Signs of shock	

Neurological	
Altered level of consciousness or altered cognition (including confusion or delirium)	Fever, headache, neck stiffness and altered level of consciousness or cognition are the red flag combination for bacterial meningitis.
Focal neurological deficits	
Headache	Fever, headache, neck stiffness and altered level of consciousness or cognition are the red flag combination for bacterial meningitis. Babies and children and young people with cognitive impairment or communication difficulties may not be able to report headache.
Neck stiffness, including more subtle discomfort or reluctance to move the neck	Fever, headache, neck stiffness and altered level of consciousness or cognition are the red flag combination for bacterial meningitis. Neck stiffness is less likely and harder to identify in babies. Neck stiffness is harder to identify in children and young people with cognitive impairment or communication difficulties.
Photophobia	Harder to identify in babies.
Seizures	
Respiratory	
Tachypnoea, apnoea, and grunting	Non-specific signs of illness, including sepsis and meningitis in babies.
Other	
Unexplained body pain, including limb, back or abdominal pain	
Vomiting	

Early Management of Bacterial Meningitis in Children and Young people

Antibiotic Therapy

Antimicrobial therapy must be started before LP results are reported.

Microbiology advice should be promptly sought when prescribing antimicrobials in the following scenarios (without delaying the administration of empiric antibiotics to obtain advice):

- Recent travel outside of the UK
- Multiple courses of antimicrobials as an inpatient within the last 3-months
- Child has neuroanatomic defects (inc. presence of CNS shunt)
- Immunodeficiency

Microbiology results must be reviewed as soon as they are available, and the antimicrobial regimen and duration amended.

Empiric antimicrobial choices are as follows.

Younger than 28 days

Cefotaxime 50 mg/kg/dose IV

- Under 7 days old – 12 hourly
- 7 to 20 days – 8 hourly
- 21 to 28 days – 6 hourly

AND

Amoxicillin 50 mg/kg/dose IV (consider doses of 100 mg/kg/dose if considering Listeria)

- Under 7 days old - 12 hourly (under 7 days old)
- 7 to 28 days old – 8 hourly

Only give Gentamicin if meets any of the following:

- Haemodynamic instability (needing inotropes/ICU care)
- Frequent hospitalisations
- Prev NICU/ICU stay
- Recent foreign travel/hospitalisation
- Previous known multi resistant gram negative organisms – to discuss with microbiology if empiric treatment needs to be adjusted.

In this age group, ceftriaxone may be used as an alternative to cefotaxime once clinical recovery is evident, but ceftriaxone should not be used if Corrected Gestational age <41 weeks, or in babies receiving calcium infusions or with jaundice, hypoalbuminaemia, hypercalcaemia or acidosis.

1 to 3 months old

Ceftriaxone IV 80 mg/kg (max 2g) once daily

AND

Amoxicillin IV 50 mg/kg (max 2g) IV 6 hourly **If Listeria is not reported on the 36hr blood culture results, and CSF microscopy (cell count and gram stain) is negative; Amoxicillin can be stopped.**

Older than 3 months old

Ceftriaxone IV 80 mg/kg (max 2g) once daily

If considering Listeria (ie. immunosuppressed patients): Add amoxicillin IV 50 mg/kg (max 2 g) 6 hourly

In cases of allergy, please discuss with microbiology.

Steroids

For people over 3 months with strongly suspected (see p3&4) or confirmed bacterial meningitis, give intravenous dexamethasone.

Prescribe IV dexamethasone 150 micrograms/kg (max 10 mg per dose) every 6 hours for 4 days.

For people receiving dexamethasone:

• give the first dose with or before the first dose of antibiotics if possible

• however, do not delay antibiotics to wait for dexamethasone to be started

• if dexamethasone is delayed for less than 12 hours after the start of antibiotics, give dexamethasone as soon as possible

• if dexamethasone is delayed for more than 12 hours after the start of antibiotics, consider giving only if *Streptococcus pneumoniae* (pneumococcus) or *Haemophilus influenzae* type b (Hib) clinically suspected/ or suspected/confirmed with microbiology results. Discuss with microbiology.

When the causative organism is found:

- continue dexamethasone if it is *Streptococcus pneumoniae* or *Haemophilus influenzae* type b (It is likely at this point that that the typing results for *Haemophilus influenzae* will not be available yet. In such circumstance, discuss with microbiology to risk assess if Hib is likely ie. reviewing vaccination status/travel history/immunocompromised/contact with a known Hib case).
- stop dexamethasone for all other organisms.

If no causative organism is found, and there continues to be a strong suspicion of bacterial meningitis, continue 4 days of Dexamethasone.

Initial Fluid Management

- Children may require fluid boluses to maintain circulation
- Normal maintenance fluids unless SIADH suspected (*serum*- low Na & low osmolality, *Urine*- raised Na / high osmolality) when restrict to 2/3rds.
- After 40 mL/kg, and persistent shock, contact PICU and anaesthetics for assistance in intubation.
- Consider the use of plasmalyte for subsequent boluses if there is evidence for severe capillary leak syndrome.
- Consider the use of inotropes early. Strict fluid balance is essential. Reduced circulating volume e.g. poor perfusion with CRT> 2 seconds requires volume boluses and needs re-evaluation and possible PICU admission.
- Aim to keep systolic BP in high normal range.

Seizures

- May present as a complication of meningitis or encephalitis.
- Please refer Encephalitis guideline (C21/2014) if this is suspected.
- Follow standard acute management as per prolonged seizure guideline (click here) and ensure child is having neuro observations taken and PEW scoring.

Indication for CT Scan

Do not delay treatment to undertake a CT scan. Clinically stabilise a child before CT scanning. Consult a paediatric intensivist or anaesthetist.

- If a child has uniformly blood stained CSF in a non-traumatic tap then intracranial haemorrhage should be excluded by CT Head, for further information see LP guideline. Lumbar Puncture UHL Childrens Hospital Guideline

- If GCS<9 or focal neurological signs in the absence of an explanation for the clinical features, (looking for complications or differential diagnoses, eg. hydrocephalus, cerebral abscess or NAI).
- There is no place for CT in acute meningitis as a screening process for raised intracranial pressure prior to LP - this should be assessed clinically. Consider CT if still febrile after 72 hours to detect subdural collections (See raised ICP in children guideline C22/2019)

Notifying UK Health Security Agency (UKHSA)

- Ring UKHSA at the earliest opportunity for notification of clinically suspected cases of acute meningitis and/or encephalitis Notifiable diseases and how to report them - GOV.UK (www.gov.uk)
- Chemoprophylaxis is used to eliminate asymptomatic carriage of *N. meningitidis* and Hib with consequent control of further cases.
- See UKHSA guidance for choice and dosage of prophylaxis: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/829326/PHE_meningo_disease_guideline.pdf
- UKHSA should lead on contact tracing and prophylaxis.

PICU/HDU

- Indications for PICU admission:
    - GCS ≤ 8 or AVPU
    - Symptomatic raised intracranial pressure (See raised ICP in children guideline C22/2019)
    - Shock (>40ml/Kg fluid bolus) – likely to need intubation +/- inotropic support.
    - Always consider if the child would be best managed in an HDU or PICU environment. If in doubt discuss with on call consultant

Further Management of Bacterial Meningitis in Children and Young People

Lumbar Puncture

Perform a Lumbar Puncture, if not already completed, once the child is stable. See Lumbar Puncture guideline Lumbar Puncture UHL Childrens Hospital Guideline

Interpretation of CSF

- In a traumatic tap, allow 1 WBC for every 600 RBCs.
- CSF glucose should normally be greater than 50% of blood glucose.
- Low CSF glucose can be seen in bacterial meningitis and TB meningitis.
- A predominance of polymorphs is suggestive of a bacterial cause, and lymphocytes suggest a viral cause. However, polymorph predominance often occurs in early encephalitis.
- A raised protein level can be seen in bacterial meningitis, TB meningitis, tumours, intracranial injury, blood in the CSF and any CNS inflammation.

Normal CSF Results Table				
Age of Child	RBC/mm^3	WBC/mm^3	Protein (g/l)	Gluc
Younger than 28 days	<10	< 20	0.15 – 1	>50% blood gluc
Older than 28 days	<10	< 5	0.15 – 0.45	>50% blood gluc
There is insufficient evidence to guide recommendations for defining the likelihood of bacterial meningitis in neonates based on the CSF WBC alone. It is recognised that neonates can have normal CSF WBCs up to 20 cells/ mm^3. However bacterial meningitis should still be considered if other signs or symptoms are present even in the context of a CSF WBC in the currently accepted normal range.				

Reviewing Antibiotic Therapy

Always review treatment in light of culture and sensitivity results. Review any previous available microbiology results to assess risk of infection with resistant organisms.

If no clinical improvement within 48 hours (for example still febrile) consider subdural collections and antimicrobial resistance. Discuss with microbiology for advice.

The following special circumstances requires consultation with an expert in the concerned field

- The treatment of bacterial meningitis in children with immune deficiency
- recent neurosurgery
- neuro-anatomic defects
- penetrating head trauma
- CSF leak
- During epidemics.

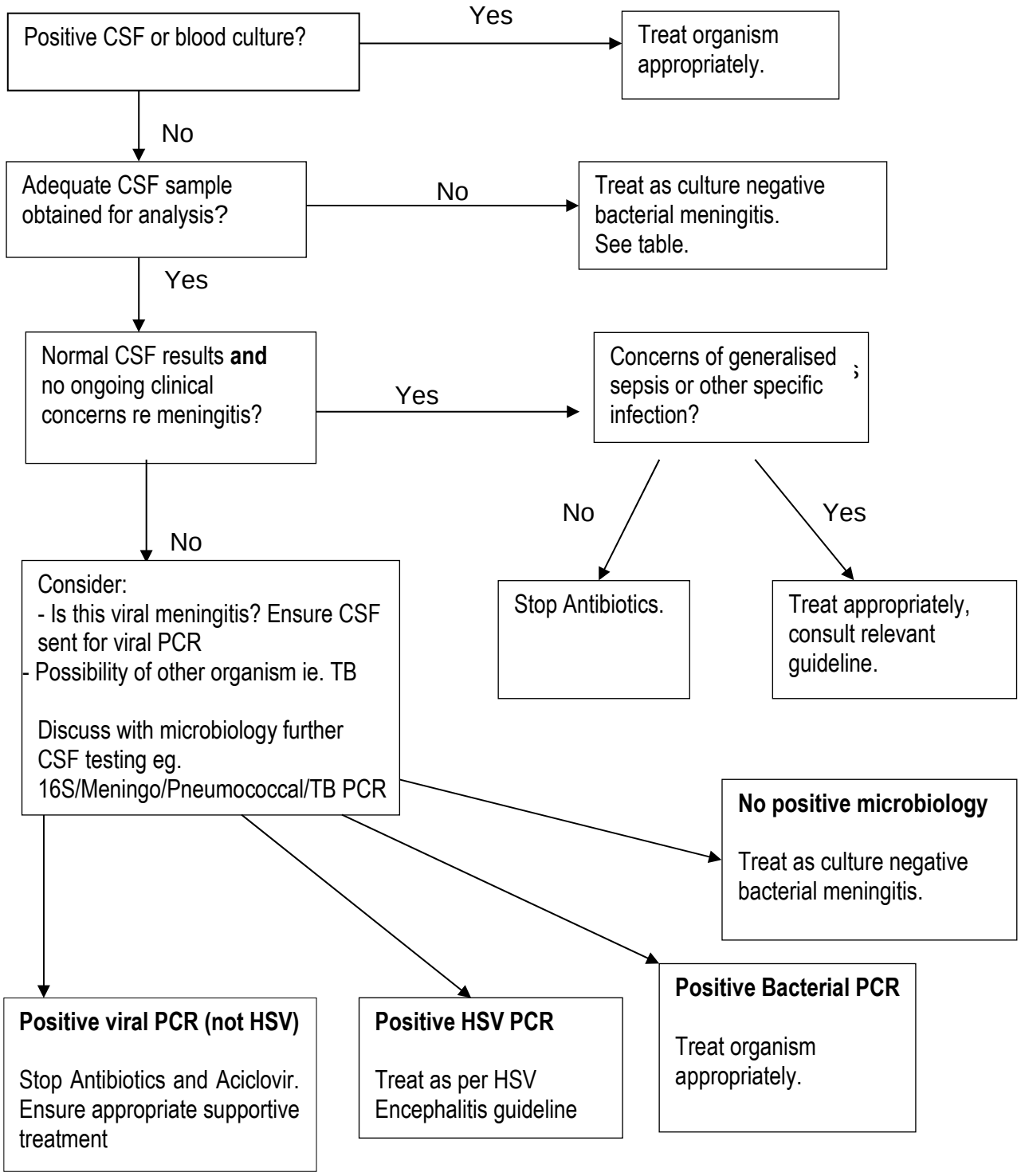
Choice and duration of antimicrobial therapy should be in line with the organism(s), if isolated, and microbiology advice. Generally, the following antimicrobial therapy are advised, **however if the patient has not recovered within this time frame, discuss with microbiology. In cases with complications from bacterial meningitis (ie intracranial abscess, ventriculitis), discuss with microbiology as duration of treatment would need to be prolonged beyond those listed in the table below.**

Organism	Antimicrobial Choice	Duration
Neisseria meningitidis	Cefotaxime/Ceftriaxone	5 days
Haemophilus influenzae	Cefotaxime/Ceftriaxone	7-10 days
Streptococcus pneumoniae	Cefotaxime/Ceftriaxone	10-14 days
Streptococcus Group B	Cefotaxime/Ceftriaxone	14 days

Escherichia coli	Cefotaxime/Ceftriaxone If *E.coli* meningitis is confirmed the baby needs to be screened for galactosaemia.		21 days May need >21 days if complicated, discuss with microbiology
Listeria monocytogenes	Amoxicillin Consider adding gentamicin (discuss with microbiology)		21 days
Culture negative or Lumbar Puncture not available.	Younger than 1 month	Cefotaxime/Ceftriaxone and Amoxicillin	14 days
	2-3 months	Ceftriaxone	14 days
	3 months or older	Ceftriaxone	10 days

In case of allergy – please discuss with microbiology.

Algorithm to reviewing antibiotic therapy



Ward management

- Follow Infection Prevention UHL Policy B4/2005 for advice on isolation and PPE (e.g. masks may be needed for aerosol generating procedures)
- Initially ½ to 1 hourly observations for 1st 4 hours, then 2 hourly for next 8 hours, then if child is stable can move to 4 hourly.
- Include PEW scoring and neuro observations.
- All babies and children with meningitis should have their scalp and back examined to look for signs of a spinal tract.
- A neurological examination should be performed daily.
- Children under 12 months should have an initial head circumference measured & repeated daily.
- Take a history to include: head trauma, immunisation history, medications (including immunosuppression and complement inhibitors).
- Consider long line / PICC line once diagnosis known for long term antibiotics.
- In children with presumed bacterial meningitis (not viral), a hearing test should ideally be arranged before discharge. Once the child is

    - Able to attend the department from the ward or as an outpatient.
    - Able to follow instruction and be as close as possible to the same developmental stage as they were prior to the Meningitis, unless long term developmental issues are apparent.
    - Email paediatricHSD@uhl-tr.nhs.uk with the referral form in appendix B. Subject: Urgent meningitis referral

Follow up & Hearing Test

Follow up should be tailored to a child's needs on discharge, with appropriate neurodevelopmental follow up with the MDT if necessary. If no concerns are identified at discharge, all children should receive a general paediatric follow up in 6-8 weeks. If vaccinations are not up to date, the family should be encouraged to complete the schedule and the GP be made aware. A hearing test should be performed within 4 weeks of presentation, if not completed before discharge.

Immune testing following bacterial meningitis

1) Test children and young people for complement deficiency if they have meningococcal disease and a family history of meningococcal disease or complement deficiency. Perform a C3, C4, CH100 & AP100. This sample needs to be taken on a week day morning and taken straight to the lab for testing.

2) Perform a more comprehensive immunodeficiency screen on children with:
    - more than one episode of bacterial meningitis*, **or**
    - a single episode of pneumococcal meningitis, **or**
    - bacterial meningitis and a history of other recurrent or serious bacterial infections,

    *In this group also consider whether structural anomalies could be a factor.

    In addition to complement testing (see above) these children should have
    HIV test
    Lymphocyte subsets,
    Total Immunoglobulins and
    Specific immunoglobulins to tetanus, Hib (if under 5 years)and Pneumococcus measured(with a vaccination history supplied).

3) Children and young people with pneumococcal meningitis, recurrent episodes of bacterial meningitis and/or other serious infections should be discussed with a specialist in infectious disease or immunology.
4) Consider vaccine failure in vaccinated children with infected with a vaccine preventable organism. (take a careful vaccine history):
(See above for investigation of pneumococcal meningitis)

Haemophilus influenzae type b, Meningococcus A,B,C,W or Y.
In cases of presumed vaccine failure, consider testing total Immunoglobulin levels and other vaccine responses (if fully vaccinated). Please note that a proportion of the 'normal' population may not respond to a particular vaccine, and in the context of normal results and no significant infection history, this does not indicate immune deficiency.

For more guidance see the Investigating Suspected Primary Immunodeficiency prior to Immunology Referral guideline (C4/2015)

2. Education and Training

None required

3. Monitoring Compliance

What will be measured to monitor compliance	How will compliance be monitored	Monitoring Lead	Frequency	Reporting arrangements
Adherence to guideline standards	Audit	R. Radcliffe	3 yearly	Departmental audit meeting.
Adherence to antimicrobial choice and duration	Trust Wide antimicrobial Prescribing Audit	Antimicrobial Pharmacists	Annually	TIPAC, CMG Boards, relevant speciality meetings

4. Supporting References

α. BNF for children, accessed online at: https://bnfc.nice.org.uk/
β. Meningitis (bacterial) and meningococcal septicaemia: recognition, diagnosis and management (NICE CG240): https://www.nice.org.uk/guidance/ng240
χ. Vergnano S, Godbole G, Simbo A*, et al.* Listeria infection in young infants: results from a national surveillance study in the UK and Ireland. *Archives of Disease in Childhood* 2021;**106:**1207-1210.https://adc.bmj.com/content/106/12/1207
δ. https://uk-pas.co.uk/Antimicrobial-Paediatric-Summary-UKPAS.pdf

5.Key Words

Children, Paediatric, Meningitis, Meningococcal, Pneumococcal,

The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.
As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

CONTACT AND REVIEW DETAILS	
Guideline Lead (Name and Title) R Radcliffe	**Executive Lead** Chief Medical Officer

Details of Changes made during review:

Hyperlinks updated;
Page 2 Algorithm Acute Management of Bacterial Meningitis in Children & Young People, reviewed and updated with changes in boxes 1 and 4
Page 3 New section : Recognising bacterial meningitis added
Page 4 Immunodeficiency added to when Microbiology advice is to be promptly sought
Page 5 Empirical Antimicrobial Chart : Amended to read ceftriaxone should not be used if Corrected Gestational age <41 weeks
Page 6 Steriods section reviewed and expanded upon regarding timings of dexamethasone administration included when causative agent found/not found
Page 7 – Indication for CT : 'Detect other intracranial pathologies' removed and GCS >8 updated to GCS >9

- Notifying UKHSA section reviewed and updated

Page 8 – Lumbar puncture added to Further Management Section
– Reviewing Antibiotic Therapy guidance added for when to discuss recovery time/complications with microbiology
Page 9 – 'Possibility of other organism' added to Consider box in Algorithm for reviewing antibiotic therapy
Page 10 – Ward management reviewed, updated and expanded

- 'If vaccinations are not up to date, the family should be encouraged to complete the schedule and the GP be made aware' added to Follow Up and Hearing Test section

Immune Testing – reviewed, updated and expanded

Appendix A

Usual organisms causing bacterial meningitis:

α. Birth – 12 weeks
   i. Group B Streptococcus
   ii. *E.Coli* & other gram –ve organisms
   iii. *Listeria monocytogenes* (Rare over 1 month)

β. 3 months – 4 years
   i. *Neisseria meningitidis*
   ii. *Streptococcus pneumoniae*
   iii. *Haemophilus influenzae* type b (now rare)
   iv. TB (rare but must be considered)

χ. Over 4years
   i. *Neisseria meningitidis*
   ii. *Streptococcus pneumoniae*
   iii. TB (rare but must be considered)