Management of Bacterial Meningitis in infants <3 months

Suspicion of bacterial meningitis?

YES → Feverish infant?

NO → **IMPORTANT**: Around 50% of young infants diagnosed with bacterial meningitis are afebrile on presentation. Do not be reassured by lack of fever in an unwell infant.
THINK: Could this be a case of bacterial meningitis? **BOX 1**

Feverish infant? YES → < 1 month of age?

< 1 month of age? NO → Child appears unwell?

< 1 month of age? YES → Check airway, breathing and circulation; gain vascular access

Child appears unwell? YES → Check airway, breathing and circulation; gain vascular access

THINK: bacterial meningitis?

Check airway, breathing and circulation; gain vascular access → Signs of shock or raised intracranial pressure?

Signs of shock or raised intracranial pressure? YES → **URGENT CARE**
NICE sepsis pathway (CG51), NICE meningococcal pathway (CG102). **Discuss with NICU/PICU**

Signs of shock or raised intracranial pressure? NO → Consider meningitis after resuscitation

INVESTIGATE

Correct any dehydration. Perform blood tests **BOX 2**

Contraindication to Lumbar puncture? **BOX 3**
Discuss with senior if uncertain

Contraindication to Lumbar puncture? NO → **Perform LP** **BOX 2**
Do not delay antibiotics
Get CSF results promptly (Aim <2 hrs)

MANAGE with empiric antibiotics within 1h

1hr

Empiric Antibiotics for suspected meningitis: **BOX 4**
- i.v. Cefotaxime + Amoxicillin
- Can replace Cefotaxime with Ceftriaxone if no contraindication **BOX 5**
- Consider i.v. Meropenem in babies at high risk of multi-drug resistant Gram negative infections (MDRGN) e.g. Those known to be colonised with MDRGN
- Consider adding Vancomycin if central line or VP shunt in situ

DO NOT DELAY ANTIBIOTICS - start within 1 hour of suspecting bacterial meningitis

EXPEDITE LP results

2hr

Lumbar puncture results available? (Aim <2h)

Lumbar puncture results available? YES → Results suggest meningitis? **BOX 6**

Lumbar puncture results available? NO → Results suggest meningitis? **BOX 6**

Results suggest meningitis? NO → Cell count is normal in 10% of cases - still consider BM if other features present. Consider other causes - sepsis/ inflammation.
Consider NICE guidance: Sepsis, NG51 and Feverish Illness in Children CG160

Results suggest meningitis? YES →
- Consider TB meningitis where risk factors exist. Refer to NICE CG117 for correct treatment
- Consider Herpes simplex infection **BOX 7**

Signs of:
- Reduced or fluctuating conscious level?
- Seizures?
- Shock?

Signs of: YES → **URGENT CARE**
APLS management
Discuss with/transfer to NICU/PICU

Signs of: NO →
- 100% maintenance fluids: enteral feeds if tolerated or isotonic i.v. fluids e.g. 0.9% Sodium Chloride with 5% Glucose
- Do not restrict fluids unless there is evidence of increased ADH secretion (SIADH) or Raised intracranial pressure (RICP)
- Monitor fluid administration, urine output, electrolytes and blood glucose
- Consideration of imaging
- Perform LP when contraindication no longer present **BOX 2** **BOX 3**
- Liaise with neurosurgical/PID unit if complications

MONITORING, REPEATED REVIEW AND ESCALATION OF CARE **BOX 8**

Specific pathogen identified? YES

Specific pathogen identified? NO

Antibiotics for confirmed meningitis
• Group B Strep: i.v. Cefotaxime for at least 14 days **OR** i.v. Benzylpenicillin for at least 14 days plus i.v. Gentamicin for first 5 days • N. meningitidis: i.v. Ceftriaxone for 7 days
• H. influenzae: i.v. Ceftriaxone for 10 days • S. pneumoniae: i.v. Ceftriaxone for 14 days • L. monocytogenes: i.v. Amoxicillin for 21 days in total plus i.v. Gentamicin for at least the first 7 days • Gram-negative bacilli: i.v. Cefotaxime for ≥ 21 days unless directed otherwise by antibiotic sensitivities
Duration may be dictated by clinical response, if poor/ complicated d/w microbiology or ID expert
Ceftriaxone & Cefotaxime are interchangeable **BOX 5**

Antibiotics for unconfirmed meningitis (viral PCR negative)
- i.v. Cefotaxime + Amoxicillin for 14 days **BOX 9**
- Ceftriaxone & Cefotaxime are interchangeable **BOX 5**

Consider ambulatory/home antibiotics in selected cases

Follow up & Long-term management **BOX 10**

Notify public health

See public health guidance for prophylaxis of household contacts:
Meningococcal Disease: http://tinyurl.com/UKmeningo
Hib: http://tinyurl.com/UKHib

Follow up schedule

Hearing test
4 weeks

Follow-up appointment
6 weeks

Follow-up appointment
2 years

BOX 1 Consider perinatal risk factors[1].
Clinical features in infants <3 months (% of cases):
• Poor feeding (67%) • Lethargy (63%) • Irritability (63%) • Fever (53%) • Respiratory distress including grunting (44%) and/or need for mechanical ventilation in a term baby • Poor perfusion (44%) • Temperature instability (20%) • Apnoea (23%) • Bulging fontanelle (20%) • Seizures (24%) • Coma (5%) • Neck stiffness (3%) • Irritability in combination with fever (41%)

BOX 2 Diagnostic tests:
• **Blood** – If limited volume prioritise blood gas, glucose, lactate, electrolytes, FBC and clotting. Also - Blood culture, CRP, U&E/LFT, Whole-blood (EDTA specimen) for PCR.
N.B. initial CRP may be normal
• **CSF** – MC&S, glucose, protein, Viral PCR (herpes, enterovirus, parechovirus) and bacterial PCR. LP information leaflet available for parents[2]

BOX 3 Contraindications to Lumbar Puncture
- Shock • Coma
- After convulsions until stabilised or convulsions >30mins
- Coagulation abnormalities:
  - clotting study results (if obtained) outside normal range
  - platelet count below 100 x 10^9/L
  - on Anticoagulant therapy
- Local superficial infection at LP site
- Respiratory insufficiency
- Other Clinical or radiological signs of raised intracranial pressure (RICP):
  - Reduced (GCS ≤8) or fluctuating level of consciousness • Relative Bradycardia and Hypertension • Focal neurological signs • Abnormal posture or posturing • Unequal, dilated or poorly responsive pupils • Papilloedema (late sign) • Abnormal 'doll's eye' movements

Perform delayed LP in infants with suspected bacterial meningitis when contraindications no longer present

BOX 4 Antibiotic doses:
Cefotaxime 50mg/kg. <7 days every 12hrs, 7-21 days every 8hrs, 21-28 days every 6-8hrs, >1 month every 6hrs. Max 12g/day
Amoxicillin 100mg/kg. <7 days every 12hrs, 7-28 days every 8hrs. Max 2g every 4hrs.
Vancomycin 15mg/kg, adjusted according to plasma concentration. <29 weeks corrected gestational age (CGA) every 24hrs, 29-34 weeks CGA every 12hrs, >35 weeks CGA every 8hrs. Max 2g daily.
Meropenem 40mg/kg. <7 days every 12hrs, >7 days every 8hrs

BOX 5 Contraindications to Ceftriaxone: as per BNFc
- <41weeks corrected gestational age
- Neonates >41weeks corrected gestational age with:
  - Jaundice • Acidosis • Hypoalbuminaemia
  - Simultaneous administration of calcium-containing infusions (inc total parenteral nutrition containing calcium)

BOX 6 Lumbar puncture results suggestive of meningitis:
- In neonates (<30 days old), ≥ 20 cells/µl
- In 29-89 day olds > 10 cells/µl
- Repeat LP if CSF blood stained or difficult to interpret and treat as meningitis until result known.

Do not wait for LP results before starting antibiotics

BOX 7 Herpes simplex infection
- If HSV is in differential diagnosis give Aciclovir.
- HSV may be suspected in the presence of seizures, abnormal LFT, abnormal clotting, vesicular rash, maternal history, negative Gram stain/cultures.
- Send CSF for PCR if Gram stain negative and no growth

BOX 8 Repeat LP after starting treatment if:
- Persistent or re-emergent fever • New clinical findings (esp. neurological) • Deteriorating clinical condition
- Persistently abnormal inflammatory markers

BOX 9 Empirical antibiotics for infants <90 days
Giving amoxicillin to cover the possibility of listeria up to the age of 3 months in addition to a 3rd generation cephalosporin, conforms to current NICE guidelines. However, research increasingly challenges the need for this, showing that Listeria infection in infants aged >30 days is very rare[3,4,5]. Future updates of NICE guidelines may be revised to reflect this

BOX 10 Long-term management:
- Use MRF discharge checklist https://www.meningitis.org/healthcare-professionals/resources
- Before discharge: consider need for after care, discuss potential long-term effects with parents and arrange hearing test within 4 weeks of being fit enough to test. Refer severe or profoundly deaf children for cochlear implant assessment ASAP. Direct to support organisations such as Meningitis Research Foundation, Meningitis Now & GBS Support.
- Arrange paediatric review with results of hearing test 4-6 weeks after discharge from hospital. Consider all potential morbidities at discharge and offer referral. Inform GP and health visitor.

Follow up until at least 2 years of age

This algorithm was created after MRF funded research identified delays in recognition and differences in the hospital management of young infants with bacterial meningitis(6).

Recommendations are based on the current evidence from literature and incorporate NICE Bacterial Meningitis and Meningococcal Septicaemia Guideline CG102.
Adapted from MRF's "Management of Bacterial Meningitis in Children and Young People" algorithm.
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1. NICE Neonatal infection (early onset): antibiotics for prevention and treatment (CG149) 2. LP Information sheet for parents. Available from http://bit.ly/MRFL-P. 3. Okike, I.O., et al., Empirical antibiotic cover for Listeria monocytogenes infection beyond the neonatal period: a time for change? Arch Dis Child, 2015. 100(5): p. 423-5. 4. Okike, I.O., R.F. Lamont, and P.T. Heath, Do we really need to worry about Listeria in newborn infants? Pediatr Infect Dis J, 2013. 32(4): p. 405-6. 5. Malley, Garg A, Monaghan M, Kampmann B. Prescribing amoxicillin for babies up to 3 months of age: definitely time for change Arch Dis Child, 2016;0:1. 6. Okike, I.O., et al., Assessment of healthcare delivery in the early management of bacterial meningitis in UK young infants: an observational study. BMJ Open, 2017. 7(8): p. e015700.
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