Guideline

Ministry of Health, NSW
73 Miller Street North Sydney NSW 2060
Locked Mail Bag 961 North Sydney NSW 2059
Telephone (02) 9391 9000 Fax (02) 9391 9101
http://www.health.nsw.gov.au/policies/

Infants and Children: Acute Management of Bacterial Meningitis: Clinical Practice Guideline

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Summary Clinical Practice Guidelines for the acute management of infants and children with bacterial meningitis.

Replaces Doc. No. Infants and Children: Acute Management of Bacterial Meningitis [PD2013_044]

Author Branch NSW Kids and Families

Branch contact NSW Kids and Families 02 9391 9764

Applies to Local Health Districts, Board Governed Statutory Health Corporations, Specialty Network Governed Statutory Health Corporations, Affiliated Health Organisations, Community Health Centres, Public Health Units, Public Hospitals

Audience Emergency Departments, Paediatric Units

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GUIDELINE SUMMARY

INFANTS AND CHILDREN: ACUTE MANAGEMENT OF BACTERIAL MENINGITIS: CLINICAL PRACTICE GUIDELINE

PURPOSE

The *Infants and Children: Acute Management of Bacterial Meningitis: Clinical Practice Guideline* has been developed to provide direction to clinicians and is aimed at achieving the best possible paediatric care in all parts of the state.

The Clinical Practice Guideline was prepared for the NSW Ministry of Health by an expert clinical reference group under the auspice of the state wide Paediatric Clinical Practice Guideline Steering Group.

KEY PRINCIPLES

This guideline applies to all facilities where paediatric patients are managed. It requires the Chief Executives of all Local Health Districts to have local guidelines based on the attached Clinical Practice Guideline in place in all hospitals and facilities that are required to assess or manage children with bacterial meningitis.

The clinical practice guideline reflects what is currently regarded as a safe and appropriate approach to the acute management of bacterial meningitis in infants and children. However, as in any clinical situation there may be factors which cannot be covered by a single set of guidelines. This document should be used as a guide, rather than as a complete authoritative statement of procedures to be followed in respect of each individual presentation. **It does not replace the need for the application of clinical judgement to each individual presentation.**

USE OF THE GUIDELINE

Chief Executives must ensure:

- Local protocols are developed based on the *Infants and Children: Acute Management of Bacterial Meningitis* Clinical Practice Guideline
- Local protocols are in place in all hospitals and facilities likely to be required to assess or manage paediatric patients with bacterial meningitis
- Ensure that all staff treating paediatric patients are educated in the use of the locally developed paediatric protocols.

Directors of Clinical Governance are required to inform relevant clinical staff treating paediatric patients of the revised protocols.

REVISION HISTORY

Version	Approved by	Amendment notes
July 2014 (GL2014_013)	Deputy Secretary, Population and Public Health	Fourth edition: Some medication dosages have been revised and typographical and formatting changes aligned.
December 2013 (PD2013_044)		Third edition: The antibiotic section of the document has been revised to align with NSW Health (Clinical Excellence Commission) “Sepsis Pathway” antibiotic guidelines.
August 2012 (PD2012_065)	Deputy Director-General Strategic Development	Second edition: The document has been revised to make some concepts clearer or more succinct, with an increase in emphasis for consultation with senior medical staff. The antibiotic dosing schedule has been revised and guidance on the duration of antibiotics has been added.
January 2005 (PD2005_383)	Director-General	New policy

ATTACHMENT

1. Infants and Children: Acute Management of Bacterial Meningitis: Clinical Practice Guideline.

Infants and children: Acute management of bacterial meningitis

fourth edition

CLINICAL PRACTICE GUIDELINES

NSW KIDS + FAMILIES

NSW GOVERNMENT Health

NSW MINISTRY OF HEALTH
73 Miller Street
North Sydney NSW 2060
Tel. (02) 9391 9000
Fax. (02) 9391 9101
www.health.nsw.gov.au

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This Clinical Practice Guideline booklet is extracted from the GL2014_013 and as a result, this booklet may be varied, withdrawn or replaced at any time. Compliance with the information in this booklet is mandatory for NSW Health.

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For further copies of this document please contact:
The Better Health Centre
PO Box 672
NORTH RYDE 2113
Tel. (02) 9887 5450
Fax. (02) 9887 5452

Further copies of this document can be downloaded from the NSW Health website: www.health.nsw.gov.au

July 2014
A revision of this document is due in 2016.

Contents

Introduction

These guidelines are aimed at achieving the best possible paediatric care in all parts of the State. The document should not be seen as a stringent set of rules to be applied without the clinical input and discretion of the managing professionals. Each patient should be individually evaluated and a decision made as to appropriate management in order to achieve the best clinical outcome.

Field, M.J. & Lohr, K.N. (1990) define clinical practice guidelines as:

> *'systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances.'* (Field MJ, Lohr KN (Eds). Clinical Practice Guidelines: Directions for a New Program, Institute of Medicine, Washington, DC: National Academy Press)

It should be noted that this document reflects what is currently regarded as a safe and appropriate approach to care. However, as in any clinical situation there may be factors which cannot be covered by a single set of guidelines and therefore this document should be used as a guide, rather than as a complete authoritative statement of procedures to be followed in respect of each individual presentation. It does not replace the need for the application of clinical judgment to each individual presentation.

This document represents clinical practice guidelines for the acute management of bacterial meningitis in children. Further information may be required in practice; suitable widely available resources are included in Appendix Three.

Each Local Health District and Specialty Health Network is responsible for ensuring that local protocols based on these guidelines are developed. They are also responsible for ensuring that all staff treating paediatric patients are educated in the use of the locally developed paediatric guidelines and protocols.

In the interests of patient care it is critical that contemporaneous, accurate and complete documentation is maintained during the course of patient management from arrival to discharge.

Parental anxiety should not be discounted: it is often of significance even if the child does not appear especially unwell.

Changes from previous clinical practice guideline (incorporated in 2nd & 3rd editions)

The following outlines changes to the document:

- The document, in general, has been revised to make some concepts clearer or more succinct;
- There is an increase in emphasis for consultation with senior medical staff
- A comment on considering Herpes Simplex Virus (HSV) infection in newborns in the differential diagnosis has been added;
- Interpretation of cerebrospinal fluid (CSF) parameters has been simplified (please note that the neonatal CSF white cell count (WCC) recommendation remains the same, with an accompanying note below table);
- A section on epidemiology of meningococcus and streptococcus in Australia has been added;
- A section on antibiotic resistance in Australia has been added;
- The antibiotic dosing schedule has been revised. Neonatal dosing has been included. Recommendations for alternative antibiotics in hypersensitivity to penicillin have been added.
- Guidance on the duration of antibiotics has been added;
- A link to the NSW Health (Clinical Excellence Commission) *Sepsis Pathway* has been included;
- The section on steroids has been modified and simplified;
- The "Nursing/Triage" section has been expanded;
- UK National Institute for Health and Clinical Excellence (NICE) guidelines 2010 have been added as a reference source;
- Updates to the fact sheet for parents have been recommended.

Changes to 4th edition are limited to revision of some medication dosages and typographical and formatting alignment.

Key points in the acute management of bacterial meningitis in children

First Principles

- A **high index of suspicion for meningitis** must be maintained in infants or children presenting with any signs of sepsis, particularly if there is no focus or there is altered mental status;
- Prompt recognition and early management are key goals;
- **Early consultation** with **senior paediatric** or **senior Emergency Department (ED) staff** must occur in all cases of suspected meningitis.

Clinical Presentation

- Not all patients will have fever, neck stiffness and altered mental status at presentation in acute bacterial meningitis;
- The younger the patient, the more subtle the symptoms and signs and the higher the level of suspicion should be;
- Clinical presentations can be acute (hours to 1 - 2 days) to insidious (over a few days);
- Preceding upper respiratory tract infection is often present (~ 75%);
- Seizures occur in 20–30%;
- Prior antibiotics modify presentation and diagnostic yield, and should **always** be part of the history.

Initial Management

- The priorities are ensuring the adequacy of Airway, Breathing, Circulation, Disability (level of consciousness), Exposure (rash assessment and environmental control), Fluids and Glucose i.e. "ABCDEFG";
- The risks from inadequate cerebral circulation may be higher than the risks of cerebral oedema so volume expanders should be titrated against the patient's perfusion;
- If venous access is significantly difficult, an intraosseous needle should be used;
- Seizures should be managed urgently;
- A bedside whole blood glucose reading (reflectance meter) e.g. "Dextrostix™", should be performed as part of the early assessment, especially in infants;
- Electrolyte and glucose abnormalities should be addressed.

Diagnosis

- Ensuring the adequacy of the ABCDEFG has priority over establishing a precise diagnosis;
- CSF examination provides the definitive diagnosis. Blood cultures may provide supportive evidence. Ideally, CSF via lumbar puncture (LP) and blood cultures should be taken **prior** to antibiotic therapy but should not take precedence over timely antibiotics in sick children;

- Other tests(WCC: total and differential CRP, ESR) are not specific for meningitis. Taken in the correct clinical context, they may be useful additional indicators of a significant bacterial infection. Clinical decisions **must not** be dictated by these in isolation;
- The initiation of appropriate antibiotic therapy assumes **high priority**. If the patient is too sick or unstable for immediate definitive investigations, then appropriate antibiotics should be commenced (intravenous, intramuscular or intraosseous route);
- The LP should be performed when the patient is resuscitated and stable provided there are no signs of raised intracranial pressure (ICP) or other contraindications (section 5);
- Neuroimaging (e.g. head cerebral computed tomogram (CT) scan or MRI) is not part of the routine workup. Neuroimaging is indicated only in specific situations (section 5) and should only be done when the patient is stable;
- The limits of sensitivity of the CSF diagnostic tests, especially if pre-treated with parenteral antibiotics, should be recognised;
- CSF samples should be expeditiously transported to the laboratory and urgently analysed.

Steroid therapy

- The early use (just before or with first dose of antibiotics) of adjunctive steroid therapy in children who have not been pre-treated with antibiotics, is recommended in children ≥ 3 months of age;
- There is insufficient information to recommend steroids in the < 3 months age group.

Thus, in suspected / confirmed acute bacterial meningitis, commence steroids if:

- ≥ 3 months of age;
- not pre-treated with parenteral antibiotics.

Regimen

- Dexamethasone, 0.15 mg/kg/dose IV (maximum dose 10 mg), 6 hourly for four days*;
- Give as a "push" followed by first dose of antibiotics for practical purposes.

***Note: The decision to continue steroids for 4 days should be reviewed after laboratory and microbiological information (CSF and/ or blood) becomes available over the next ≥ 48 hours (section 7).**

Antibiotic therapy

The recommended empiric antibiotic therapy is:

Neonates to 3 months:
Ampicillin (or benzylpenicillin) plus cefotaxime

(Ceftriaxone should not be used in neonates–except in extraordinary circumstances where cefotaxime is not available)

Note: If HSV encephalitis is suspected in newborns, aciclovir (20 mg/kg/dose IV, 8 hourly) should be commenced until further clinical information is available

≥ **3 months:**
Cefotaxime or ceftriaxone
(NB: Ceftriaxone should **not** be administered concurrently with calcium containing fluids)

When infection with antibiotic resistant *Streptococcus pneumoniae* is suspected, vancomycin should be **added**. Mono therapy with vancomycin is **not** recommended. Stop vancomyin when cultures confirm a penicillin or 3rd generation cephalosporin sensitive *Streptococcus pneumoniae* strain.

In case of **penicillin anaphylaxis** use moxifloxacin (10mg/kg/dose IV, 24 hourly, maximum dose 400mg) or ciprofloxacin (10mg/kg/dose IV, 12 hourly, maximum dose 400mg) plus vancomycin.

For further information regarding antibiotics, as well as dilutions and options for delivery, including intraosseous, see *NSW Health Paediatric Sepsis Toolkit* (www.cec.health.nsw.gov.au/programs/sepsis).

Infection control and prevention

- Appropriate infection prevention and control measures must be observed;
- Standard and transmission based (droplet) precautions must be observed and appropriate personal protective equipment used when attending to patient and contact with body secretions/fluid is expected;
- Isolation of patients must be considered, particularly if meningococcal infection is suspected.

Further acute care

- Once the patient is resuscitated and stabilised, further management and investigations can be arranged under direction of the responsible team;
- The decision to transfer the patient or to continue to provide care locally will be determined by the local resources and the patient's needs;
- If there is doubt, then a tertiary centre should be consulted as soon as possible. This can be done via the NETS Clinical Coordination Centre **(1300 36 2500)**;
- If the patient is to be transferred, the degree of urgency and the use of a retrieval team should also be discussed as soon as possible. Use of the NETS line allows for simultaneous consultation and transfer.

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Algorithm: Acute management of suspected bacterial meningitis in children

(Use in conjunction with text)

Clinical presentations (Section 1)
- History & examination
- Clinical presentation by age (1.1)
- Presentation with prior antibiotics (1.2)
- Complications (1.3)

Minimize delay in diagnosis (Section 2)

Initial management (Section 3)
- ABCDEFG (section 3.1)
- Seizures (section 3.2)

Diagnostic tests (Sections 4 & 5)

Triage Category 1*
*The Australasian Triage Scale (ATS): Table 8.2 of the Emergency Triage Education Kit

CHILD CLINICALLY SUSPECTED OF HAVING MENINGITIS* (Section 1)
Note: Consult a senior staff member if in doubt

ASSESS AND ATTEND TO AIRWAY, BREATHING, CIRCULATION, LEVEL OF CONSCIOUSNESS +/- SEIZURES, FLUIDS AND GLUCOSE * (Section 3)

PATIENT STABLE

- Take blood for investigations (Section 4 & Table 1) at the time of establishing IV access if practical
- "Routine" tests include: Blood cultures, FBC/diff, U&E/Creatinine, blood glucose

INDICATION TO DELAY LP? (Section 5)

NO

CONSULT SENIOR STAFF

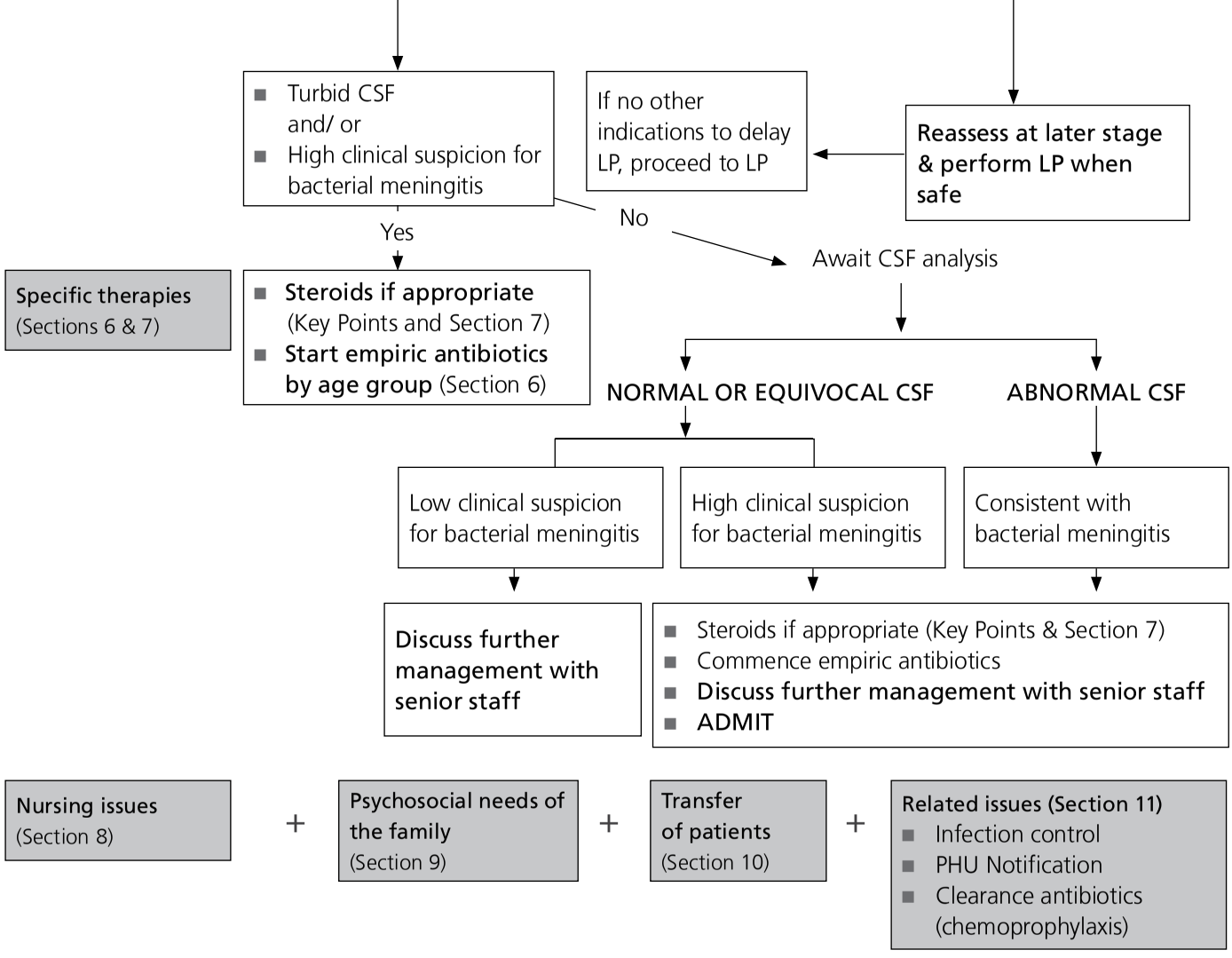
LUMBAR PUNCTURE# (Sections 4 and 5)

Expedite lab analysis of the CSF
- M/C/S: urgent microscopy, culture and sensitivity
- Protein
- Glucose – best interpreted with concurrent serum glucose

YES

CONSULT SENIOR STAFF

- Blood cultures
- Assess need for empiric antibiotic cover before further investigations


Turbid CSF
and/ or
High clinical suspicion for bacterial meningitis
If no other indications to delay LP, proceed to LP
Reassess at later stage & perform LP when safe
Yes
No
Await CSF analysis
Specific therapies (Sections 6 & 7)
Steroids if appropriate (Key Points and Section 7)
Start empiric antibiotics by age group (Section 6)
NORMAL OR EQUIVOCAL CSF
ABNORMAL CSF
Low clinical suspicion for bacterial meningitis
High clinical suspicion for bacterial meningitis
Consistent with bacterial meningitis
Discuss further management with senior staff
Steroids if appropriate (Key Points & Section 7)
Commence empiric antibiotics
Discuss further management with senior staff
ADMIT
Nursing issues (Section 8)
+
Psychosocial needs of the family (Section 9)
+
Transfer of patients (Section 10)
+
Related issues (Section 11)
Infection control
PHU Notification
Clearance antibiotics (chemoprophylaxis)

Assessment and initial management of bacterial meningitis

Bacterial meningitis is a medical emergency. Despite medical advances, acute bacterial meningitis continues to be a disease with high mortality and morbidity. Bacterial meningitis in childhood is associated with morbidity rates of ~20% and mortality rates of ~ 5% in developed countries[1] even after widespread pneumococcal vaccination.[2]

These guidelines describe basic clinical practice in the acute assessment and management of bacterial meningitis in otherwise healthy infants and children. They are intended for medical and nursing staff working in an emergency department (ED) and focus on the acute management in the ED. Follow-up management is outside the scope of this document. It is anticipated that modifications may be required for local practice. Variations in management may also be required in individual cases. It is stressed that the guidelines are, by necessity, general in nature and are not intended as a substitute for clinical judgement.

Early consultation with a senior ED or paediatric staff member must occur in all cases of suspected meningitis. If working in an environment where no senior emergency or paediatric staff are immediately available, **early consultation with senior clinical staff from your referral hospital** must be undertaken, without delaying patient care.

1. Clinical presentations

- Viral meningitis is more common than bacterial meningitis, particularly in the era of conjugate polysaccharide vaccines (*Haemophilus influenzae* type b (Hib) and Pneumococcus);
- However, it can be difficult to distinguish between viral and bacterial meningitis at the time of presentation. As the clinical manifestations of viral meningitis can be indistinguishable from bacterial meningitis, **it is prudent to assume a bacterial cause in the initial management;**
- *Mycobacterium tuberculosis* (MTB) meningitis is rare in Australia[3] but must also be considered in the differential diagnosis particularly in the context of overseas travel or immigrants from areas with high MTB prevalence.

1.1. Common presentations

- Clinical presentations of bacterial meningitis vary, depending on age, duration of illness, pre-treatment antibiotics, the infecting organism and the patient's response to infection;
- The presentations could be insidious (evolving over a few days) or acute (fulminant) (occurring over a few hours);[4]
- Fever, seizures, meningeal signs and/or altered consciousness are consistent features of acute bacterial meningitis;[5]
- Overall, severity of illness at presentation[6] including level of

consciousness at admission[7] appear most predictive of outcome;

- The procedure of taking a history and examination of a child presenting with suspected meningitis is the same as any acutely unwell child. In addition to the usual history and examination, ask about:
  - Age (~ 90% of bacterial meningitis occurs at age < 5 years);
  - Vaccination history;
  - Predisposing factors: recent infections, known contact with someone with meningitis, recent travel, head trauma or cranial surgery and maternal obstetric history if child < 3 months, including maternal group B streptococcus status;
  - Recent use of antibiotics;
  - Drug allergies.

0 – 3 months

- The diagnosis may be more difficult in the very young as history and presentations can be non-specific. Features include:
  - Fever or hypothermia;
  - Bulging fontanelle;
  - Irritability;
  - High pitched cry;
  - Lethargy;
  - Altered mental state;
  - Seizures;
  - Apnoea;
  - Poor feeding;
  - Vomiting.
- **A high index of suspicion for meningitis must exist in sick, febrile or hypothermic newborns with or without the above features.**

Note: Herpes Simplex Virus (HSV) infection in newborns, although uncommon, can present in a similar manner and should be considered in the differential diagnosis.

≥3 months

- Symptoms become more CNS specific after this age. Acute presentations include:[8-10]
  - Fever (not always present on presentation to ED ~ 50% in infants);[6,10]
  - Bulging fontanelle or acute increase in head circumference (more useful in children 2 - 12 months of age);[8]
  - Neck stiffness (60 - 80%, more useful in children > 3 years);[11,12]
  - Kernig's sign (inability to completely extend the leg) in older children. Absence does not exclude meningitis;
  - Brudzinki's sign (flexion at the hip and knee in response to forward flexion of the neck) in older children. Absence does not exclude meningitis;
  - Irritability or lethargy;
  - Altered mental state (highly variable);

- Anorexia, nausea and/or vomiting (a common/non-specific symptom);
- Photophobia (older children);
- Seizures (about 20 - 30% incidence).

NB: Papilloedema in uncomplicated early bacterial meningitis is rare. The presence of papilloedema suggests complications like venous sinus thrombosis, hydrocephalus, abscess or subdural empyema.

1.2. Children who have received prior antibiotics

- The clinical presentations and CSF findings in children who have received previous antibiotics may be modified.[13-15]

Some features include:

- Less frequent presentations with temperature > 38.5°C;
- More frequent vomiting,
- Less frequent alterations in mental status;
- The rate of positive CSF culture and Gram stain recovery may decrease with pre-treatment with antibiotics, but other CSF parameters (like cell count and biochemistry) are not significantly influenced;
- The relationship between polymorphonuclear cells and lymphocytes in CSF may be reversed.

- The time to diagnosis of acute bacterial meningitis may be delayed in children pre-treated with antibiotics but the complication rate is not necessarily increased.[16]

1.3. Complications

- Patients may uncommonly present with early complications of sepsis or raised intracranial pressure which include:
  - Septic shock;
  - Disseminated intravascular coagulopathy (DIC);
  - Purpura fulminans;
  - Waterhouse-Friderichsen syndrome;
  - Cerebral herniation;
  - Neurogenic pulmonary oedema (rare).[17,18]

About 83% of appropriately treated children will have an uncomplicated recovery. However, later complications include cerebrovascular events, subdural effusions, hearing deficits and a range of neurological sequelae.[1]

2. Minimise delay in diagnosis

To avoid a delay in the diagnosis of meningitis, the following important points must be noted:

- The early diagnosis of bacterial meningitis can be difficult even for experienced clinicians – a high index of suspicion should be maintained. **If doubts exist about a diagnosis, consult a senior staff member;**
- Meningitis must be considered in any child with unexplained fever;
- Meningitis needs to be considered in all children presenting with seizures in

association with fever, particularly in children aged < 12 months, or the fever is prolonged in nature or refractory to management;

- Not all children presenting with fever and convulsions will have meningitis.[19] Simple, first febrile seizures in infants aged 6-18 months who appear well have a low risk of bacterial meningitis.[20] However, a high index of suspicion is recommended;
- An apparent explanation for fever e.g. pharyngitis or otitis media does not rule out the possibility of meningitis. A history of a preceding upper respiratory tract infection is present in ~ 75%;[21]
- Maculopapular, petechial or purpuric rashes may sometimes be associated with Neisseria meningitidis meningitis/ septicaemia. Petechiae and/or purpura have also (less commonly) been observed in *Haemophilus influenzae* type b or Streptococcus pneumoniae sepsis;
- Prior oral antibiotics for unexplained fever or other focus may confuse and delay diagnosis;
- Apparent improvement with paracetamol does not exclude a diagnosis of meningitis or other significant disease;
- Examination of any CSF sample taken is **URGENT**. Thus, appropriate labelling of requests, facilitation of delivery of specimens and direct communication with the pathology laboratory is recommended.

3. Initial management

- The assessment of any critically unwell child must always focus initially on resuscitation;
- The diagnostic test for meningitis is the lumbar puncture (LP);
- The LP should not be undertaken until the patient has been resuscitated and stabilised and does not have any contraindications for LP (see section 5.1: Indicators to delay the lumbar puncture);
- Assessment of "**Airway, Breathing, Circulation, Disability** (level of consciousness), **Exposure** (presence of rash, temperature control), **Fluids** (input and output) and **Glucose**" is the first priority;
- Once the patient has been stabilised, the examination should include general assessment looking for features of sepsis and meningitis.

3.1. Resuscitation

3.1a Airway and Breathing

- Ensure that the airway is patent and adequate ventilation is established;
- Supplemental oxygen should **always** be administered;
- If ventilation or oxygenation is inadequate, then respiratory support should be commenced in the form of bag and mask technique, followed by endotracheal intubation.

3.1b Circulation

- Fluid restriction is not an issue in the initial stabilisation of children with meningitis;[22]

- Patients with evidence of shock should be treated with a rapid infusion intravenous/intraosseous crystalloid (0.9% sodium chloride) **20ml/kg;**
- Considerations for fluid restriction (for Syndrome of Inappropriate Anti-diuretic Hormone, SIADH) should only be undertaken once the patient is no longer shocked.

3.1c Disability (level of consciousness)

- If there are signs of cerebral oedema (decreasing level of consciousness, bulging fontanelle, papilloedema, rising blood pressure with falling heart rate), **mannitol 0.25 g/kg/dose IV, infused over 30 mins** (dose range up to 1.0 g/kg) should be given.

3.1d Exposure

- The presence of a rash may be indicative of meningococcal sepsis;
- Regulation of temperature is important in the acute management of children presenting with sepsis.

3.1e Fluids (input/output, urea and electrolytes)

- Fluid restriction is not an issue in the initial stabilisation of children with meningitis;[22]
- Urea and electrolytes must be checked early in the management process and corrected if necessary;
- Ensure patient is adequately hydrated (but not overloaded) by closely monitoring input/output and physical assessment.

3.1f Glucose (blood glucose levels)

- Blood glucose levels must be checked early in the management process and corrected if necessary;
- A bedside whole blood glucose (reflectance meter) e.g. "Dextrostix™" should be performed in the early assessment, especially in infants.

3.2. Seizures

- Seizures should be treated immediately with a rapid injection of a benzodiazepine (e.g. **midazolam, 0.15 mg/kg/dose IV**);
- Alternatively, **midazolam (0.15 – .2 mg/kg/dose IM)** or **buccal or nasal midazolam (0.3 mg/kg/dose buccal or nasal)** or **rectal diazepam (0.5 mg/kg/dose rectal)** could be used. These doses may be repeated at least once by any of the modalities;
- If seizures continue consideration should be given to a loading dose of phenytoin **(20 mg/kg IV in 0.9% sodium chloride, over 20 minutes)**.
- Phenytoin has the benefit of avoiding sedation, although **phenobarbitone (loading dose of 20 mg/kg IV or IM)** is often used to treat seizures in neonates with suspected meningitis.

4. Diagnostic tests

- The laboratory gold standard for establishing the diagnosis of bacterial meningitis is the isolation of the causative bacteria from the cerebrospinal fluid (CSF);

- However, laboratory diagnosis is often made using the combination of blood and/or CSF cultures along with Gram stain and chemical analysis of the CSF.

4.1. Investigations

Table 1 Routine investigations for all patients with suspected bacterial meningitis

Category of test	Tests	Comments
Microbiology	BLOOD Blood cultures CSF M/C/S (microscopy, culture and sensitivity)	Valuable, particularly if CSF analysis is not possible Microscopy includes Gram stain and WCC and differential (for urgent analysis)
Haematology	BLOOD FBC, WCC differential + film	A low or normal WCC does not exclude meningitis Thrombocytopaenia can occur in DIC
Biochemistry	BLOOD Urea, Electrolytes, Creatinine, BGL, LFTs CSF CSF protein, glucose	Monitor Na^+ to detect SIADH. Renal and liver impairment can occur with sepsis and should be monitored See Table 4 for expected CSF protein and CSF: blood glucose ratios

In the context of ED care, samples may be taken and marked for storage (particularly CSF) for the later addition of relevant studies to avoid haphazard ordering of tests.

Table 2 Possible additional tests based on clinical presentation

Category of test	Tests	Comments
Haematology	BLOOD Coagulation profile including Fibrin Degradation Products (FDP)	Indicated in patients with clinical evidence of a coagulopathy Inflammatory markers like CRP and ESR may be useful markers of a *bacterial* infection but lack specificity for meningitis
Biochemistry	URINE Urinary osmolality and Na+ PLASMA plasma osmolality	Indicated if patient has hyponatraemia and SIADH is possible
Radiology	Neuroimaging (Head CT +/- contrast or MRI)	Indicated if clinical evidence of raised ICP e.g. significantly altered mental state, bradycardia, hypertension or focal neurological signs or in those who may have an alternative diagnosis (e.g. trauma, subarachnoid haemorrhage). It does not reliably exclude raised ICP. Patient should be clinically stable
Microbiology & Virology & Serology	CSF Bacterial antigen detection	Limited sensitivity. Only occasionally indicated e.g. if previous antibiotics used (discuss with senior staff or clinical microbiologist)
	Viral culture (largely superseded by PCR)	Indicated if CSF pleocytosis and viral meningitis suspected
	Neissiera meningitidis PCR	Helpful if prior antibiotics used
	Streptococcus pneumoniae PCR	Helpful if prior antibiotics used
	Streptococcus pneumoniae antigen or PCR	May assist if available
	Enteroviral PCR Herpes simplex PCR	Indicated if viral meningitis is suspected
	Mycobacterium tuberculosis (MTB) stain, PCR and culture	Indicated if MTB suspected. Adequate volumes should be obtained for mycobacterial culture (important for determining resistance) – aim for 5-10 mls minimum
	Cryptococcal stain and antigen	Usually in immunocompromised patients, particularly HIV infected patients, but not exclusively **(NB: discuss with senior staff or Infectious Diseases physician)**

Category of test	Tests	Comments
	Cytology	Indicated if CNS leukaemia is possible. Ask lab to send to haematology for cytology if eosinophilic meningitis is suspected, as eosinophils are labile.
	SKIN Scrapings of skin lesions *(largely superseded by PCR for meningococcus)*	M/C/S Gently de-roof the skin lesion with a needle. Roll the sterile swab over the base of the lesion and then onto a glass slide (for Gram stain). Collect another swab and place into Stuart's Transport media for culture
	SERUM *Neisseria meningitidis* IgM serology	Helpful in aiding diagnosis. Utility for immediate diagnosis limited. May require convalescent serology
	Cryptococcal antigens	Indicated if cryptococcal meningitis suspected
	Enteroviral serology Herpes simplex serology	Indicated if viral meningitis suspected

5. The Lumbar Puncture

- An LP for CSF analysis should be performed once the diagnosis of meningitis is suspected and after the patient is stabilised;
- **If there are reasons to delay LP (see below) and bacterial meningitis is clinically suspected, antibiotics should be given prior to the LP;**
- CSF taken after antibiotics are administered may still be useful. Antibiotics may sterilise the CSF within 1 hour in meningococcal meningitis and within 4 hours in pneumococcal meningitis;[23]
- Blood cultures +/- CSF bacterial antigens should also be done to increase the diagnostic yield;[24, 25]
- A CT scan before the LP delays diagnosis.[26] Herniation is unlikely in children, unless there are focal neurological findings or they are comatose;[20]
- A **CT scan cannot rule out raised intracranial pressure**. A normal CT scan does not absolutely exclude subsequent risk of herniation;[27]
- A CT scan prior to LP is only recommended in patients who have clinical evidence of **raised intracranial pressure** e.g. significantly altered mental state bradycardia, hypertension or focal neurological signs or in those who may have an alternative diagnosis (e.g. trauma, subarachnoid haemorrhage);
- **Do not delay antibiotics or supportive management** to undertake or wait for a CT scan;

- The potential disadvantage of transporting a sick child for neuro-imaging should be factored in as the transport itself and the neuro-imaging area may pose risks to a critically ill child. Movement artefact can also lead to poor or useless image quality in the non-anaesthetised child.

5.1 Indications to delay the LP

Table 3: Indications to delay the LP*

Broad categories	Specific indications to delay LP
Local site for LP	• Skin infection at site of LP • Anatomical abnormality at the LP site
Patient instability	• Respiratory or cardiovascular compromise • Continuing seizure activity
Suspicion of space occupying lesion or raised intracranial pressure	• Focal seizures • Focal neurological signs • Reduced conscious state (some suggest a GCS of <8) and especially if the patient is comatose • Decerebrate or decorticate posturing • Fixed dilated or unequal pupils • Absent dolls eye movement • Papilloedema • Hypertension or bradycardia • Irregular respirations
Haematological	• Coagulopathy

*note: If there is no pathology service readily available, take a sample if no other contraindications exist and process later.

5.2 Interpreting the CSF

- No single CSF test parameter reliably distinguishes bacterial from non-bacterial meningitis;
- "Normal" CSF findings in rare instances (< 3%) have been associated with culture proven bacterial meningitis;[6]
- However, in most cases, clinical indicators of meningitis or sepsis will be present;[28,29]
- Clinical decision rules may be useful in identifying patients at low risk of bacterial meningitis.[30,31] However, these require further validation and should not influence the **initial** use of antibiotics in a child with CSF pleocytosis and clinical features of meningitis;
- When clinical indicators of meningitis are present but initial CSF examination is normal a repeat LP at 24-48 hours may be indicated. This may also be the case with antibiotic resistant pneumococcal meningitis;

- Post-ictal CSF abnormalities (pleocytosis or raised protein) are rare, and should **not** be readily accepted as a cause for an abnormal CSF.[32]

If there is difficulty in interpreting the CSF, an infectious diseases physician, clinical microbiologist, or senior staff member should be consulted.

Table 4: CSF - normal ranges and typical findings in patients with meningitis

	Polymorphs (PMN) ($\times 10^6$/L)	Mononuclear cells (lymphocytes) ($\times 10^6$/L)	Protein (g/L)	Glucose (mmol/L)	Glucose (CSF:Blood ratio)
NORMAL ≤ 1 month of age	0*	< 20	< 1.0	≥ 2.5	≥ 0.6
NORMAL > 1 month of age	0	≤ 5	< 0.4	≥ 2.5	≥ 0.6
Bacterial meningitis	100 - 10,000 (but may be normal)	Usually < 100	> 1.0 (but may be normal)	Usually decreased	< 0.4 (but may be normal)
Viral meningitis	Usually <100	10 - 1000 (but may be normal)	0.4 - 1 (but may be normal)	Usually normal	Usually normal

Table from the Royal Children's Hospital, Melbourne, Clinical Practice Guidelines on Meningitis, "CSF interpretation" http://www.rch.org.au/clinicalguide/cpg.cfm?doc_id=5185

* The presence of polymorphonuclear (PMN) cells in a neonate is unusual and should **ALWAYS** raise concerns for bacterial meningitis. The safest option in the initial management is to treat for bacterial meningitis pending further information (laboratory and clinical course).

5.2.1 **White cells in CSF**

- The CSF characteristics in normal patients and in acute bacterial and viral meningitis are outlined in Table 4;
- Polymorphonuclear predominance suggests bacterial aetiology but may occur in the early phase of viral meningitis, (lymphocytosis is more commonly seen);
- In partially treated bacterial meningitis, the relationship between PMNs and lymphocytes may be reversed.

5.2.2 **Red cells in the CSF**

Guide to distinguishing a traumatic tap from CSF pleocytosis:

- A simple guide commonly cited is that a ratio of **1 WBC: 500 RBC** in the CSF is considered acceptable. However this is dependent on the peripheral white and red cell counts;

- As the 'predicted' WC in CSF in determining a traumatic tap may not be reliable, the safest strategy is to use the un-adjusted total WBC count (disregard the RC count) and treat for bacterial meningitis in the **initial management** if there are more WC than the normal range pending further information (laboratory and clinical course).

5.2.3 **CSF glucose concentration**

- Blood glucose levels obtained at the time of the LP enables proper interpretation of the CSF glucose as changes in the CSF glucose level follow changes in the blood glucose by ≥ 30 minutes;[33]
- Low CSF glucose (< 2.2 mmol/L) is found in about two thirds of patients with bacterial meningitis;[34]
- However, **a normal glucose does not exclude bacterial meningitis.**

5.2.4 **CSF protein concentration**

- About 90% of patients with bacterial meningitis will have elevated protein levels;[24]
- The protein levels may be elevated in a traumatic tap. There will be an approximate **0.01 - 0.015 g/L increase** in protein levels for every **1000 RBCs** in uncentrifuged CSF samples.

5.2.5 **Gram stain**

- This is the best single test for rapidly diagnosing bacterial meningitis, and initiating appropriate therapy;[34-36]
- The Gram stain will identify bacteria in **60 - 90%** of cases.[35] **A negative Gram stain does not exclude bacterial meningitis.**
- Occasionally, the Gram stain will be positive despite the absence of pleocytosis;[34,37]
- Gram stain yields are reduced if there has been prior treatment with antibiotics, but other CSF indices may still indicate a likely bacterial infection.[15]

Table 5: Gram stain results of common bacteria causing community acquired bacterial meningitis

ORGANISM	CSF GRAM STAIN
Group B streptococcus	Gram positive cocci resembling streptococci
Streptococcus pneumoniae	Gram positive diplococci or GPC resembling streptococci
Neisseria meningitidis	Gram negative diplococci or gram negative cocci
Haemophilus influenzae	Gram negative cocco-bacilli
Enterobacteriaceae e.g. E coli	Gram negative rods
Listeria monocytogenes	Gram positive or Gram variable rods*

*Discuss with microbiologist

6. Antibiotic management

6.1 General

- Empiric antibiotic selection is dependent on the likely bacterial organism and expected antibiotic resistance patterns;
- Culture and sensitivities guide continuing antibiotic choice;
- Antibiotic doses are adapted from the current Australian Antibiotic Therapeutic Guidelines;[38]
- Therapy should be initiated immediately after LP results or immediately after the LP if clinical suspicion for meningitis is high, or the CSF is turbid. **Do not delay antibiotics by waiting for the LP results;**
- Whilst prevention strategies like intrapartum antibiotics for group B streptococcus and routine childhood immunisations against *Haemophilus influenza* type b *Neisseria meningitidis* type c and *Streptococcus pneumonia* are effective, the differential diagnosis should still include these organisms;

6.1.1 **Invasive meningococcal and pneumococcal disease (Australian)**

- Invasive disease with meningococcus or pneumococcus in Australia has decreased following the introduction of the routine conjugate meningococcal serogroup C vaccine (2003) and pneumococcal vaccine (2005);[39]
- Serogroup B *Neisseria meningitidis,* the predominant invasive strain, is not currently covered by immunisation;[40]
- Not all serotypes of pneumococcus are covered by the pneumococcal vaccine. In addition, emerging non-vaccine pneumococcal strains overseas are a concern;[41]
- Therefore, pneumococcal or meningococcal meningitis needs to be in the differential diagnosis and appropriate antibiotics commenced despite previous meningococcal (group c) or pneumococcal vaccinations.

6.1.2 **Antibiotic resistance patterns in meningococcus and pneumococcus (Australia)**

- Whilst ~ 80% of meningococcal isolates (laboratory surveillance) are 'less sensitive' to penicillin, clinical failure has not been reported;
- All isolates are sensitive to third generation cephalosporins;[40]
- Multi-resistant *Streptococcus pneumoniae* has risen since the mid-1990s.~28% of *Streptococcus pneumoniae* strains in Australia (laboratory surveillance data) have reduced susceptibility to penicillin, with regional variations;
- ~10 - 15% of invasive strains (strains associated infections of sterile sites including the meninges) have reduced penicillin susceptibility and ~3% had reduced susceptibility to third generation cephalosporins.[42]

Table 6 summarises the common bacterial pathogens by age and antibiotic selection.

Table 6: Empiric Antibiotic Selection

Age Group	Common Organisms	Antibiotic
0 – 3 months	Group B streptococcus, *Escherichia coli, Listeria monocytogenes*	• Ampicillin (or benzylpenicillin) + cefotaxime * NB: Ceftriaxone is contraindicated in newborns
	Note: if HSV encephalitis is suspected in newborns, aciclovir (20mg/kg/dose IV 8 hourly) should be commenced until further clinical information is available	
≥ 3 months – 16 years	*Neisseria meningitidis* (Meningococcus) *Haemophilus influenzae* (now rare with Hib vaccination)	• Cefotaxime or ceftriaxone
NOTE: Any age	*Streptococcus pneumoniae* (Pneumococcus)	• **ADD** vancomycin to the above regimen if *Streptococcus pneumoniae* is suspected (note: vancomycin must be used in **combination** with a third generation cephalosporin for penicillin resistant *Streptococcus pneumoniae* meningitis, and not as a single agent)

6.2 Empiric antibiotic management of suspected *Streptococcus pneumoniae* meningitis

When *S. pneumoniae* meningitis is suspected, a third generation cephalosporin **PLUS** vancomycin as empiric antibiotic regimen is recommended e.g. CSF with Gram positive diplococci or Gram positive cocci resembling streptococci seen on Gram stain.

- CSF is negative by Gram stain but the clinical presentation and/or other CSF findings are highly suspicious for bacterial meningitis;
- High clinical suspicion of bacterial meningitis but an LP is contra-indicated (see Table 3).

6.3 Duration of therapy

As a guide, the duration of antibiotic therapy in 'uncomplicated' cases of acute bacterial meningitis are:

- Group B streptococcus, 14 days;
- Gram negative rods, 21 days;
- Listeria monocytogenes, 21 days;
- *Neisseria meningitidis*, 7 days;
- *Haemophilus influenzae* type b, 10 days;
- *Streptococcus pneumoniae*, 14 days;
- 'Culture negative' but significant CSF pleocytosis present, minimum of 7 days recommended.

6.4 Antibiotic doses IV (Note: further information in text: Introduction and Section 6)

Antibiotic doses are shown in Table 7

Table 7: Antibiotic doses (IV)

Drug	Dose	Frequency of Dose by Age		
		First Week of Life	Weeks 2 – 4 of Age	Age > 4 Weeks
Benzylpenicillin	60 mg/kg (max 2.4g)	12 hourly	6 – 8 hourly	4 hourly
Ampicillin	50 mg/kg (max 2g)	8 hourly	6 hourly	4 hourly
Cefotaxime	50 mg/kg (max 2g)	12 hourly	8 hourly	6 hourly
Ceftriaxone*	50 mg/kg (max 2g)	N/A	N/A	12 hourly
Vancomycin#	15 mg/kg (max 750 mg) *Term baby*	12 hourly#	8 hourly#	6 hourly

Antibiotic doses are adapted from the current Australian Antibiotic Therapeutic Guidelines[38]
* Ceftriaxone should not be used in newborns (≤ 28 days old). Do not mix ceftriaxone together with calcium containing solutions or administer calcium containing solutions simultaneously with ceftriaxone.
# The vancomycin dose and frequency recommended are CNS dosing regimens for children (adult regimens differ). Therapeutic drug monitoring with vancomycin trough levels should be performed just prior to the fifth dose. Trough levels between 15 to 20 mg per litre are preferred; if not achieved discussion with an infectious diseases physician may assist in dose escalation.

7. Adjunctive Therapy - Corticosteroids

- Current evidence suggests that early steroids (first dose given before, with or just after antibiotics) in children with acute bacterial meningitis reduce the risk of hearing loss and neurological sequelae;[43,44]
- These benefits are seen in paediatric patients with acute bacterial meningitis from "high income" countries and not in children living in low income countries;
- Steroid use in children with acute bacterial meningitis does not appear to influence mortality;
- Steroid use is not associated with increased adverse events;
- The timing of steroids (before, with or after first dose of antibiotics) appears equivalent in efficacy. The range of time applicable to "after the first dose" has not been adequately defined;
- There is insufficient information about steroids in infants < 3 months of age and in those presenting with severe sepsis;
- The influence of antibiotic penetration into the CNS if steroids are used is uncertain.

Summary: Steroids are recommended **early** in children ≥3 months of age with acute bacterial meningitis, provided that they have not been pre-treated with parenteral antibiotics.

Recommendations:

a) In children ≥3 months of age with suspected bacterial meningitis, steroids (dexamethasone) should be given **early**, just before or at the time of antibiotics,

as a single push to minimise potential delay in antibiotic administration.

b) The dosing regimen is **0.15 mg/kg/ dose IV, every 6 hours** for **4 days.**

c) If resistant pneumococcus is found (or suspected), careful monitoring of patients during therapy for indications of failure of drug therapy should be done. A repeat LP at 48 - 72 hours after antibiotic therapy is recommended to document sterilisation of CSF.

Note: If the CSF results are not consistent with bacterial meningitis and the child is clinically improving, the recommendation is to stop steroids but continue antibiotics for at least 48 hours until negative CSF cultures are confirmed.

8. Nursing issues

8.1 Triage

- The Australasian Triage Scale (ATS) should be used to determine urgency in the infant, child & adolescent. Recognition of serious illness is assessed using the ABCDEFG approach (see table below), presenting complaint, past history and parental concerns;
- Paediatric physiological discriminators in relation to the ATS can be found http://www.health.gov.au/internet/main/publishing.nsf/Content/5E3156CFFF0A34B1CA2573D0007BB905/$File/Triage%20Quick%20Reference%20Guide.pdf (Australian Government Department of Health and Ageing);
- Additional local documents providing paediatric physiological discriminators may be available to guide staff in recognition of the sick child and should be used in conjunction with the *Emergency Triage Education Kit* (2009) (Appendix 3);
- Seriously ill children should be reviewed by a senior paediatrician or senior staff member shortly after arrival in hospital.

Absence of senior specialist input from paediatrics, anaesthesia and intensive care - including the absence of consultant supervision during the first 24 hours in hospital - has been associated with increased mortality and is also an independent risk factor for death.[45]

Table 8: Prioritise assessment and management

Airway and Breathing	Circulation	Disability	Exposure	Fluids	Glucose
Effort	Heart rate	Conscious level (AVPU)	Body temperature	Input	Hypoglycaemia
Efficacy	Capillary refill time	Posture	Rash	Output	Hyperglycaemia
Effects	Blood pressure	Pupils	Injury	Injury	
	Skin temperature		Bleeding etc	Bleeding etc	

Refer to the age appropriate Standard Paediatric Observation Chart (SPOC) for guidance in normal and abnormal parameters for vital signs. If an infant, child or adolescent has vital signs outside of the specified normal parameters then manage according to local processes and guidelines.

8.1.1 **Primary assessment of Airway and Breathing**

- Recognition of potential respiratory failure:
  - Effort of breathing including respiratory rate, recession, inspiratory or expiratory noises, grunting, accessory muscle use, flaring of nasal alae, gasping (sign of severe hypoxia);
  - Efficacy of breathing including chest expansion (or in infants, abdominal expansion), auscultation of chest;
  - Effects of respiratory inadequacy on other organs including heart rate, skin colour, mental status.

8.1.2 **Primary Assessment of Circulation**

- Recognition of potential respiratory failure:
  - Cardiovascular status including heart rate, pulse volume, capillary refill, blood pressure;
  - Effects of circulatory inadequacy on other organs including respiratory system, skin, mental status and urinary output.

8.1.3 **Primary assessment of Disability**

- Recognition of potential respiratory failure:
  - Neurological function including conscious level (AVPU), posture, and pupils;
  - AVPU stands for:
    - **A**lert;
    - Responds to **V**oice;
    - Responds to **P**ain only;
    - **U**nresponsive;
  - Respiratory effects of central neurological failure including breathing pattern abnormalities.

8.1.4 **Exposure**

- Examination for markers of illness such as temperature and rash.

8.2 Summary: the rapid clinical assessment of an infant or child[46]

Airway and Breathing

Effort of breathing;
Respiratory rate/rhythm;
Stridor/wheeze;
Auscultation;
Skin colour.

Circulation

Heart rate;
Pulse volume;
Blood pressure;
Capillary refill;
Skin temperature.

Disability

Mental status/conscious level (AVPU);
Posture;
Pupils.

The whole assessment should take less than a minute to complete

Once this rapid assessment is undertaken and intervention commenced as needed, a structured primary assessment and resuscitation should occur.

8.3 Additional information:

- Serious illness should not be automatically excluded if young children present with non-specific symptoms such as fever, decreased activity/arousal, poor feeding, nausea, vomiting and irritability or a non-blanching rash;
- Children with non-specific symptoms at initial presentation, in whom conditions such as meningococcal disease cannot be excluded, should be reassessed by a medical officer **within 4 to 6 hours**. This should result in the admission of any child in whom the possibility of the diagnosis of meningitis is being considered and this admission may need to be to the observation area of an ED or a paediatric ward.

    1. Ensure vital signs are documented on the age-relevant Standard Paediatric Observation Chart (SPOC). In children there are age related differences in normal values for blood pressure, heart rate and respiratory rate. The SPOC facilitates trending of vital signs, and provides guidance regarding normal ranges.

    2. Valuable information can be gained from frequent repeated observations to detect a trend in the patient's condition. Repeated observations over time are required to ensure subtle signs or cues of illness are detected as recommended in the *Recognition of a Sick Baby or Child in the Emergency Department Clinical Practice Guideline* found at http://www0.health.nsw.gov.au/policies/pd/2011/PD2011_038.pdf.

    3. Repeated observation of vital signs provides the possibility of excluding some of the confounding signs and symptoms since these evolve progressively within a 24hr time-span.

- Nursing staff are encouraged to take a proactive approach to parent/carer advice throughout the assessment and management of the child;
- Local arrangements for health care need to be considered prior to discharging a patient where a diagnosis of bacterial meningitis has not been confirmed and is considered unlikely. Before discharge, parents should be given verbal and written

advice (e.g. a fact sheet) regarding signs and symptoms of bacterial meningitis which would necessitate the child's return to ED;

- If there are sufficient concerns such that parents/carers are advised to seek further clinical advice if their child's condition deteriorates then, depending on the services available and the capacity of parents, a review within 24 hours or admission should be considered.

9. Psychosocial needs of the family

The diagnosis of bacterial meningitis is a frightening one for families, especially if the child is critically ill. When the child is stabilised, staff should set aside time as soon as possible to address family concerns.

10. Transfer of patient to tertiary referral centre

Patients with bacterial meningitis will need admission to hospital. If in-patient facilities are not available locally, transfer to a regional centre with specialist paediatric facilities may be required. Most significantly unwell children will require transfer to a paediatric intensive care unit. If this facility is not available locally, the NETS line should be called **(1300 36 2500)** as soon as possible after presentation rather than delaying until the patient has been fully assessed, investigated and stabilised.

11. Related issues

11.1 Infection control issues

- Infection control practices during patient care are outlined in NSW Health *Infection Control Policy* http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_036.html (see section 2, Infection Control Process).
- The Infection Prevention and Control team for the facility are required to be informed if invasive meningococcal disease or *Haemophilus influenzae* type b infection is suspected;
- Personal Protective Equipment (PPE), including surgical mask and eye protection, must be worn when undertaking any procedure where the likelihood of splashing or splattering of any bodily fluids exists. Procedures such as venepuncture, intubation and LP are indications for PPE (eye and face protection as well as gloves and apron/gown);
- All cases of suspected bacterial meningitis should be isolated initially in a single room until 24 hours after a third generation cephalosporin has been administered;
- Ongoing isolation requirements however, should be determined by the hospital infection control team and is based on the suspected or confirmed organism.

11.2 Notification to Public Health Unit

- In accordance with the NSW Public Health Act (1991), hospital staff are required to notify suspected or confirmed invasive infections (including meningitis) due to *Haemophilus influenzae* type b, *Neisseria meningitidis* or *invasive pneumococcal* infection to their local Public Health Unit;

  Unit Notification forms can be found at: http://www.health.nsw.gov.au/policies/ib/2012/pdf/IB2012_011.pdf

- Cases are to be notified on clinical suspicion;
- The need for clearance antibiotics (chemoprophylaxis) for contacts of the index case, including health care workers, should be discussed with the local public health unit.

11.3 Clearance antibotics (chemoprophylaxis) for contacts

- The local Public Health Unit should be consulted. Clearance antibiotics are recommended for contacts of meningococcal disease cases (strongly suspected or proven), as defined in the Communicable Diseases Network of Australia guidelines for management of meningococcal disease in Australia, available at: http://www.health.gov.au/internet/main/Publishing.nsf/Content/BC329B583B663546CA25736D007674AA/$File/meningococcal-guidelines.pdf;
- Clearance antibiotics are not recommended for health care workers unless direct contact with respiratory secretions of patient with suspected (or proven) *Neisseria meningitidis* has occurred;
- The regimen for *Haemophilus influenzae* type b prophylaxis and dosing can be found at eTG complete, available at http://etg.hcn.com.au/desktop/index.htm.

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Appendix Two - Glossary

AVPU	Is the patient **A**wake, responding to **V**oice, responding to **P**ain or **U**nresponsive
BGL	Blood glucose level
ED	Emergency department
CNS	Central nervous system
CSF	Cerebrospinal fluid
CRP	C-reactive protein
CT	Computed tomography
DI	Diabetes insipidus
DIC	Disseminated intravascular coagulation
Diff	Differential
ESR	Erythrocyte sedimentation rate
FBC	Full blood count
FDPs	Fibrin degradation products
GCS	Glasgow Coma Scale
Hib	*Haemophilus influenzae* type b
HSV	Herpes Simplex Virus
ICP	Intracranial pressure
IgM	Immunoglobulin M
IM	Intramuscular
IV	Intravenous
LFTs	Liver function tests
LP	Lumbar puncture
MRI	Magnetic resonance imaging
MTB	*Mycobacterium tuberculosis*
M/C/S	Microscopy, culture and sensitivity
Na+	Serum sodium
NETS	NSW Newborn and Paediatric Emergency Transport Service
NHMRC	National Health and Medical Research Council
PCR	Polymerase chain reaction
PPE	Personal protective equipment
PHU	Public Health Unit
PMN	Polymorphonuclear
RBC	Red blood cell
SIADH	Syndrome of inappropriate antidiuretic hormone
WBC	White blood cell
WCC	White cell count

Appendix Three - Resources

- **Australian Government Department of Health and Ageing**: The Australasian Triage Scale (ATS): Table 8.2 of the *Emergency Triage Education Kit*

  http://www.health.gov.au/internet/main/publishing.nsf/Content/5E3156CFFF0A34B1CA2573D0007BB905/$File/Triage%20Education%20Kit.pdf

- **National Institute for Health and Clinical Excellence (NICE)**: *Clinical guideline 102: Bacterial meningitis and meningococcal septicemia (June 2010). The management of bacterial meningitis and meningococcal septicemia in children and young people younger than 16 years in primary and secondary care.* (UK)

  http://guidance.nice.org.uk/CG102

- **Royal Children's Hospital Clinical Practice Guidelines (Melbourne)**:

  http://www.rch.org.au/clinicalguide/cpg.cfm?doc_id=5179

- **Department of Health and Ageing publication from the Communicable Diseases Network of Australia (CDNA)**: *Guidelines for the early clinical and public health management of meningococcal disease in Australia*

  http://www.health.gov.au/internet/main/publishing.nsf/Content/BC329B83B663546CA25736D007674AA/$File/meningococcal-guidelines.pdf

- **Infectious Diseases Society of America (IDSA) Bacterial Meningitis Guidelines (2004).**

  Tunkel AR, Hartman BJ, Kaplan SL, Kaufman BA, Roos KL, Scheld WM, et al. *Practice guidelines for the management of bacterial meningitis*. Clin Infect Dis. 2004;39(9):1267-1284.

- **NSW Department of Health**: *Recognition of a Sick Baby or Child in the Emergency Department* (second edition) Clinical Practice Guidelines http://www.health.nsw.gov.au/policies/pd/2011/PD2011_038.html

Appendix Four - Parent information

A Bacterial Meningitis Fact Sheet has been jointly developed by The Children's Hospital at Westmead, Sydney Children's Hospital, Randwick and Kaleidoscope Hunter Children's Health Network.

The Bacterial Meningitis Fact Sheet is available at:

http://www.sch.edu.au/health/factsheets/joint/?meningij.htm

http://kidshealth.schn.health.nsw.gov.au/fact-sheets/meningitis

http://kidshealth.schn.health.nsw.gov.au/sites/kidshealth.schn.health.nsw.gov.au/files/fact-sheets/pdf/meningitis.pdf

Disclaimer: This fact sheet is for educational purposes only. Please consult with your doctor or other health professional to make sure this information is right for your child.

Appendix Five - Expert working party membership

Pamela Palasanthiran (Chair)	Infectious Diseases Specialist, Department of Paediatric Immunology & Infectious Diseases, Sydney Children's Hospitals Network (Randwick)
Peter Grant	Staff Specialist, Emergency Department, St George Hospital, Kogarah
Alan Tankel	Director, Emergency Medicine, Coffs Harbour Base Hospital
Mary-Lou Morrit	Clinical Nurse Consultant, Paediatric Intensive Care Sydney Children's Hospitals Network (Randwick)
Melinda Simpson-Collins	CHN, Paediatric Emergency Clinical Nurse Consultant, Northern Sydney Local Health District
Alison Kesson	Head of Infectious Diseases and Microbiology, Sydney Children's Hospitals Network (Westmead)
Nicholas Wood	General Paediatrician, Sydney Children's Hospitals Network (Westmead) and National Centre for Immunisation Research and Surveillance
Mark DeSouza	General Paediatrician, Illawarra Shoalhaven Local Health District
Ian Andrews	Neurologist, Sydney Children's Hospitals Network (Randwick)

SHPN: (NKF) 140090