Commonly encountered central nervous system infections in the neurointensive care unit

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Learning objectives

After reading this article, you should be able to:

- recognize the common infections that cause neurointensive care unit admissions
- demonstrate an understanding of the most useful diagnostic laboratory tests that should be sent on patients with neurological and neurosurgical infections
- select the most appropriate antimicrobial agent for the common CNS infections seen on the neurointensive care unit

Abstract

The central nervous system (CNS) may be infected by a number of organisms including bacteria, viruses, fungi, and protozoa. Non-infectious causes such as autoimmune and vascular conditions may present with similar clinical syndromes necessitating the appropriate laboratory requests and good diagnostics. CNS infections are associated with significant morbidity and mortality, often requiring surgical intervention and admission to neurointensive care units. Common infection diagnoses seen in the neurointensive care unit include meningitis, ventriculitis, encephalitis and abscesses, including brain and spine. New and emerging pathogens in ITU settings include *Candida auris* and multi-resistant Gram negative bacteria, which are easily transmissible and may threaten the antimicrobial choices available for patients.

Keywords Abscess; antibiotics; cerebrospinal fluid (CSF); infection; intensive care; meningitis; ventriculitis

Royal College of Anaesthetists CPD Matrix: 1A02, 1E01, 1I05, 2CO3

Acute bacterial meningitis (community acquired)

Introduction

Bacterial meningitis and meningococcal sepsis are rare conditions with high all-cause case fatality rates (approximately 20%), increasing with age at presentation. There has been an overall reduction in the frequency of bacterial meningitis in recent years, largely in children; however, rates in adults remain stable or have increased (with the highest incidence in the 45–64 year age group 1.21/100,000).[1] The epidemiology has changed with the introduction of *Haemophilus influenzae* B vaccine (early 1990s), meningococcal group C vaccine (1999) and, more recently, meningitis B vaccine (2015).

Clinical presentation

The 'classic triad' of fever, neck stiffness and altered mental state occurs in less than 50% of cases. Clinical features alone cannot distinguish between bacterial and viral meningitis. Typically, pneumococcal disease is more associated with seizures, focal neurology and reduced Glasgow Coma Scale (GCS) and *Neisseria meningitidis*-associated with rash (although not always). Meningococcal disease presents with meningitis in 60% of cases, 10–20% with shock with or without meningitis and 30% with a mild disease with just fever and rash without meningitis or shock. Urgent transfer to critical care is essential in all patients with a rapidly evolving rash, GCS <12 (or a drop >2 points), uncontrolled seizures or requirement for specific organ support.

Risk factors for fatal outcomes in meningococcal disease include: rapidly progressive rash, coma, hypotension, lactate >4 mmol/L, low/normal peripheral white cell count (WCC), low acute phase reactants, low platelets, coagulopathy and absence of meningitis.

Diagnosis and testing

Cerebrospinal fluid (CSF) sampling is crucial to the diagnosis of meningitis, and a lumbar puncture (LP) should be performed (if no contraindications) within the first hour after admission. Recent guidelines recommend that patients should not have neuroimaging before their LP unless there is a clinical indication suggestive of brain shift.

Delay for CT scanning is associated with delay in antibiotics and a subsequent increase in mortality. A CT scan can detect space-occupying lesions or brain shift, but may be normal despite raised intracranial pressure. Subdural haematoma is a potential complication of LP therefore ascertainment of clotting abnormalities/medication history is important prior to LP (Tables 1 and 2).

Treatment

Antibiotic therapy should be commenced within the first hour of presentation to hospital (if not given in the community). Antibiotics should not be delayed if LP cannot be performed in the first hour, but commenced immediately after blood cultures have been taken. Empirical guidelines for adults younger than 60 years is cefotaxime 2 g 6-hourly or ceftriaxone 2 g 12-hourly. If the patient is over 60 years old or there are other causes of immunocompromise, add amoxicillin 2 g 4-hourly to the empirical regimen (to cover for listeria). If the patient has had penicillin anaphylaxis/angioedema then chloramphenicol 25 mg/kg 6-hourly with co-trimoxazole 10–20 mg/kg (of the trimethoprim component) 6-hourly is an alternative.

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Recommended tests for suspected meningitis case

Sample type	Test
Blood	FBC, clotting profile Urea, creatinine, electrolytes, LFTs, glucose, lactate Blood culture (prior to antibiotics where possible, within 1st hour of admission) Pneumococcal and meningococcal PCR (EDTA sample) Serum save sample: to enable serological testing if cause not identified with paired sample 4–6 weeks later
CSF	Opening pressure (unless performed sitting) Microscopy, culture and sensitivities Glucose, Protein, Lactate PCR for pneumococci and meningococci PCR for viral pathogens typically: HSV/enteroviruses/VZV CSF saved sample for further tests, e.g. cryptococcal antigen
Swabs	Posterior nasopharyngeal wall for meningococcal culture If viral meningitis suspected: stool or throat swab for enterovirus PCR Vesicle swab if rash and VSVZVV/HSV suspected

Table 1

If the patient has recently travelled (in last 6 months) to a county where penicillin-resistant pneumococci are present (discuss with microbiology/infectious disease departments) then IV vancomycin 15–20 mg/kg 12-hourly or rifampicin 600 mg 12-hourly should be considered.

If a causative agent is identified then tailored targeted therapy can be commenced. There is little evidence to guide the duration of therapy in adults: 10 days for pneumococcal disease (if patient has clinically recovered) and 5 days for meningococcal disease. If no pathogen has been identified, then antibiotics should be stopped after 10 days if there has been clinical resolution.

Corticosteroid therapy in meningitis has been controversial. Recent evidence suggests that there is no evidence of harm, and that in pneumococcal meningitis it is associated with a small reduction in mortality with reduction in long-term sequelae in all causes of meningitis. Therefore, it is recommended that adults receive dexamethasone 10 mg IV 6-hourly before or up to 12 hours after antibiotics are started for 4 days. They should be stopped if a cause other than *Streptococcus pneumoniae* is identified. Sequelae occur in about 30% of patients following pneumococcal meningitis compared to 7% with meningococcal meningitis. Common early complications include subdural empyema or venous sinus thrombosis. Late complications include hearing loss, epilepsy and behavioural changes.

There are no specific treatments for viral meningitis; treatment should be supportive with analgesia and fluids.

Ventriculitis and postoperative meningitis

Introduction

CSF diversion or pressure monitoring may be required following neurosurgical procedures: either with temporary drains, external ventricular drains (EVDs) or lumbar drains (LDs), or more permanent CSF shunts. Common indications for placement of EVDs include subarachnoid haemorrhage (SAH), intracerebral haemorrhage and obstructive hydrocephalus. The most common site of placement for EVD is the frontal horn of the right lateral ventricle, and LD typically at L3–L4 or L4–L5. Infections related to EVDs (0%–28%) and LDs (0%–50%) are serious.[2] See Table 3 for factors associated with infection and interventions to prevent EVD infections.

CSF interpretation

Appearance	Opening pressure (mmH_2O)	Cell count and differential	Protein (g/l)	Glucose (mmol/l)	Differential diagnosis
Clear	12–21	<6 lymphocytes	0.15–0.4	2.2–3.5 (approx 60% of blood glucose level)	Normal CSF
Slightly turbid	Normal/mildly raised	15–500 lymphocytes	Slight increase	Normal	Viral meningitis Partially treated bacterial meningitis Early listeria meningoencephalitis
Fibrin Web	Raised	30–500 lymphocytes plus polymorphs	1.0–6.0	Decreased or 0	TB meningitis Brain abscess Cryptococcal meningitis
Turbid	Raised	100+ polymorphs	0.5–3.0	0–2.2	Bacterial meningitis Amoebic meningitis Cerebral abscess

Table 2