How can your microbiologist help you manage paediatric infection?

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Abstract

The presentation of a child to hospital with an acute illness is distressing for the child and his/her parents or carers. The clinical aim of the admitting paediatric team is to identify the cause of the illness, to treat it effectively and to discharge the child home quickly and safely. Multi-disciplinary care between the paediatric and the clinical microbiology team, who oversee and support the laboratory work of skilled scientists, is essential to manage paediatric infection. In this review, we will focus on current diagnostic methods for common paediatric microbiology consultations, with a focus on newer molecular technology to reduce laboratory turnaround time, and discuss the emergence of multi-drug resistant organisms that are impacting on antimicrobial prescribing practices. We will also highlight useful infection prevention and control advice that will be beneficial to the on-call paediatrician.

Keywords clinical microbiology; consultations; laboratory; molecular diagnostics; paediatrics

Introduction

In approaching any child with a potentially infectious illness it is worth considering the following: (1) what is the likely source of infection, what are the usual organisms that either colonise that site or can readily gain access to the site to cause infection, what are the optimal specimens to send and can molecular technology such polymerase chain reaction (PCR) be utilised, (2) does the child have any past microbiology results and/or is the child colonised with a multi-drug resistant organism (MDRO) that may limit prescribing practices, (3) is the child potentially harbouring a transmissible organism and if so what infection prevention and control precautions do I need to implement pending confirmation, (4) is prophylaxis needed for parents/carers or staff who have come into contact with this child and (5) is a vaccination or vaccination booster required.

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Interpreting preliminary microbiology results

Paediatric trainees are often phoned with preliminary results from the microbiology laboratory describing a Gram stain result. Table 1 is a reference guide for the common organisms that cause paediatric infections, divided into Gram-positive and Gram-negative organisms and those that are identified by alternative methods.

Common paediatric microbiology consultations

The eye

Conjunctivitis is an inflammation of the conjunctiva of either one or both eyes and is frequently described as 'red or sticky eyes' by parents or carers. Occasionally, conjunctivitis may occur in association with infection of the cornea (keratoconjunctivitis) or eyelid (blepharoconjunctivitis). The most common causes of bacterial conjunctivitis are *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Haemophilus influenzae,* while the most common causes of viral conjunctivitis are adenoviruses, herpes simplex virus (HSV)-1/-2 and varicella zoster virus (VZV). *Neisseria gonorrhoea, Haemophilus parainfluenzae* and Group B Streptococcus (GBS) can cause infection in the neonatal period. When conjunctivitis is suspected, eye swabs should be sent for culture and/or viral PCR analysis. Orbital cellulitis is an infection of the orbital tissue that can occur secondary to trauma, surgery or following the spread of infection from the paranasal sinuses. The most common causes of orbital cellulitis are *S. aureus*, anaerobes and various streptococci. Eye swabs are of limited value in the investigation of orbital cellulitis. Intra-operative aspirates from infected tissues should be sent to the laboratory. Table 2 shows the spectrum of cover of commonly prescribed topical ophthalmic antimicrobials.

The brain and spine

Encephalitis is an inflammatory process in the brain accompanied by cerebral dysfunction manifesting as an altered level of consciousness. Seizures are common. Encephalitis is predominantly caused by viruses including VZV, Ebstein Barr virus (EBV), cytomegalovirus (CMV), HSV-1/-2 and enteroviruses. Meningitis is defined as inflammation of the meninges. From neonates to babies up to 2 months of age, GBS, *Escherichia coli*, *Listeria monocytogenes*, *N. meningitidis* are commonly isolated. In older children viral meningitis is more common than bacterial meningitis. Other bacterial causes of meningitis include *S. pneumoniae*, *N. meningitidis* and *H. influenzae* type b (Hib), in unvaccinated children. In taking the child's history it essential to discuss potential risk factors for meningitis including the previous diagnosis of a cerebral tumour, the presence of cerebrospinal fluid (CSF) shunts or cochlear implants, whether the child has a meningomyelocoele or other spinal congenital malformations, preceding infections of contiguous sites such as the orbit, paranasal sinuses, middle ear cavity or recent trauma such as a basilar skull fracture. Chronic meningitis is defined by the continued signs and symptoms of meningitis for greater than four weeks with abnormal CSF findings, most commonly caused by *Mycobacterium tuberculosis*. Rare non-infectious causes of meningitis include sarcoid meningitis, post intravenous immunoglobulin (IVIG) administration or treatment with co-trimoxazole or non-steroidal anti-inflammatories (NSAIDs).

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The diagnosis of meningitis is established by the examination of CSF. It is essential to write on the request form if a CSF shunt (ventriculo-atrial or ventriculo-peritoneal) and/or extra ventricular drain (EVD) are in-situ. CSF should be collected into three or more containers numbered consecutively. No more than 2 h should elapse between CSF collection and laboratory microscopy and culture as cells can disintegrate rapidly. Never place a CSF sample in any hospital refrigerator until microscopy and culture have been performed. Laboratory examination of CSF includes a complete cell count, differential leucocyte count, examination of a Gram stained smear and culture. Normal CSF values are detailed in Table 3. In-house testing of CSF using multiplex PCR panels, with the capability to identify bacteria, viruses and fungi simultaneously, such as the FilmArray® Meningitis/Encephalitis (Biomérieux, France), are increasingly utilised. Blood cultures, pharyngeal swabs and stool specimens should also be sent when meningitis and/or encephalitis are suspected.

The ear

Otitis externa is defined as infection of the external auditory canal. Acute localised otitis externa is usually caused by *S. aureus*. Acute diffuse otitis externa, also known as "swimmer's

Classification of common organism causing paediatric diseases

	Organisms detected via Gram stain			
	Typical shape of the organism when Gram stained and viewed under the microscope			
	Coccus (sphere shaped)	**Bacillus (rod shaped)**	**Cocco-bacillus (variable appearance)**	**Vibrio (curved rod/comma-shaped)**
Gram-positive	*Staphylococcus* spp.	*Nocardia* spp.		
	Streptococcus spp.[a]	*Bacillus* spp.		
	Enterococcus spp.	*Clostridium* spp.		
	Micrococcus spp.	*Listeria* spp.		
		Corynebacteria spp.		
Gram-negative	*Kingella* spp.	*Pseudomonas* spp.	*Haemophilus influenzae*	*Vibrio* spp.
	Neisseria spp.	*Bordatella* spp.		
	Moraxella spp.	*Legionella* spp.		
		Stenotrophomonas spp.		
		Pasteurella spp.		
		Capnocytophagus spp.		
		Bacteroides spp.		
		Fusobacterium spp.		
		Acinetobacter spp.		
		Shigella spp.		
		Campylobacter spp.		
		Helicobacter pylori		
		Salmonella spp.		
		Citrobacter spp.		
		Enterobacter spp.		
		Klebsiella spp.		
		Escherichia coli		
Organisms not detected using Gram stain method. If suspect infection due to microorganisms listed below contact the clinical microbiology team to discuss local methods of diagnostic testing performed. Samples may be referred to a reference laboratory.				
Spirochaetes	*Treponema* spp.			
	Leptospira spp.			
	Borrelia spp.			
Non-culturable as no cell wall	*Mycoplasma* spp.			
Obligate intracellular pathogens	*Rickettsia* spp.			
	Chlamydia spp.			
	Coxiella spp.			
Special staining process performed to detect presence of acid fast bacilli (AFB)	*Mycobacteria* spp.			

[a] *Streptococcus* spp. can be classified by their appearance on blood agar after overnight incubation. A greenish appearance on the blood agar plate signifies the presence of α-haemolytic *Streptococcus* spp., usually *S. pneumoniae* or a member of the *viridans* group, which encapsulates a broad range of Streptococci including *S. oralis*, *S. sanguis*, *S. mutans*, *S. mitis*, which are commensals of the oral cavity and upper respiratory tract. A clear zone of complete haemolysis on the blood agar plate around visible colonies after an overnight incubation demonstrates the presence of β-haemolytic *Streptococcus* spp., which includes Groups A, B, C, G Streptococci.

Table 1

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