Guideline

Antimicrobial treatment: Antibiotic duration and timing of the switch from intravenous to oral for common bacterial infections in children

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HUMAN RIGHTS

This governance document has been human rights compatibility assessed. Limitations identified were deemed justifiable indicating reasonable confidence that, if adhered to, there are no implications arising under the *Human Rights Act 2019.*

PURPOSE

This guideline is aimed to help facilitate prudent prescribing practices and appropriate intravenous (IV) to oral (PO/enteral) conversion of antimicrobial therapy. Minimum IV duration can vary depending on the bacterial infection and as a result minimum IV and total antibiotic duration (includes IV and PO) are also covered. The standards included in the guideline should be followed whenever possible and support Antimicrobial stewardship clinical care standards of practice.

SCOPE

This guideline provides information for Children's Health Queensland staff caring for patients receiving antimicrobial therapy.

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GUIDELINE FOR EARLY INTRAVENOUS TO ORAL ANTIMICROBIAL SWITCH

Introduction

Administration of antimicrobials by the intravenous (IV) route may be preferable initially in severe infection. However, in the majority of patients who have clinically improved and have adequate enteral absorption, administration can be switched to the oral route after a period of initial IV therapy (IV to oral switch). The minimum IV duration can vary depending on the type and severity of bacterial infection. The recommended minimum IV and total antibiotic duration (IV and PO) are outlined in table one.

Advantages of early IV to oral switch

The oral route of administration for antimicrobials is preferred to the IV route wherever possible as oral administration is associated with:

- Decreased risk of infection from IV lines.
- Decreased risk of thrombophlebitis.
- Significantly less cost than IV therapy.
- Reduction in hidden costs (diluents, equipment, needles, nursing time).
- More patient friendly.
- Earlier discharge and shorter hospital stay.

When to switch? (Flowchart-1 and Table-1)

- Patients should be reviewed 24 to 48 hours after initiation of IV therapy. This period allows the clinician adequate time to review the child's microbiology results, assess their response to treatment and assess whether antibiotic treatment is still indicated.
- The child must fulfill several criteria prior to switching such as (see Flowchart-1):
    - Show signs of clinical improvement,
    - Be able to tolerate oral/ enteral therapy and
    - Not have a condition in which higher concentrations of antimicrobials are required in the tissue or a prolonged course of IV therapy is required (see Table-1)
- It is important to note that the minimum IV durations can vary depending on the bacterial infection (see Table-1).
- Please refer to Table-2 for dosing recommendations for suitable oral agents where applicable

What agent? (Table-1)

- When selecting an antimicrobial, it is recommended that the clinician follow the antimicrobial creed of MINDME
    - **M** Microbiology guides therapy where possible
    - **I** Indications should be evidence based
    - **N** Narrowest spectrum required
    - **D** Dosage appropriate to age of the patient, organ function, the site and type of infection
    - **M** Minimise duration of therapy
    - **E** Ensure monotherapy in most cases

When to consult Infectious Diseases (Table-1)?

- In cases where there is no suitable equivalent oral formulation available or concerns about absorption due to age (neonates)
- Multi-resistant organisms (eg. mMRSA, ESBL, AmpC producers, ESBL)
    - Chromosomal Amp C β-lactamases are produced by *Enterobacter cloacae, Klebsiella aerogenes, Providencia spp, Serratia marcescens, Citrobacter freundii and Morganella morganii.*
- Complicated bloodstream infections, such as:
    - High risk patients with *S. aureus* bacteraemia or gram-negative bacteraemia (see Table-1)
    - Evidence of sepsis or toxic shock syndrome
    - Evidence of dissemination with multi-focal disease
- Not clinically improving despite appropriate management (i.e., persisting fevers, up trending inflammatory markers)
- Endocarditis
- Central nervous system infections
- Patients with severe immediate hypersensitivity or severe delayed type hypersensitivity to antimicrobials
- Complicated bone and joint infection (multifocal disease, vertebral or pelvic involvement, significant bone destruction, unusual pathogen, delayed or incomplete surgical drainage, delayed presentation or immunocompromised)
- Infected metal-ware or infection site in close proximity to foreign material

Flowchart 1. Identification of children suitable for early switch to oral antibiotics

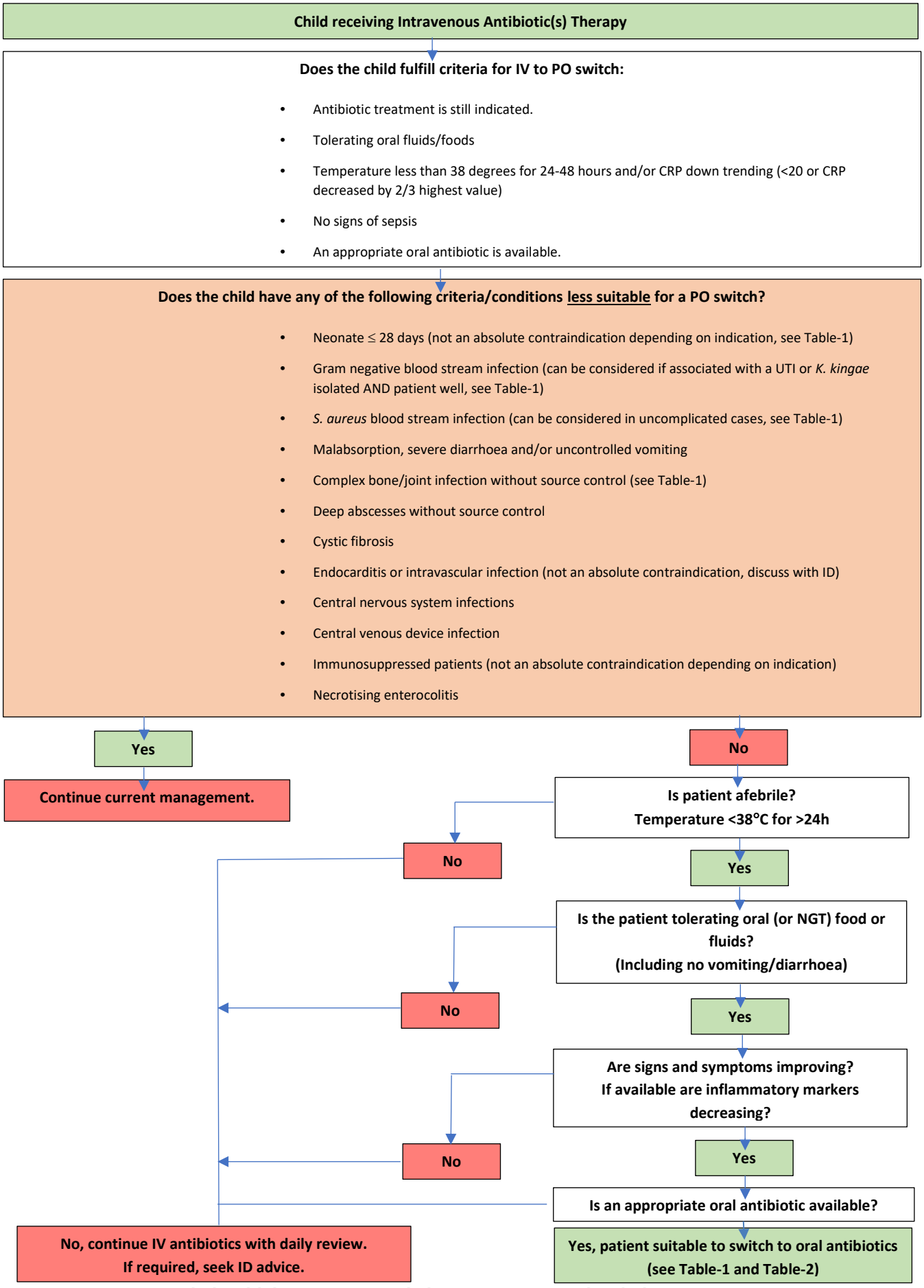

Table 1. Antibiotic and timing of the switch (IV to PO) for bacterial infections in children

* For patients with immediate severe or delayed severe hypersensitive to beta-lactam antibiotics, consult ID.

$ For neonatal dosing, refer to CHQ AMS Antimicrobial dosing recommendations

Infection	First choice antimicrobial	Minimum IV antibiotic duration	Criteria for PO switch	Minimum total antibiotic duration (includes IV)	Comments
Bacteraemia					
Meningococcal bacteraemia	**1.** IV Ceftriaxone (>1 month of age) **OR** **1.** IV Cefotaxime (all ages) If susceptibility to benzylpenicillin confirmed and the patient is **not** hypersensitive to penicillin, use: IV Benzylpenicillin	5 days	No oral switch	5 days	Duration applicable for uncomplicated bacteraemia Antibiotics for nasopharyngeal clearance of *N. meningitidis* are required if the patient was treated with benzylpenicillin alone. Clearance antibiotics are also recommended for some close contacts. See CHQ Clearance antibiotics for invasive meningococcal disease.
Pneumococcal bacteraemia (without meningitis)	If susceptibility to benzylpenicillin is confirmed use: IV Benzylpenicillin	Afebrile at 0 or 24h: 0-1 days Persisting fevers/septic **or** neonate: 7-10 days	Clinical improvement No oral switch	7-10 days	Oral switch not recommended in neonates. If ongoing fever repeat blood culture, consider other focal investigations (eg, lumbar puncture, chest imaging). Also refer to CHQ Invasive pneumococcal disease: Assessment & initial investigation to exclude immune deficiency
Streptococcus pyogenes (Group A Streptococcus)	1. IV Benzylpenicillin	Afebrile at 0h or afebrile > 24-48h with clinical improvement: 0-3 days Persisting fevers/septic **or** neonate: 7-10 days	Clinical improvement No oral switch	7-10 days	Oral switch not recommended in neonates. If ongoing fever repeat blood culture, consider source of infection (chest, skin, bone & joint) +/- focal investigations. Clearance antibiotics are also recommended for some close contacts. Refer to *CDNA Guideline*.
Group B Streptococcus	1. IV Benzylpenicillin or IV Ampicillin * (can be used interchangeably, confirm supply availability at your local hospital)	Neonates & infants <3 months: 7-10 days	No oral switch	7-10 days	Oral switch is not recommended in neonates and infants <3 months. A lumbar puncture is recommended for all neonates & young infants with a GBS bacteraemia. If ongoing fever repeat blood culture, consider source of infection (meningitis, chest, skin, bone & joint).

Infection	First choice antimicrobial	Minimum IV antibiotic duration	Criteria for PO switch	Minimum total antibiotic duration (includes IV)	Comments
Bacteraemia					
Staphylococcus aureus bacteraemia	For a MSSA (flucloxacillin susceptible) isolate: • IV Flucloxacillin **OR** • IV Cefazolin If **nMRSA** use IV Lincomycin If **mMRSA** use IV Vancomycin (see CHQ IV Vancomycin Guideline), consult ID.	**Low risk:** 5-7 days **High risk:** 14 days	Clinical improvement **AND** no further positive blood culture **AND** low-risk	14 days	**Low-risk:** Non-neonate that does not fulfill the below high risk criteria **AND** no further positive blood cultures > 48h after initial positive **AND** no evidence of a deep seated undrained infection **AND** no involvement of a non-removable prosthetic material. **High risk (consult ID):** neonates (≤28 days), severe immunocompromise, complication of an indwelling medical device (ie. CVAD – see CHQ Fever in a child with CVAD) or instrumentation (eg. joint prosthesis – see CHQ bone & joint guideline), associated with endocarditis, deep seated infection without source control. If associated with endocarditis, please refer to endocarditis recommendations. If associated with bone & joint infection, IV duration can be shortened to 5 days if condition is improving quickly & is uncomplicated, with remainder oral (see CHQ Paediatric Bone & Joint Guideline)
Gram-negative bacteraemia	Agent choice according to the results of susceptibility testing when available. For ESBL isolates (as suggested by resistance to third generation cephalosporin) OR Amp C B-lactamase producing organisms (Enterobacter sp., C, freundii, S. marcescens) consult ID.	**Low-risk:** 5-7 days **High-risk:** 10-14 days	Clinical improvement **AND** low-risk	10 days Pseudomonas spp. in HSCT 14 days (IV) For non-typhoidal Salmonella please refer to CHQ Management Guideline for Non-typhoidal Salmonellosis in Children)	**Low-risk:** Non-neonate that does not fulfill high-risk criteria **AND** no further positive blood cultures >48h after initial positive **AND** associated with a UTI **OR** *K. kingae* bacteraemia & patient well (shorter IV frequently considered for *K. kingae*) **High-risk (consult ID):** neonates (≤28 days), severe immunocompromise (ie. HSCT), complication of an indwelling medical device (ie. CVAD – see CHQ Fever in a child with CVAD) or instrumentation (eg. joint prosthesis – see CHQ Bone & Joint Infection Management), associated with endocarditis, deep seated infection without source control. If multi-resistant, duration is from first negative blood culture. For multi-resistant organism, please consult ID.
CVC-associated bacteraemia	Please refer to "CHQ Fever in a child with Central Venous Access Device"				

Central nervous system infection (please consult ID)					
Infection	**First choice antimicrobial**	**Minimum IV antibiotic duration**	**Criteria for PO switch**	**Minimum total antibiotic duration (includes IV)**	**Comments**
Bacterial meningitis	Agent choice according to the organism isolated and results of susceptibility testing when available.	5-21 days depending on organism.	No oral switch	*N. meningitidis* 5 days *H. influenzae* 7-10 days *S. pneumoniae* 10-14 days Group B Streptococcus (GBS): 14-21 days Gram negative bacilli 21 days (except Salmonella) *L. monocytogenes* 21 days	Please consult ID.
Brain abscess and subdural empyema	Agent choice according to the organism isolated and results of susceptibility testing when available. **If not available:** **1.** IV Ceftriaxone (>1 month of age) **OR** **1.** IV Cefotaxime (all ages)	2-4 weeks	Clinical improvement (afebrile, normal conscious state, CRP normalised)	6 weeks	Please consult ID.
VP shunt infections	Agent choice according to the organism isolated and results of susceptibility testing when available. **If not available:** **1.** IV Cefotaxime and IV vancomycin (see CHQ IV Vancomycin Guideline),	10 days	No oral switch	10 -14 days	Refer to Clinical Practice Guidelines for Healthcare-Associated Ventriculitis & Meningitis. Please consult ID.

ENT/Respiratory infections					
Infection	**First choice antimicrobial**	**Minimum IV antibiotic duration**	**Criteria for PO switch**	**Minimum total antibiotic duration (includes IV)**	**Comments**
Peritonsillar abscess	IV Benzylpenicillin	1-2 days following successful drainage	As soon as tolerated	10 days	
Retropharyngeal abscess	Agent choice according to the organism isolated and results of susceptibility testing when available. **If not available use:** **1.** IV Amoxicillin/clavulanate OR **2.** IV Cefazolin	3–5 days for conservative or surgical management	Afebrile, neck mobility, tolerating oral diet	10–14 days	Even if abscess is drained, intravenous antibiotics needed for surrounding tissue involvement
Mastoiditis	Agent choice according to the organism isolated and results of susceptibility testing when available **If not available use:** 1. IV Cefotaxime (all ages) OR 2. IV Ceftriaxone (>1 month old)	3- 5 days	Clinical improvement	14 days	Longer courses might be required for intracranial complications; refer to brain abscess and consult ID.
Acute bacterial sinusitis	1. IV Amoxicillin/clavulanate OR 2. IV Ceftriaxone (>1 month old) AND Metronidazole oral	0 days Systemically unwell or high risk of suppuration: 1–2 days	Clinical improvement	Moderate or severe: 7 days after improvement in symptoms; usually 10–14 days	
Acute cervical lymphadenitis	Agent choice according to the organism isolated and results of susceptibility Testing when available. **If not available use:** IV Flucloxacillin OR IV Cefazolin If **nMRSA** use IV Lincomycin **OR** **mMRSA** use IV Vancomycin (see CHQ IV Vancomycin Guideline)	0 days Systemically unwell or rapid progression: 2–3 days	Clinical improvement including reduction in fever, pain, and size	5–7 days	May be longer if slow progression or abscess formation

ENT/Respiratory infections					
Infection	**First choice antimicrobial**	**Minimum IV antibiotic duration**	**Criteria for PO switch**	**Minimum total antibiotic duration (includes IV)**	**Comments**
Community-acquired pneumonia	IV Benzylpenicillin OR PO amoxicillin	0 days Severe or complicated: initial intravenous treatment	Clinical improvement	Mild/moderate: 5 days Severe complicated: 7 days	Oral antibiotics can be used in most children including children requiring hospital admission; if associated with bacteraemia refer to the relevant guideline
Pleural empyema/ Lung abscess	Refer to Empyema: management of parapneumonic effusions and empyema in previously well children.				
Musculoskeletal infections					
Acute osteomyelitis	Agent choice according to the organism isolated and results of susceptibility testing when available See CHQ Bone and Joint Management	Uncomplicated: 2 days	Afebrile, clinical improvement, CRP or ESR decreasing	3–4 weeks See CHQ Bone and Joint Management	If associated with bacteraemia, initial intravenous but may be shortened to 5–7 days if improving quickly and uncomplicated, with remainder oral for total duration as for non-bacteraemic infection. Complicated bone and joint infection (please consult ID): multifocal disease, vertebral or pelvic involvement, significant bone destruction, unusual pathogen, delayed or incomplete surgical drainage, delayed presentation or immunocompromised. See CHQ Bone and Joint Management
Chronic osteomyelitis	Agent choice according to the organism isolated and results of susceptibility testing when available. See CHQ Bone and Joint Management. Consult ID	Clinically well and no prosthetic material: 0 days Prosthetic material: initial treatment and consult ID	As soon as tolerated; clinical improvement	6-12 weeks (consult ID)	Consult ID
Septic arthritis	Agent choice according to the organism isolated and results of susceptibility testing when available See CHQ Bone and Joint Management	Uncomplicated: 2 days	Afebrile, clinical improvement, CRP or ESR decreasing	2–3 weeks Complicated (delayed presentation, associated wound or abscess): longer duration intravenous route is likely to be required	If associated with bacteraemia, initial intravenous route but may be shortened to 5–7 days if improving quickly and uncomplicated, with remainder oral route for total duration as for non-bacteraemic infection. Complicated bone and joint infection (please consult ID): multifocal disease, vertebral or pelvic involvement, significant bone destruction, unusual pathogen, delayed or incomplete surgical drainage, delayed presentation or immunocompromised. See CHQ Bone and Joint Management

Musculoskeletal infections					
Infection	**First choice antimicrobial**	**Minimum IV antibiotic duration**	**Criteria for PO switch**	**Minimum total antibiotic duration (includes IV)**	**Comments**
Pyomyositis	Agent choice according to the organism isolated and results of susceptibility testing when available **If not available use:** **1.** IV Flucloxacillin OR **1.** IV Cefazolin If risk factors for: **nMRSA** use IV Lincomycin **OR mMRSA** use IV Vancomycin (see CHQ IV Vancomycin Guideline) Consult ID	2–5 days	Clinical improvement	2–3 weeks	Pus should be drained
Skin and soft tissue infections					
Cellulitis/skin abscesses or boils/surgical site infection	IV Flucloxacillin OR IV Cefazolin If risk factors for: **nMRSA** use IV Lincomycin **OR** **mMRSA** use IV Vancomycin (see CHQ IV Vancomycin Guideline) Consult ID	Mild: 0 days; moderate or severe: 1–3 days	Clinical improvement: reduction in fever and erythema	5–7 days	If associated with deep infection or osteomyelitis, refer torelevant guideline; Moderate or severe: rapidly spreading erythema, tenderness, lymphangitis, systemic features. If drained or small abscess, usually 5 days from drainage is sufficient.
Preseptal (periorbital) cellulitis	IV Flucloxacillin OR IV Cefazolin If risk factors for: **nMRSA** use IV Lincomycin **OR** **mMRSA** use IV Vancomycin (see CHQ IV Vancomycin Guideline) Consult ID	2–3 days	Clinical improvement: reduction in fever and erythema	7–10 days	

Skin and soft tissue infections					
Infection	**First choice antimicrobial**	**Minimum IV antibiotic duration**	**Criteria for PO switch**	**Minimum total antibiotic duration (includes IV)**	**Comments**
Orbital cellulitis	IV Cefotaxime If nMRSA **add** IV Lincomycin If mMRSA **add** IV Vancomycin (see CHQ IV Vancomycin Guideline) Consult ID	3–4 days	Clinical resolution of fever, erythema, and pain	7–10 days	Intra-orbital abscesses should be drained, with non-operative management in selected patients ; if symptoms persist intravenous antibiotics should continue while investigating for complications
Genitourinary infections					
Lower UTI	Agent choice according to the organism isolated and results of susceptibility testing when available	0 days Age <3 months: initial Treatment (1-2 days)	Clinical improvement	3–5 days	If associated with bacteraemia, refer to bacteraemia guideline
Pyelonephritis	Agent choice according to the organism isolated and results of susceptibility testing when available	0 days Age <3 months or not tolerating orals: initial treatment (1-2 days)	Clinical improvement, or as soon as tolerating orals	10 days In a child who rapidly improves 7 days may be sufficient	If associated with bacteraemia, refer to bacteraemia guidelines
Epididymitis	Agent choice according to the organism isolated and results of susceptibility testing when available	0 days	Clinical improvement	Negative urinalysis: no antibiotic Positive urinalysis: oral antibiotic 14 days	Nil

Table-2: Oral antibiotics considered suitable and equivalent for IV to oral switch

Please refer to CHQ Antimicrobial prescribing guidelines for dosing in specific indications.

If on intravenous antibiotic and dose	Suggested ORAL antibiotic conversion	ID approval required
Ampicillin or Amoxicillin[#] 50 mg/kg/dose IV 6-hourly (Maximum 2 g/dose)	Amoxicillin[#] 30 mg/kg/dose oral three times daily (Maximum 1 g/dose)	No
Benzylpenicillin[#] 60 mg/kg/dose IV 6-hourly (Maximum 2.4 g/ dose)	Amoxicillin[#] 30 mg/kg/dose oral three times daily (Maximum 1 g/dose)	No
Ceftriaxone 100 mg/kg IV 24-hourly (Maximum 4 g/day) **OR** Cefotaxime 50 mg/kg/dose IV 6-hourly (Maximum 2 g/dose)	Amoxicillin/Clavulanic acid[#] 22.5 mg/kg/dose oral twice daily (Maximum 875 mg Amoxicillin component per dose) If treating a resistant Gram negative infection, seek ID advice.	No (up to 14 days) (if treating a resistant Gram negative infection, seek ID advice)
	OR	
	Cefalexin 30 mg/kg/dose orally three times daily (Maximum 1 g/dose)	No (up to 14 days)
Ampicillin (Amoxicillin) IV 50 mg/kg/dose 6-hourly (Maximum 2 g/dose) **PLUS** Gentamicin (see TDM guideline for dosing) **PLUS** Metronidazole^ 7.5 mg/kg/dose IV 8-hourly (Maximum 500 mg/dose)	Amoxicillin/ clavulanic acid[#] 22.5 mg/kg/dose oral twice daily (Maximum 875 mg Amoxicillin component per dose) If treating a Pseudomonas or resistant Gram negative infection, seek ID advice.	No (up to 14 days) (if treating a Pseudomonas or resistant Gram negative infection, seek ID advice.)
Amoxicillin-clavulanate IV 25 mg/kg/dose 8-hourly to 6-hourly (Maximum 2 g/dose amoxicillin component)		
Piperacillin/tazobactam[#] IV 100 mg/kg/dose 6-hourly (Maximum 4 g/dose Piperacillin component)		
Flucloxacillin[#] 50 mg/kg/dose IV 6-hourly (Maximum 2 g/dose)	Flucloxacillin[#] 25 mg/kg/dose orally four times daily (Maximum 1 g/dose)	No (up to 14 days)

If on intravenous antibiotic and dose	Suggested ORAL antibiotic conversion	ID approval required
Cefazolin 50 mg/kg/dose IV 8-hourly (Maximum 2 g/dose)	(Use capsules. Note: suspension – poor oral palatability) OR Cefalexin 30 mg/kg/dose orally three times daily (Maximum 1 g/dose)	
Lincomycin 15 mg/kg/dose IV 8-hourly (Maximum 1.2 g/dose) Or Clindamycin IV – dosing as per AMH CDC	Clindamycin^ 10 mg/kg/dose oral three to four times daily (Maximum 450 mg/dose) (Use capsules. Open/dispersed capsules – poor oral palatability)	Yes
	OR	
	Trimethoprim/sulfamethoxazole 8 mg/kg twice daily (Maximum 320mg/dose of trimethoprim component) **OR** Trimethoprim/sulfamethoxazole 5 mg/kg three times daily (Maximum 320mg/dose of trimethoprim component)	Yes
IV Vancomycin – see TDM guideline for dosing	Review microbiology susceptibility results and consult ID for suitable oral switch options	Yes

*Usual dose for children with normal renal function.
Do **not** use suggested doses for **neonates – refer to CHQ AMS website for neonatal dosing guidance**.
Dose adjustment may be required based on type of infection/renal or liver dysfunction.
Ensure patient does not have immediate severe or delayed severe hypersensitivity to beta-lactam antibiotics – seek ID advice.
^Antimicrobials with excellent oral bioavailability.

SUPPORTING DOCUMENTS

Supporting documents:

- CHQ-PROC-01036 Antimicrobial: Prescribing and Management
- CHQ Antimicrobial restrictions list

CONSULTATION

Key stakeholders who reviewed this version:

• Director - Infection Management and Prevention Service (CHQ)	• Paediatric Infection Specialist Consultant, Gold Coast University Hospital • Medications Advisory Committee – Endorsed

• Paediatric Infection Specialist Consultant and Fellow Team (CHQ) • Pharmacist Advanced, Antimicrobial Stewardship (CHQ)	

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GUIDELINE REVISION AND APPROVAL HISTORY

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1.0	Antimicrobial Stewardship Pharmacist (CHQ)	Medicines Advisory Committee	General Manager Operations	
2.0 14/01/2016	Antimicrobial Stewardship Pharmacist (CHQ)	Medicines Advisory Committee	Executive Director Hospital Services	
3.0 25/02/2019	Director – Infection Management and Prevention service, Immunology and Rheumatology Pharmacist Advanced-Antimicrobial Stewardship (CHQ)	Medicines Advisory Committee	Executive Director Clinical Services (QCH)	
4.0 10/06/2021	Pharmacist Advanced-Antimicrobial Stewardship (CHQ))	Director – Infection Management and Prevention service, Immunology and Rheumatology	Divisional Director Medicine	
5.0	Paediatric Infection Specialist Director – Infection Management and	Medicines Advisory Committee	Executive Director Clinical Services (QCH)	

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