Guideline

Empiric Antimicrobial Guidelines for Paediatric Intensive Care Unit (PICU)

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Applicable to	All CHQ staff caring for PICU patients				
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Purpose

This Guideline provides recommendations regarding best practice for empiric antimicrobial treatment for patients admitted to the Paediatric Intensive Care Unit (PICU).

Scope

This Guideline provides information for all Children's Health Queensland (CHQ) staff working in PICU Environment. This guideline is not intended for use outside of this clinical area without the advice of a Paediatric Infectious Diseases consultant.

Related documents

Procedures, guidelines, protocols and useful resources

- CHQ-PROC-01036 Antimicrobial: Prescribing and Management and CHQ Antimicrobial restrictions
- Pathology Queensland – Queensland Children's Hospital Antibiograms
- CHQ-GDL01202 CHQ Paediatric Antibiocard: Empirical Antibiotic Guideline
- CHQ-GDL-01249 Management of Fever in a Paediatric Oncology Patient: Febrile Neutropenia and Febrile Non-neutropenia
- CHQ Paediatric Medication Guideline: Vancomycin
- CHQ Paediatric Medication Guideline: Intravenous Aminoglycoside therapy (Amikacin, Gentamicin and Tobramycin)
- CHQ-GDL-01075 Antifungal Prophylaxis and Treatment in Paediatric Oncology Patients and other Immunocompromised Children

Guideline

Standards for Antimicrobial Stewardship in Critically ill patients cared for in Children's Health Queensland

- Take cultures before starting antibiotics
- Cease antibiotics if cultures negative at 48 hours except if:
  - the child has signs of severe sepsis
  - cultures were taken after antibiotic treatment was started (discuss with Infectious Diseases)
  - ongoing infection is likely
- Change to narrow spectrum antimicrobials once sensitivities are known and discuss with Infectious Diseases (ID) if required
- Recommendations for treatment duration in confirmed infections: duration different for different bacteria or clinical syndrome
  - pneumonia/ventilator associated pneumonia: 5 to 7 days (discuss appropriate duration with ID)
  - sepsis, negative blood culture: 3 to 7 days (discuss appropriate duration with ID)
  - blood-culture positive sepsis: 5 to 14 days (discuss appropriate duration with ID)
- Consult ID specialist
  - if patient has a previous (or new onset) severe antimicrobial hypersensitivity reaction (include the following information: type of antimicrobial, type of reaction and severity, onset of reaction in relation to commencing antimicrobial, treatment required to treat symptoms)
  - to confirm appropriate treatment and duration for positive culture results
  - when escalation to broader antibiotic treatment is considered for ongoing infection
  - for recommendations for treatment duration in confirmed infections
- Perform therapeutic drug monitoring (TDM) and optimize antimicrobial dosing based on severity of infection, clinical response and organ dysfunction
  - Consider extended beta-lactam/cephalosporin infusions in consultation with ID specialist
    - Liaise with Critical care/AMS pharmacist with regarding to dosing and antimicrobial stability, in consultation with ID team
  - Seek Pharmacist / ID advice on appropriate therapeutic drug monitoring (TDM) and appropriate dosing for patients in organ failure, receiving extracorporeal therapies (continuous and intermittent replacement therapy and/or ECMO, plasmapheresis etc)
    - Novel therapeutic drug monitoring methods in the paediatric critical care population is currently being investigated. Seek ID specialist and AMS/Critical care specialist advice for guidance on appropriate TDM targets in this high risk patient population.
  - Antimicrobial dosing in ECMO is complex, individualized and requires specialist ECMO pharmacist advice. In addition to pharmacokinetic changes, other considerations for dosing whilst patients are on ECMO:
    - Consider drug properties such as hydrophilicity and lipophilicity
    - Renal replacement therapy
    - Priming volume/haemodilution

- Adsorption to OR sequestration of some hydrophilic and lipophilic drugs by the circuit(expect considerable loss in the ECMO circuit)
- Recirculation

- To facilitate judicious use of antimicrobials appropriate documentation is of the utmost importance. The antimicrobial plan should be documented consistently in either the Integrated Electronic Medical Record (ieMR), Metavision or the National Inpatient Medication Chart (NIMC).

  The order should include the following information:

  - The Indication for Antimicrobial Therapy (note: this is a mandatory field for all electronic medication orders in Metavision and ieMR and should be as descriptive as possible)
  - The Intended Duration or Review Date for Antimicrobial Therapy
  - The words "ID approved" with the unique ID Approval number provided by the Approving ID Physician or Microbiologist
  - The order should include the antimicrobial therapy start date, scheduled review date, and proposed duration of therapy to assist with appropriate follow-up and review of therapy.
  - Where extension of antimicrobial therapy past the predetermined review date is clinically indicated, the order should be modified to reflect the most current plan and updated approval number where required.

- Daily review of antibiotic plan (stop/continue antibiotics) should occur at PICU morning ward round. Review should include:
  - Consideration of Early Intravenous (IV) to Oral Switch Therapy - Patients should be reviewed at 24 to 48 hours to consider whether early IV to oral switch would be appropriate. Refer to CHQ-GDL-01057 Antimicrobial treatment: Early intravenous to oral switch – Paediatric Guideline for further information.
    - Exercise caution when considering a switch to oral in neonates and infants because of the possibility of variable enteral absorption (including administration via enteral feeding tubes for example TPT, NGT, PEG and PEJ).
    - Review of pathology results and appropriate antimicrobial dosing and choice based on these results.

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
SEPSIS		
COMMUNITY ACQUIRED SEPSIS (PICU) NEONATES and INFANTS (less than or equal to 2 months old) **(Meningitis excluded)** **Note:** **If Meningitis has not or cannot been excluded treat as stated under MENINGITIS**	**Ampicillin IV (or Amoxicillin IV)** **Neonates:** Refer to neonatal dosing section. **1 month or older:** 50 mg/kg/dose IV every 6 hours (maximum 2 g/dose). **PLUS** **Gentamicin IV** (Dose based on adjusted body weight. Perform TDM)** **Neonates:** Age dependent - Refer to Gentamicin neonatal dosing section. **If 1 month or older:** 7.5 mg/kg IV once daily (maximum 320 mg/day).	**Immediate type penicillin hypersensitivity,** **Cefotaxime IV** **For immediate [severe] cephalosporin hypersensitivity, seek ID / Microbiology advice**
	If MRSA suspected: **Neonates:** **Ampicillin (or Amoxycillin) IV** **PLUS Gentamicin IV** **PLUS Vancomycin IV.** Refer to neonatal dosing section. **Seek ID advice at 24 hours.** **If more than 1 month old:** **Ampicillin IV (or Amoxicillin IV)** • **More than 1 month old:** 50 mg/kg/dose IV every 6 hours (maximum 2 g/dose). **PLUS Gentamicin IV** (Dose based on adjusted body weight. See TDM section)** • **If more than 1 month and less than (or equal to) 10 years old**: 7.5 mg/kg once daily (maximum 320 mg/day). **PLUS Vancomycin IV** 15 mg/kg every 6 hours (maximum initial Vancomycin dose of 750 mg) (Perform TDM)**.** **Seek ID advice at 24 hours.**	**Immediate type penicillin hypersensitivity,** **Cefotaxime IV and Vancomycin IV** **For immediate [severe] cephalosporin hypersensitivity, seek ID / Microbiology advice**

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
SEPSIS		
COMMUNITY ACQUIRED SEPSIS (PICU) **INFANTS and CHILDREN (more than 2 months old)** **(Meningitis excluded)**	**Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose); **OR Ceftriaxone IV** 100 mg/kg once daily (maximum 4 g/day). **Note: If Meningitis clinically or by LP treat as below under MENINGITIS.** Seek ID advice within 24 hours	**Immediate type [severe] cephalosporin hypersensitivity** **Ciprofloxacin IV** 10 mg/kg/dose 8-hourly (maximum 400 mg/dose) **PLUS** **Vancomycin IV** Seek ID advice within 24 hours.
	If nmMRSA suspected: **Cefotaxime IV** **PLUS Lincomycin IV** 15 mg/kg/dose every 8 hourly (maximum 1.2 g/dose). Seek ID advice within 24 hours	
	If multi-resistant MRSA suspected: **Cefotaxime IV** **PLUS Vancomycin IV** 15 mg/kg every 6 hours (maximum initial Vancomycin dose of 750 mg) (Perform TDM). Seek ID advice within 24 hours	
	If septic shock present: **Cefotaxime IV** **PLUS Gentamicin IV** (Dose based on adjusted body weight. Perform TDM)** • **If more than 1 month and less than (or equal to) 10 years old**: 7.5 mg/kg once daily (maximum 320 mg/day). • **If more than 10 years old:** 7 mg/kg once daily (maximum 640 mg/day). **PLUS Vancomycin IV** 15 mg/kg every 6 hours (maximum initial Vancomycin dose of 750 mg) (Perform TDM). Seek ID advice within 24 hours	**Immediate type [severe] cephalosporin hypersensitivity** **Ciprofloxacin IV** 10 mg/kg/dose 8-hourly (maximum 400 mg/dose) **PLUS** **Gentamicin IV** **PLUS** **Vancomycin IV** Seek ID advice within 24 hours
	In North Queensland during wet season (November to May) **Replace Cefotaxime with Meropenem IV** 40 mg/kg/dose every 8 hours (maximum 2 g/dose of Meropenem) to cover Melioidosis. Seek ID advice within 24 hours	**Immediate type hypersensitivity**, seek ID advice.

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
SEPSIS		
Nosocomial sepsis (Hospital-acquired and healthcare associated sepsis)	**If nosocomial sepsis where meningitis has <u>not</u> been excluded – discuss with Infectious Diseases consultant on service.** **All ages <u>and</u> meningitis excluded:** **Piperacillin- Tazobactam IV** • **Neonates:** Refer to Piperacillin/Tazobactam IV neonatal dosing section. • **Over 1 month of age:** 100 mg/kg/dose every 6 hours (maximum 4 g/dose Piperacillin component) **<u>If central venous access device in-situ:</u>** **ADD Teicoplanin IV (Dose based on actual body weight**) **Neonates:** 16 mg/kg as a single dose on day 1 (loading dose), then 8 mg/kg 24-hourly (maintenance dose). **If more than 1 month of age: Loading dose:** 10 mg/kg (Maximum 800 mg/dose) 12-hourly for 3 doses. **Maintenance dose:** 10 mg/kg (Maximum 800 mg/day) 24-hourly Perform TDM. **<u>If septic shock:</u>** **ADD Gentamicin IV** (dose based on adjusted body weight. Perform** TDM**)**: • Less than 10 years: 7.5 mg/kg once daily (maximum 320 mg/day); • More than 10 years: 7 mg/kg once daily (maximum 640 mg/day). • (Consider risk factors for renal impairment. Discuss with Oncologist) **<u>AND</u> Teicoplanin IV (dosing as above)**. **Seek ID advice within 24 hours.**	**Delayed type hypersensitivity,** **Ceftazidime IV** 50 mg/kg/dose every 8 hours (maximum 2 g/dose). **<u>PLUS</u>** **Gentamicin IV** (single dose then review). **<u>If CVAD in situ or septic shock:</u>** **ADD IV Teicoplanin** **Immediate type hypersensitivity, seek ID advice.** **Seek ID advice within 24 hours.**

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
SEPSIS		
TOXIC SHOCK SYNDROME **Seek ID advice within 24 hours.**	**If organism and focus unknown:** **Cefotaxime IV** • **Neonates:** Refer to Cefotaxime IV neonatal dosing section. • **If more than 1 month of age:** 50 mg/kg/dose every 6 hours (maximum 2 g/dose) **PLUS Lincomycin IV** 15 mg/kg/dose every 6 hours (maximum 1.2 g/dose) (Neonates – use Clindamycin IV - Refer to Clindamycin IV neonatal dosing section.) **PLUS Vancomycin IV** • **Neonates:** Refer to Vancomycin IV neonatal dosing section. • **If more than 1 month of age:** 15 mg/kg/dose IV every 6 hours (maximum initial dose of 750 mg) (Perform therapeutic drug monitoring for Vancomycin.) **PLUS consider Intragam ® 2 g/kg IV as a single dose**	**Immediate type hypersensitivity, seek ID advice.**
	If known Group A Streptococcal infection: **Benzylpenicillin IV** • **Neonates:** Refer to Benzylpenicillin IV neonatal dosing section. • **If more than 1 month of age:** 60 mg/kg/dose every 4 hours (maximum 2 g/dose) **PLUS Lincomycin IV** 15 mg/kg/dose every 6 hours (maximum 1.2 g/dose) (Neonates – use Clindamycin IV - Refer to Clindamycin IV neonatal dosing section.) **PLUS consider Intragam ® 2 g/kg IV as a single dose.**	
	If known Staphyloccocus aureus infection or known bone focus: **Flucloxacillin IV** • **Neonates:** Refer to Benzylpenicillin IV neonatal dosing section. • **If more than 1 month of age:** 50 mg/kg/dose every 4 hours (maximum 2 g/dose) **PLUS Lincomycin IV** 15 mg/kg/dose every 6 hours (maximum 1.2 g/dose) (Neonates – use Clindamycin IV - Refer to Clindamycin IV neonatal dosing section.) **PLUS Vancomycin IV (see above for dosing and TDM recommendation)** **PLUS consider Intragam ® 2 g/kg IV as a single dose.**	

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
SEPSIS		
Febrile neutropenia (Oncology / Haematology)	**Over 1 month of age:** **Piperacillin- Tazobactam IV** 100 mg/kg/dose every 6 hours (maximum 4 g/dose Piperacillin component) and seek ID review within 72 hours. **If critically ill add both:** **Gentamicin IV** (dose based on adjusted body weight. Perform** TDM**)**: Less than 10 years: 7.5 mg/kg once daily (maximum 320 mg/day); More than 10 years: 7 mg/kg once daily (maximum 640 mg/day). (Consider risk factors for renal impairment. Discuss with Oncologist) **AND** **Vancomycin IV** 15 mg/kg (maximum initial dose of dose 750 mg) every 6 hours. **If Gram positive bacteraemia with resistance to Piperacillin/Tazobactam proven or suspected clinically (e.g. line or post-surgical)**: Add **IV Vancomycin** 15 mg/kg (maximum initial dose of 750 mg) every 6 hours (Perform TDM for Gentamicin and Vancomycin). **Refer to** CHQ-GDL-01249 Management of Fever in a Paediatric Oncology Patient (Febrile Neutropaenia and Febrile Non-neutropaenia).	**Delayed type hypersensitivity,** **Ceftazidime IV** 50 mg/kg/dose every 8 hours (maximum 2 g/dose). **PLUS** **Gentamicin IV** (single dose then review). **Immediate type hypersensitivity, Meropenem IV** 40mg/kg/dose every 8 hours (maximum 2g/dose) and **seek ID advice.**
Febrile non-neutropenia (Oncology)	**Over 1 month of age:** **Ceftriaxone IV** 100 mg/kg once daily (maximum 4 g/day) **and discuss with Paediatric Oncologist.** **Refer to** CHQ-GDL-01249 Management of Fever in a Paediatric Oncology Patient (Febrile Neutropaenia and Febrile Non-neutropaenia).	**Immediate type hypersensitivity, seek ID advice.**

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
CENTRAL NERVOUS SYSTEM		
Meningitis (less than or equal to 2 months old)	**Cefotaxime IV PLUS Ampicillin IV (or Amoxicillin IV)** **Neonates:** Refer to Ampicillin/Amoxicillin & Cefotaxime neonatal dosing section. **If more than 1 month of age:** **Cefotaxime IV** 50 mg/kg/dose IV every 6 hours (maximum 2 g/dose) **PLUS** **Ampicillin IV (or Amoxicillin IV)** 50 mg/kg/dose IV every 6 hours (maximum 2 g/dose) **(Comment: For Gram negative meningitis/sepsis – Consult ID)**	**Immediate type hypersensitivity, seek ID advice.**
Meningitis (more than 2 months old)	**Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose) **PLUS** **If more than 2 months of age:** **Dexamethasone IV** 0.15 mg/kg/dose (maximum 10 mg) every 6 hourly for 4 days. Start before or with the first dose of antibiotic (however can be administered up to 4 hours after starting IV antibiotics) but not beyond 4 hours. Discuss with ID within 24 to 48 hours with cerebrospinal fluid (CSF) culture and susceptibility results.	**Immediate type hypersensitivity, Ciprofloxacin IV** 10 mg/kg/dose 8-hourly (maximum 400 mg/dose) **PLUS Vancomycin IV** and seek ID advice within 24 hours.
	If Gram positive cocci in CSF: **Add Vancomycin# IV (see** TDM section**)** and discuss with ID. **If more than 1 month old:** 15 mg/kg/dose IV every 6 hours (maximum 750 mg/dose starting dose). Perform TDM.	
If HSV Encephalitis suspected (all ages) **(see** Infectious encephalitis: investigation & initial management**)**	**Add Aciclovir IV (Duration of 3 weeks or till PCR negative.)** • **Neonates:** Refer to Aciclovir neonatal dosing section. • **If 1 to 2 months old:** 20mg/kg/dose IV 8-hourly • **If more than 2 months old or less than 12 years old:** 500 mg/m^2/dose IV every 8 hours (maximum 1000 mg/dose). • **If more than 12 years old:** 10 mg/kg/dose IV every 8 hours (maximum 1000 mg/dose).	

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
CENTRAL NERVOUS SYSTEM		
CSF shunt infection	**Cefotaxime IV** • **Neonates:** Refer to Cefotaxime neonatal dosing section. • **If more than 1 month old: Cefotaxime IV** 50 mg/kg/dose IV every 6 hours (Maximum 2g/dose) **PLUS Vancomycin# IV (see** TDM section**)** • **Neonates:** Refer to Vancomycin neonatal dosing section. • **If more than 1 month old:** 15 mg/kg/dose IV every 6 hours (maximum initial dose of 750 mg) Perform TDM for Vancomycin. Discuss with ID within 48 hours.	**Immediate type hypersensitivity, seek ID advice.**
RESPIRATORY		
Severe pneumonia **Less than 5 years old** **(PICU/HDU care required)**	**Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose). **Discuss with ID within 48 hours.** **Neonates – seek ID advice**	**Immediate type hypersensitivity, seek ID advice**.
	If *S. aureus* (including nmMRSA) pneumonia suspected: **Cefotaxime IV PLUS Lincomycin IV** **Seek ID advice within 24 hours.**	
Life-threatening pneumonia **Less than 5 years old** **(PICU/High dependency unit care required)**	**If life threatening pneumonia OR multi-resistant MRSA suspected:** **Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose) **PLUS Lincomycin IV** 15 mg/kg/dose every 6 hours (maximum 1.2 g/dose) **PLUS Vancomycin IV** 15 mg/kg/dose IV every 6 hours (maximum initial dose of 750 mg) (Perform therapeutic drug monitoring for Vancomycin.) **Consider Azithromycin IV** 10 mg/kg once daily (maximum 500 mg/day). **Seek ID advice within 24 hours**	

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
RESPIRATORY		
Severe pneumonia More than 5 years old (PICU/HDU care required)	**Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose). **Consider Azithromycin IV** 10mg/kg once daily (maximum 500 mg/day). (Swap to oral Roxithromycin 4 mg/kg/dose (maximum 150 mg/dose) twice daily, after 24 hours if possible). **Seek ID advice within 24 hours.**	**Immediate type hypersensitivity, seek ID advice.**
	If S. aureus (including nmMRSA) pneumonia suspected: Cefotaxime IV PLUS Lincomycin IV and seek ID advice within 24 hours.	
Life-threatening pneumonia More than 5 years old (PICU/HDU care required)	**If life threatening pneumonia OR multi-resistant MRSA suspected: Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose) **PLUS Lincomycin IV** 15 mg/kg/dose every 6 hours (maximum 1.2 g/dose) **PLUS Vancomycin IV** 15 mg/kg/dose IV every 6 hours (maximum initial dose of 750 mg) (Perform therapeutic drug monitoring for Vancomycin.) **Consider Azithromycin IV** 10 mg/kg once daily (maximum 500 mg/day). **Seek ID advice within 24 hours.**	
Empyema (Severe pneumonia in PICU)	**Cefotaxime IV** 50 mg/kg/dose every 6 hours (Maximum of 2 g/dose) **PLUS Lincomycin IV** 15 mg/kg/dose every 8 hours (maximum 1.2 g/dose) Consult Respiratory team regarding pleural drainage. Seek ID advice within 72 hours.	**Delayed type hypersensitivity, Cefotaxime IV and Lincomycin IV Immediate type hypersensitivity, seek ID advice.**
Nosocomial and ventilator-associated pneumonia	**If less than 5 days in PICU: Neonates:** Refer to Cefotaxime neonatal dosing section. **Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose). ID review within 48 hrs.	**Immediate type hypersensitivity, seek ID advice.**
	If more than 5 days in PICU: Neonates: Refer to Piperacillin-Tazobactam neonatal dosing section. **Over 1 month of age: Piperacillin- Tazobactam IV** 100 mg/kg/dose every 6 hours (maximum 4 g/dose Piperacillin component) and seek ID review within 48 hours.	
Pertussis	**Azithromycin IV Neonates and infants less than or equal to 6 months old:** 10 mg/kg once daily (maximum 500 mg/day) for 5 days. **Infants more than 6 months old:** 10 mg/kg once daily on Day 1 (maximum 500 mg), then 5 mg/kg daily on Day 2 to 5 (maximum 250 mg/day). Swap to oral azithromycin when clinically appropriate.	

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
GASTRO-INTESTINAL		
Intra-abdominal infection (including Necrotising enterocolitis or peritonitis)	**OPTION 1:** **Ampicillin IV (or Amoxicillin IV)** • **Neonates:** Refer to Ampicillin (Amoxicillin) IV neonatal dosing section. • **More than 1 month old:** 50 mg/kg/dose IV every 6 hours (maximum 2 g/dose). **PLUS Metronidazole IV** • **Neonates:** Refer to Metronidazole IV neonatal dosing section. • **More than 1 month old:** 7.5 mg/kg/dose every 8 hours (maximum 500 mg/dose). **PLUS Gentamicin IV** (Dose based on adjusted body weight. See TDM section)** • **Neonates:** Refer to Gentamicin IV neonatal dosing section. • **If more than 1 month and less than (or equal to) 10 years old**: 7.5 mg/kg once daily (maximum 320 mg/day). • **If more than 10 years old:** 7 mg/kg once daily (maximum 640 mg/day). Perform therapeutic drug monitoring for Gentamicin as advised by pharmacy. **Seek ID advice within 48 hours.** **OPTION 2:** **Piperacillin- Tazobactam IV** **Neonates:** Refer to Piperacillin/Tazobactam IV neonatal dosing section. **Over 1 month of age:** 100 mg/kg/dose every 6 hours (maximum 4 g/dose Piperacillin component) **Seek ID advice within 48 hours.**	**Delayed type hypersensitivity,** **Ceftriaxone IV** 100 mg/kg once daily (Maximum 4 g/day) **PLUS Metronidazole IV.** **Immediate type hypersensitivity,** **Gentamicin IV** **PLUS Lincomycin IV** 15 mg/kg/dose every 8 hours (maximum 1.2 g/dose).

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
SKELETAL / SOFT TISSUE / SKIN / OSTEO-ARTICULAR INFECTION		
If less than or equal to 5 years old WITH Severe cellulitis/ Osteomyelitis	**Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose) Refer to CHQ-GDL-01067 Paediatric Bone and Joint Infection Management for further information.	**Immediate type hypersensitivity,** seek ID advice.
	If nmMRSA suspected: **Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose). **PLUS Lincomycin IV** 15 mg/kg/dose every 8 hours (maximum 1.2 g/dose).	
	If multi-resistant MRSA suspected: **Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose) **PLUS Vancomycin IV** 15 mg/kg/dose every 6 hours (maximum initial dose of 750 mg). (Perform therapeutic drug monitoring for Vancomycin).	
If more than 5 years old WITH Severe cellulitis/ Osteomyelitis	**Flucloxacillin IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose) Refer to CHQ-GDL-01067 Paediatric Bone and Joint Infection Management for further information.	**Immediate type hypersensitivity,** seek ID advice.
	If nmMRSA suspected: **Flucloxacillin IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose). **PLUS Lincomycin IV** 15 mg/kg/dose every 8 hours (maximum 1.2 g/dose).	
	If multi-resistant MRSA suspected: **Flucloxacillin IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose) **PLUS Vancomycin IV** 15 mg/kg/dose every 6 hours (maximum initial dose of 750 mg). (Perform therapeutic drug monitoring for Vancomycin).	

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
SKELETAL / SOFT TISSUE / SKIN / OSTEO-ARTICULAR INFECTION		
Suspected necrotising fasciitis	**Cefotaxime IV** 50 mg/kg/dose every 6 hours (maximum 2 g/dose). **PLUS Lincomycin IV** 15 mg/kg/dose every 8 hours (maximum 1.2 g/dose) **PLUS Vancomycin IV**15 mg/kg/dose every 6 hours (maximum initial dose of 750 mg). (Perform therapeutic drug monitoring for Vancomycin). **Seek ID advice within 24 hours.**	**Immediate type hypersensitivity** seek ID advice.
	If external wound / inoculation associated with necrotising fasciitis: **Meropenem IV** 40 mg/kg/dose every 8 hours (maximum 2 g/dose) **PLUS Lincomycin IV** 15 mg/kg/dose every 8 hours (maximum 1.2 g/dose) **PLUS Vancomycin IV** 15 mg/kg/dose every 6 hours (maximum initial dose of 750 mg). (Perform therapeutic drug monitoring for Vancomycin). **Seek ID advice within 24 hours.**	
Compound fractures	**For open fractures with no clinical evidence of skin or soft tissue infection or severe tissue damage, give systemic antibiotic prophylaxis:** **Cefazolin IV** 50 mg/kg/dose (maximum 2 g/dose) every 8 hourly and **seek ID advice within 24 hours.**	**Immediate type hypersensitivity** **Lincomycin IV** and seek ID advice.
	For open fractures with severe tissue damage or clinical evidence of skin or soft tissue infection: **Piperacillin - Tazobactam IV** 100 mg/kg/dose every 6 hours (maximum 4 g/dose Piperacillin component) and **seek ID advice within 24 hours.**	**Immediate type hypersensitivity** **Ciprofloxacin IV** 10 mg/kg/dose 8-hourly (maximum 400 mg/dose) **PLUS Lincomycin IV** and seek ID advice within 24 hours.

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
SKELETAL / SOFT TISSUE / SKIN / OSTEO-ARTICULAR INFECTION		
Animal bites	**Severe infection:** **Amoxicillin-Clavulanic acid IV** (for up to 14 days). **Neonates and Infants (0 to 3 months old):** **If less than or equal to 4 kg:** 25 mg/kg/dose (amoxicillin component) every 12 hours. **If more than 4 kg:** 25 mg/kg/dose (amoxicillin component) every 8 hours. **Infants and children (more than 3 months old):** 25 mg/kg/dose (amoxicillin component) every 6 hourly (maximum 1 g/dose amoxicillin component). **Adolescents older than 12 years old (and more than 40kg):** 25 mg/kg/dose (amoxicillin component) every 6 hourly (maximum 2 g/dose amoxicillin component; note: maximum 200 mg/dose clavulanate component).	**Delayed type hypersensitivity,** **IV Ceftriaxone** 100 mg/kg once daily (maximum 4 g/day) **PLUS** **Metronidazole orally** 7.5 mg/kg/dose every 8 hours (maximum 400 mg/dose).
URINARY TRACT		
Urinary tract infection/ Pyelonephritis	**Ampicillin IV (or Amoxicillin IV)** • **Neonates:** Refer to Ampicillin (Amoxicillin) IV neonatal dosing section. • **If more than 1 month old:** 50 mg/kg/dose IV every 6 hours (maximum 2 g/dose) **PLUS** **Gentamicin IV** (Dose based on adjusted body weight. See** TDM section**)** • **Neonates:** Refer to Ampicillin (Amoxicillin) IV neonatal dosing section. • **If more than 1 month old and less than (or equal to) 10 years old:** 7.5 mg/kg once daily (maximum 320 mg/day). • **If more than 10 years old:** 6 mg/kg IV once daily (maximum 560 mg/day). Seek ID advice within 72 hours. Perform TDM. **Note: Less than 1 month old, refer to Ampicillin/Amoxicillin and Gentamicin neonatal section. If Gram negative/resistant to Ampicillin-Consult ID.**	**Immediate type penicillin hypersensitivity,** **Cefotaxime IV.** **For immediate [severe] cephalosporin hypersensitivity, seek ID / Microbiology advice** Seek ID advice within 72 hours.

INFECTION (PICU)	FIRST CHOICE ANTIMICROBIAL (Dosing recommendations based on normal renal and hepatic function)	Alternative antibiotic in the event of immediate type (e.g. anaphylaxis) or delayed type (e.g. rash) hypersensitivity to 1st line antimicrobial
CARDIAC		
Post cardiac surgery (within 72 hours of surgery) **suspicion of infection WITHOUT a focus** **Deep cardiac surgical wound infection (mediastinitis suspected)** **CVAD associated or bloodstream infection focus**	**Gentamicin IV plus Teicoplanin IV** **Gentamicin IV** (Dose based on adjusted body weight. See** TDM section**)** • **Neonates:** Refer to Gentamicin IV neonatal dosing section. • **If more than 1 month and less than (or equal to) 10 years old**: 7.5 mg/kg once daily (maximum 320 mg/day). • **If more than 10 years old:** 7 mg/kg once daily (maximum 640 mg/day). Perform therapeutic drug monitoring for Gentamicin as advised by pharmacy. **Teicoplanin IV (Dose based on actual body weight**) **Neonates:** 16 mg/kg as a single dose on day 1 (loading dose), then 8 mg/kg 24-hourly (maintenance dose). **If more than 1 month of age: Loading dose:** 10 mg/kg (Maximum 800 mg/dose) 12-hourly for 3 doses. **Maintenance dose:** 10 mg/kg (Maximum 800 mg/day) 24-hourly Perform TDM. **Seek ID advice within 24 hours.** **For CVAD associated or bloodstream infection focus:** **Consider replacing CVAD. Seek ID advice on duration of treatment.**	**Immediate type hypersensitivity** seek ID advice.
Post Cardiac surgery WITH respiratory focus	Nasopharyngeal swab for respiratory viruses and deep tracheal aspirate for MCS **Piperacillin/Tazobactam IV** • **Neonates:** Refer to Piperacillin/Tazobactam IV neonatal dosing section. • **If more than 1 month of age:** 100 mg/kg/dose (Maximum 4 g Piperacillin component) every 6 hours. **Seek ID advice at 48 hours**	**Immediate type hypersensitivity** seek ID advice.

SPECIFIC NEONATAL ANTIMICROBIAL DOSING - AUSTRALASIAN NEONATAL MEDICINES FORMULARY (ANMF)	
Antimicrobial	**Link to recommended guideline/resource**
Aciclovir IV	ANMF – Aciclovir monograph (2021)
Amikacin IV	ANMF – Amikacin monograph (2021)
Ampicillin IV	ANMF – Ampicillin monograph (2021)
Amoxicillin IV	ANMF – Amoxicillin monograph (2021)
Azithromycin IV	ANMF – Azithromycin monograph (2022)
Benzylpenicillin IV	ANMF – Benzylpenicillin monograph (2021)
Cefalexin PO	ANMF – Cefalexin monograph (2020)
Cefazolin IV	ANMF – Cefazolin monograph (2021) **Comment: Does not provide CNS cover – seek ID advice**
Cefotaxime IV	ANMF – Cefotaxime monograph (2020)
Ceftazidime IV	ANMF – Ceftazidime monograph (2022)
Clindamycin IV	ANMF - Clindamycin monograph (2022) **Comment: Does not provide CNS cover – seek ID advice**
Flucloxacillin IV	ANMF – Flucloxacillin monograph (2020) **Comment: Higher oral mg/kg doses may be required in neonates – see AMH CDC for dosing recommendations**
Gentamicin IV	ANMF – Gentamicin monograph (2021) **Comment: TDM required. Seek AMS/ Paediatric pharmacist advice.**
Meropenem IV	ANMF – Meropenem monograph (2021)
Metronidazole IV	ANMF – Metronidazole monograph (2020)
Piperacillin/Tazobactam IV	ANMF – Piperacillin/Tazobactam monograph (2020) **Comment: Does not provide CNS cover – seek ID advice**
Tobramycin IV	ANMF – Tobramycin monograph (2020) **Comment: TDM required. Seek AMS/ Paediatric pharmacist advice.**
Trimethoprim/ sulfamethoxazole PO	ANMF – Trimethoprim/sulfamethoxazole monograph (2022) **Caution: Kernicterus risk in neonates – seek ID advice**
Vancomycin IV	ANMF – Vancomycin monograph (2020) **Comment: TDM required. Seek AMS/ Paediatric pharmacist advice.**

Abbreviations

ABW	Actual body weight
Adj BW	Adjusted body weight
AMS	Antimicrobial stewardship
CHQ	Children's Health Queensland
CNS	Central nervous system
CSF	Cerebral spinal fluid
ECMO	Extra corporeal membrane oxygenation
iEMR	Integrated electronic medical record
ID	Infectious diseases team
IV	Intravenous
LP	Lumbar puncture
MRSA	Multi-resistant staphylococcus aureus
nmMRSA	Non multi-resistant staphylococcus aureus
QCH	Queensland Children's hospital
TDM	Therapeutic drug monitoring

Consultation

Key stakeholders who reviewed this version:

- Service Group Director (Infection Management and Prevention service, Rheumatology and Immunology, CHQ)
- Director, PICU (CHQ)
- Paediatric Infection Specialist team (CHQ)
- Infectious Diseases Fellow (CHQ)
- Pharmacist Advanced - Antimicrobial Stewardship (CHQ)
- Pharmacist Lead Critical Care (CHQ)
- Medicines Advisory Committee (CHQ) endorsed 17/08/2023

References and suggested reading

1. Therapeutic Guidelines: Antibiotic 2022 Therapeutic Guidelines Ltd. Melbourne
2. Taketomo CK eds. Pediatric Dosage Handbook International Lexi-comp . Available online www.uptodate.com
3. Bijleveld YA et al. Population Pharmacokinetics and Dosing Considerations for Gentamicin in Newborns with Suspected or Proven Sepsis Caused by Gram-Negative Bacteria. Antimicrobial Agents and Chemotherapy. 2017; 61 (1): e01304-16.
4. Queensland Paediatric Emergency department and Inpatient Sepsis pathway (2022)
5. Australasian Neonatal Medicines Formulary. NSW. Available online: https://www.anmfonline.org/clinical-resources/

Guideline revision and approval history

Version No.	Modified by	Amendments authorised by	Approved by
1.0	Infectious Diseases Consultant (IMPS, RCH) Infectious Diseases Consultant (Mater) Director of PICU (RCH) Paediatric Intensivist (Mater) Antimicrobial Stewardship Pharmacist (RCH) Paediatric Intensive Care Pharmacist (Mater)	Medicines Advisory Committee (RCH)	General Manager Operations
2.0	Infectious Diseases Consultant (IMPS, RCH) Infectious Diseases Consultant (Mater) Director of PICU (RCH) Paediatric Intensivist (Mater) Antimicrobial Stewardship Pharmacist (RCH) Paediatric Intensive Care Pharmacist (Mater)	Medicines Advisory Committee (RCH)	General Manager Operations
3.0	Infectious Diseases Consultant (IMPS, LCCH) Infectious Diseases Consultant (LCCH) Paediatric Intensivist (LCCH) AMS Pharmacist (LCCH) Clinical Pharmacy Team Leader - Paediatric Intensive Care (LCCH)	Medicines Advisory Committee (LCCH)	General Manager Operations
4.0 (01/05/2020)	Infectious Diseases Consultant (IMPS, LCCH)Infectious Diseases Consultant (LCCH) Paediatric Intensivist (LCCH) AMS Pharmacist (LCCH)	Medicines Advisory Committee (LCCH)	General Manager Operations
5.0 (17/10/2019)	Legal Governance and Risk update review date	Divisional and Medical Director, Division of Medicine	Executive Leadership Team
6.0 10/06/2020	Infectious Diseases Consultants Director, Infection Management and Prevention Services Medical Lead, Antimicrobial Stewardship (QCH) AMS Pharmacist (QCH)	Medicines Advisory Committee (CHQ)	Executive Director Clinical Services (QCH)
7.0 19/07/2021	Infectious Diseases Consultants Director, Infection Management and Prevention Services Medical Lead, Antimicrobial Stewardship (QCH) Pharmacist Advanced – Antimicrobial Stewardship (QCH)	Service Group Director – Infection Management and Prevention Services Medical Director – Division of Medicine	Executive Director Clinical Services

8.0 07/08/2023	Infectious Diseases Consultants Director, Infection Management and Prevention Services Medical Lead, Antimicrobial Stewardship (QCH) Pharmacist Advanced – Antimicrobial Stewardship	Service Group Director – Infection Management and Prevention Services Medical Director – Division of Medicine	Executive Director Clinical Services

Keywords	Paediatric intensive care unit, PICU, Empiric, Empiric Antibiotics, AMS, Antimicrobial Stewardship, critical care, toxic shock syndrome, meningitis, nosocomial sepsis, community acquired sepsis, pertussis, pneumonia, nosocomial pneumonia, ventilator-associated pneumonia; compound fracture, severe cellulitis, osteomyelitis, deep cardiac surgical wound infection, mediastinitis, surgical wound infection, urinary tract infection, abdominal infection, necrotising enterocolitis, peritonitis; febrile neutropenic sepsis, NEC, neonatal antibiotic dosing, therapeutic drug monitoring, ampicillin, amoxicillin, azithromycin, benzylpenicillin, gentamicin, cefotaxime, cefazolin, ceftriaxone, ciprofloxacin, clindamycin, vancomycin, gentamicin, roxithromycin, flucloxacillin, cefalexin, clindamycin, trimethoprim/ sulfamethoxazole, metronidazole, meropenem, piperacillin-tazobactam, lincomycin, amoxicillin/ clavulanic acid, teicoplanin, therapeutic drug monitoring, TDM, area under the curve, AUC, nmMRSA, mrMRSA,01066
Accreditation references	National Safety and Quality Health Service Standards (1-8) – • **Standard 3:** Preventing and Controlling Healthcare-Associated Infection • **Standard 4:** Medication Safety ISO 9001:2015 Quality Management Systems: (4-10):