

ANTIMICROBIAL PROPHYLAXIS GUIDELINES FOR PEDIATRIC PATIENTS UNDERGOING CARDIAC SURGERY

I. PURPOSE

The purpose of these guidelines is to standardize perioperative antibiotic prophylaxis in pediatric patients undergoing cardiothoracic surgery, to prevent surgical site infections (SSI), and minimize unintended effects of antimicrobial exposure. These guidelines incorporate evidence and recommendations from the literature below. Where pertinent literature or specific guidelines are lacking, prophylaxis recommendations were determined based on comparative practice with other pediatric heart centers and local consensus involving representatives from the CICU, Cardiac Surgery, Cardiology, Cardiac Anesthesia, the Antibiotic Stewardship Program, and Pediatric Pharmacy.

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Critical Points

1. The goal of these guidelines is to standardize perioperative antibiotic prophylaxis in pediatric patients undergoing cardiothoracic surgery to prevent surgical site infections (SSI) and minimize unintended effects of antimicrobial exposure.
2. The guidelines incorporate evidence and recommendations from the literature below. Where pertinent literature or specific guidelines are lacking, prophylaxis recommendations were determined based on comparative practice with other pediatric heart centers and local consensus involving representatives from the CICU (RN and providers), Cardiac Surgery, Cardiology, the Antibiotic Stewardship Program, and Pediatric Pharmacy.
3. This guideline provides recommendations for perioperative antibiotic prophylaxis in pediatric patients undergoing cardiac surgery and should be adhered to whenever possible. The guidelines are not intended to replace clinical judgement. Modification of the prophylaxis regimen in individual circumstances may be warranted.

Procedure

1. Antibiotic selection should be made based on the type of cardiac procedure and the phase of care per [Table 1](#) below.
2. Antibiotic dosing should follow guidelines based on age and phase of care per [Table 3](#) for Infants and Children ≥ 1 Month of Age and Corrected Gestational Age ≥ 45 weeks and [Table 5](#) for Neonates < 45 weeks Corrected Gestational Age below or based on consultation with a pediatric clinical pharmacist. **Corrected gestational age (CGA)** and **postmenstrual age (PMA)** are numerically equivalent and

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represent the infant's gestational age at birth plus chronological age after birth. In this document, CGA is used throughout, with PMA considered an equivalent term.

3. For surgical procedures performed in the CICU, antibiotic prophylaxis should be selected as appropriate based on the [pre-operative/intra-operative](#) recommendation.
 - a. Even if the patient is already receiving antimicrobials for post-operative prophylaxis from another procedure, appropriate antibiotic prophylaxis should be re-dosed prior to a new procedure as in the OR. For example, if a patient undergoes chest closure in the CICU, cefazolin should be given within 60 minutes prior to chest closure, unless the previous dose was given within the intra-operative re-dosing interval (4 hours).
4. The duration of prophylaxis should be limited to that recommended in [Table 1](#), regardless of presence of lines or drains.
5. Modification of prophylaxis for patients with beta-lactam allergy or MRSA colonization:
 - a. For patients with beta-lactam antibiotic allergy, assessment is recommended per the [Inpatient Beta-Lactam Allergy Guideline](#). Many patients with beta-lactam allergy can tolerate cefazolin, which provides more effective SSI prophylaxis than vancomycin.
 - b. For patients with history of methicillin-resistant *Staphylococcus aureus* (MRSA) infection or colonization, See [Table 2](#).
 - c. Specific recommendations for patients with beta-lactam allergy or history of MRSA are included in the "routine" case rows in [Table 1](#). For any of the remaining cardiac procedure categories where the patient has a documented beta-lactam allergy or known history of MRSA colonization or infection, the prophylaxis selection should be modified accordingly without beta-lactam prophylaxis for patients with documented beta-lactam allergy, and with addition of vancomycin for pre-operative and post-operative prophylaxis for patients with known history of MRSA.

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TABLE 1: Antimicrobial Selection and Duration by Procedure Category

Cardiac Procedure Category	Pre-Op/Intra-Op Antimicrobial(s)	Post-Op Antimicrobial(s)	Post-Op Prophylaxis Duration
Routine case (not meeting any below exception criteria)	Cefazolin	Cefazolin	Until 24 hours post-op
Routine case with beta-lactam allergy	Vancomycin	Vancomycin	Until 24 hours post-op
Routine case with h/o MRSA infection or colonization	Cefazolin + Vancomycin	Cefazolin + Vancomycin	Until 24 hours post-op
Aortic root surgery, defined as aortic root replacement or reconstruction	Cefazolin + Vancomycin	Cefazolin + Vancomycin	Until 24 hours post-op
Presence of tracheostomy	Cefazolin (+ Vancomycin if h/o MRSA)	Cefazolin (+ Vancomycin if h/o MRSA)	Until 7 days post-op
Open sternum	Cefazolin (+ Vancomycin if h/o MRSA)	Cefazolin + Vancomycin + Fluconazole	Until 24 hours post-chest closure
Sternum re-opened in CICU, sterility maintained	Cefazolin (+ Vancomycin if h/o MRSA)	Cefazolin + Vancomycin + Fluconazole	Until 24 hours post-chest closure
Sternum re-opened in CICU, sterility not maintained	Cefazolin (+ Vancomycin if h/o MRSA)	Cefepime + Vancomycin + Fluconazole	Until 24 hours post-chest closure or for 7 days if sternum remains open > 7 days If sternum remains open > 7 days, change to Vancomycin + Cefazolin + Fluconazole and continue until 24 hours post-chest closure

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Cardiac Procedure Category	Pre-Op/Intra-Op Antimicrobial(s)	Post-Op Antimicrobial(s)	Post-Op Prophylaxis Duration
Slide tracheoplasty with open or closed sternum post-op	Cefepime + Vancomycin	Cefepime + Vancomycin + Fluconazole	Until 7 days post-op
ECLS, peripheral cannulation, or placement of ventricular assist device	Cefazolin (+ Vancomycin if h/o MRSA)	Cefazolin (+ Vancomycin if h/o MRSA)	Until 24 hours following <u>initial cannulation (or VAD placement)</u> (prophylaxis should not be continued while cannulas in place)
ECLS, central cannulation, or placement of ventricular assist device, with open sternum	Cefazolin (+ Vancomycin if h/o MRSA)	Cefazolin + Vancomycin + Fluconazole	Until 24 hours post-chest closure
Rhythm management and monitoring device (e.g. pacemaker) implantation)	Cefazolin MRSA infection / colonization: Cefazolin + vancomycin Beta lactam allergy (rare in infants): Cefazolin + vancomycin	Cefazolin until able to take PO, then Cephalexin Cefazolin + Vancomycin, transition to PO: Clindamycin Cefazolin + Vancomycin, until able to take PO then clindamycin	Until 7 days post-op Low risk >20 kg, only requiring generator change: only intra-operative dose

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Table 2: Modifying Surgical Antimicrobial Prophylaxis for Patients with Methicillin-Resistant *Staphylococcus aureus* (MRSA) Colonization

Category	Recommendation
Patients with identified MRSA colonization identified by pre-operative screening for specific procedures: • Presence of tracheostomy • Open sternum • Sternum re-opened in CICU, sterility maintained • Sternum re-opened in CICU, sterility not maintained • ECLS, peripheral cannulation, or placement of ventricular assist device • ECLS, central cannulation, or placement of ventricular assist device, with open sternum	Add antimicrobial prophylaxis with MRSA activity. This usually involves administration of vancomycin which is recommended to start infusion 60 to 120 minutes prior to incision. Logistics of vancomycin administration should be coordinated in advance. If there are < 60 minutes to incision and Vancomycin has not yet been initiated, Clindamycin should be used as an alternative agent
Patients with history of documented MRSA carriage or infection within the last 6 months	Addition of antimicrobial prophylaxis with activity against MRSA may be considered

TABLE 3: Antimicrobial Dosing by Age and Phase of Care for Infants and Children ≥ 1 Month of Age and Corrected Gestational Age ≥ 45 weeks

	Cefazolin	Vancomycin	Cefepime	Fluconazole	Cephalexin	Clinda mycin
Intra-operative dosing						
Initial dose						
Usual dose	30 mg/kg	15 mg/kg/dose (max 1000 mg/dose)	50 mg/kg/dose (max 2000 mg/dose)			
Admin (may differ from usual floor admin)	IV push over 3-5 mins	60 min infusion	30 min infusion			
Timing of initial dose	0-60 min prior to incision	Infusion start 60-120 min prior to incision	Infusion start 30-60 min prior to incision			
Intra-operative re-dosing intervals						
Pediatric Age > 1 mo ^a	q4h	q8h	q4h			
When to start standard dosing	After 3 doses	Already standard	After 3 doses			

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	convert to q8h		convert to q8h			
Post-operative dosing						
Usual dose	25 mg/kg/dose (max 2000 mg/dose)	15 mg/kg/dose (max 1000 mg/dose initial)	50 mg/kg/dose (max 2000 mg/dose)	6 mg/kg/dose (max 400 mg/dose)	25 mg/kg/do se (max 500 mg/dose)	10 mg/kg/dose (max 600 mg/dose)
Interval, Pediatric Age > 1 mo	q8h	q8h	q8h	q24h	TID	TID/q8h

Dosing guidelines are provided for patients with normal renal function. If impaired renal function, consult a pharmacist.

Antimicrobial Pre-Operative Dosing Guideline for Neonates < 45 weeks Corrected Gestational Age

	Cefazolin	Vancomycin	Cefepime
Intra-operative dosing			
Initial dose			
Usual dose	30 mg/kg	≤ 29 weeks CGA 10 mg/kg/dose 30 to 36 weeks CGA 12.5 mg/kg/dose 37 to < 45 weeks CGA 15 mg/kg/dose	50 mg/kg/dose (max 2000 mg/dose)
Admin (may differ from usual floor admin)	IV push over 3-5 mins	60 min infusion	30 min infusion
Timing of initial dose	0-60 min prior to incision	Infusion start 60-120 min prior to incision	Infusion start 30-60 min prior to incision
Intra-operative re-dosing intervals			
Neonate Age ≤ 7 d, OR Weight ≤ 2 kg	q6h	Do not re-dose	q8h
Neonate Age > 7 d AND Weight > 2 kg	q4h	Do not re-dose	q8h

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When to start standard dosing	After 3 doses convert to postoperative dosing	Already standard	After 3 doses convert to postoperative dosing
Post-operative dosing			
Usual dose	25 mg/kg/dose (max 2000 mg/dose)	≤ 29 weeks CGA 10 mg/kg/dose 30 to 36 weeks CGA 12.5 mg/kg/dose 37 to < 45 weeks CGA 15 mg/kg/dose	50 mg/kg/dose (max 2000 mg/dose)

Table 5: Antimicrobial Post-Operative Dosing Guideline for Neonates < 45 weeks Corrected Gestational Age

Please see the [Neonatal Antimicrobial Dosing at Benioff Children's Hospitals](#) for post-operative dosing guidance

6. Rationale for recommendations in [Table 1](#) including changes from previous guidelines:
 - a. Open sternum antibiotic prophylaxis, the current recommendations are based on local consensus and review of microbiologic isolates in SSI cases.
 - b. Slide tracheoplasty is a clean-contaminated procedure involving incision into the intrathoracic trachea, with anticipated contamination of the mediastinum with tracheal flora. The procedure is performed for congenital tracheal stenosis and patients may come to surgery with prior airway colonization including multi-drug-resistant organisms. Optimal antibiotic prophylaxis for this procedure is not well-defined, but in case series, *Staphylococcus aureus* and *Pseudomonas aeruginosa* are the most described microbial isolates.
 - c. Recommendations for prophylaxis in patients placed on ECLS is based on recommendations from the ELSO Infectious Diseases Task Force, with modification of the central ECLS recommendation to be concordant with updated open chest guidelines.
 - d. Prophylaxis following pacemaker placement is based on local consensus. Published guidelines

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(ASHSP and AHA) recommend single dose antibiotic prophylaxis or up to 24 hours post-operative prophylaxis. These recommendations are based on data from adult patients. Currently data supporting short duration prophylaxis are lacking in pediatric patients. Of 9 pediatric institutions responding to a survey on duration of prophylaxis following pacemaker placement, 5 provide single dose or 24h post-operative prophylaxis, and 4 provide longer durations of prophylaxis (2-7 days).

- e. Presence of GI ostomy or recent GI surgery has been removed as an exception to the routine prophylaxis recommendations based on a study by Flett, et al. finding no difference in SSI rates or pathogen profile (equivalent rates of MSSA ~ 80% and Gram-negative rods ~ 20%) in patients with gastrostomy tubes vs. those without. The median sternotomy incision can be isolated from lower GI ostomy or surgical sites via draping and dressing procedures, and cefazolin provides activity against the most common enteric Gram-negative rods including *Escherichia coli* and *Klebsiella* species.
- f. Further details of intra-operative surgical prophylaxis including re-dosing recommendations for blood loss can be found in the [UCSF Antimicrobial Surgical Prophylaxis Guidelines](#).

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Guidelines History

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