

# Development of quality metrics for ambulatory pediatric cardiology: Infection prevention

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## Abstract

**Introduction:** In 2012, the American College of Cardiology's (ACC) Adult Congenital and Pediatric Cardiology Council established a program to develop quality metrics to guide ambulatory practices for pediatric cardiology. The council chose five areas on which to focus their efforts; chest pain, Kawasaki Disease, tetralogy of Fallot, transposition of the great arteries after arterial switch, and infection prevention. Here, we sought to describe the process, evaluation, and results of the Infection Prevention Committee's metric design process.

**Methods:** The infection prevention metrics team consisted of 12 members from 11 institutions in North America. The group agreed to work on specific infection prevention topics including antibiotic prophylaxis for endocarditis, rheumatic fever, and asplenia/hyposplenism; influenza vaccination and respiratory syncytial virus prophylaxis (palivizumab); preoperative methods to reduce intraoperative infections; vaccinations after cardiopulmonary bypass; hand hygiene; and testing to identify splenic function in patients with heterotaxy. An extensive literature review was

performed. When available, previously published guidelines were used fully in determining metrics.

**Results:** The committee chose eight metrics to submit to the ACC Quality Metric Expert Panel for review. Ultimately, metrics regarding hand hygiene and influenza vaccination recommendation for patients did not pass the RAND analysis. Both endocarditis prophylaxis metrics and the RSV/palivizumab metric passed the RAND analysis but fell out during the open comment period. Three metrics passed all analyses, including those for antibiotic prophylaxis in patients with heterotaxy/asplenia, for influenza vaccination compliance in healthcare personnel, and for adherence to recommended regimens of secondary prevention of rheumatic fever.

**Conclusions:** The lack of convincing data to guide quality improvement initiatives in pediatric cardiology is widespread, particularly in infection prevention. Despite this, three metrics were able to be developed for use in the ACC's quality efforts for ambulatory practice.

#### KEYWORDS

infection prevention, quality, ambulatory, pediatric cardiology

## 1 | INTRODUCTION

In 2012, the American College of Cardiology's Adult Congenital and Pediatric Cardiology Council established a program to develop quality metrics to guide ambulatory practices for pediatric cardiology. The council chose the following five areas on which to focus their efforts; chest pain, Kawasaki disease, tetralogy of Fallot, transposition of the great arteries after arterial switch, and infection prevention. The initial results of the overall effort were published earlier this year by Chowdhury et al.<sup>1</sup> The Infection Prevention Committee focused on areas in outpatient pediatric cardiac care where infection prevention may play a significant role. Surgical outcomes and related infectious concerns, while initially considered by the committee, were not addressed in order to focus on outpatient pediatric cardiology practice.

Here, we describe the process, evaluation, and results of the Infection Prevention Committee's metric design process.

## 2 | METHODS

### 2.1 | Work process

The infection prevention metrics team consisted of 12 members from 11 institutions in the United States and Canada. Work was carried out via monthly conference calls and email communication. Team members were initially surveyed regarding potential areas of focus within outpatient infection prevention. Once specific areas were identified, team members organized into groups of 2–3 people for each topic. The agreed upon topics included antibiotic prophylaxis for endocarditis, rheumatic fever, and asplenia/hyposplenism; influenza vaccination and respiratory syncytial virus (RSV) prophylaxis (palivizumab); preoperative methods to reduce intraoperative infections; vaccinations after cardiopulmonary bypass; hand hygiene; and testing to identify splenic function in patients with heterotaxy.

Initial metrics were written by the individual groups and circulated to the full committee for review. Each metric underwent several modifications before the final submitted metric. Metrics considered by the committee to be logistically difficult to implement were discarded. All metrics were reviewed by outside personnel, contacted by individual teams, with knowledge of prior ACC quality metric efforts to help enhance the metrics. Metric structure included the following sections: description, numerator/denominator measured, period of assessment, data source, rationale, method of reporting, and challenges to implementation.

### 2.2 | Existing guidelines

Previously published guidelines played a substantial role in determining our recommended quality metrics, particularly in the cases of endocarditis prophylaxis, rheumatic fever secondary prophylaxis, hand hygiene, RSV prophylaxis, and influenza vaccination.<sup>2–9</sup> When available, any known published data on pediatric cardiology providers' levels of adherence to the guidelines were considered in formulating the metrics.<sup>10–12</sup> In the cases of endocarditis prophylaxis and rheumatic fever secondary prophylaxis, the final metric proposed was in effect a measure of adherence to the published guideline.<sup>2,3</sup> Existing guidelines used and consulted when designing the metrics in this subgroup are listed in Table 1.

## 3 | RESULTS

### 3.1 | Literature review

#### 3.1.1 | Influenza vaccination

Current guidelines recommend seasonal influenza immunization (trivalent or quadrivalent) for all children over 6 months of age.<sup>9,13</sup> This is particularly important for patients with medical conditions that increase

TABLE 1 Existing guidelines used in metric design

Infection prevention		
Area of interest	Existing published guidelines	Sponsoring organization
Endocarditis	Wilson, et al. Prevention of infective endocarditis: guidelines from the American Heart Association. <i>Circulation</i> 2007;116:1736–1754. <sup>2</sup>	AHA
Rheumatic fever	Gerber, et al. Prevention of rheumatic fever and diagnosis and treatment of Streptococcal pharyngitis. <i>Circulation</i> 2009;119:1541–1551. <sup>3</sup>	AHA/AAP
Hand hygiene	Boyce and Pittet. Guideline for hand hygiene in health-care settings. <i>Am J Infect Control</i> . 2002;30: S1–S46. <sup>4</sup> WHO guidelines on hand hygiene in health care: first global patient safety challenge: clean care is safer care. Geneva, Switzerland: World Health Organization, Patient Safety; 2009. <sup>5</sup>	HICPAC WHO
Influenza vaccination	AHA/ACCF secondary prevention and risk reduction therapy for patients with coronary and other atherosclerotic vascular disease: 2011 update. <i>JACC</i> . 2011;58:2432–2446. <sup>6</sup> Policy statement: recommendations for prevention and control of influenza in children, 2012–2013. <i>Pediatrics</i> . 2012;130:780–792. <sup>9</sup>	AHA/ACCF AAP
RSV prophylaxis	Modified recommendations for use of palivizumab for prevention of respiratory syncytial virus infections. <i>Pediatrics</i> . 2009;124:1694. <sup>7</sup>	AAP

Abbreviations: AHA, American Heart Association; AAP, American Academy of Pediatrics; WHO, World Health Organization; HICPAC, Healthcare Infection Control Practices Advisory Committee; ACCF, American College of Cardiology Foundation.

the risk of complications from influenza, including asthma, immunosuppression, neurologic disorders, hemodynamically significant cardiac disease, and conditions requiring long-term aspirin therapy. For health care providers, universal influenza vaccination is recommended. However, in the 2011–2012 influenza season, only 67% of healthcare providers report receiving the vaccine.<sup>14</sup> Overall, less than 50% of children and adults in the United States are immunized against influenza.<sup>13,15</sup> Vaccination of family members is effective in reducing transmission of disease to others, raising the importance of recommending vaccination for family members of patients under 6 months of age (who cannot themselves be vaccinated).<sup>6,15</sup>

### 3.1.2 | Respiratory syncytial virus (RSV) prophylaxis (palivizumab)

Prior guidelines recommended palivizumab prophylaxis for infants and children under the age of 24 months who had hemodynamically significant cyanotic or acyanotic congenital heart disease.<sup>7</sup> This included patients receiving medications for congestive heart failure, as well as those with pulmonary hypertension. Palivizumab prophylaxis is effective in reducing hospitalization for RSV in patients with these underlying conditions.<sup>16</sup> Of note, guidelines for RSV prophylaxis were updated by the American Academy of Pediatrics during the open comment period of this quality metric process.<sup>17</sup>

### 3.1.3 | Hand hygiene

The potential for infection transmission via ambulatory care<sup>18</sup> and for inconsistent hand hygiene practice<sup>19</sup> has long been recognized.<sup>20</sup> Infectious transmission risks modifiable by hand hygiene have been identified.<sup>18,21</sup> However, some situations such as waiting room exposures<sup>21</sup> and fomite transmission<sup>22</sup> may not be as modifiable by typical health care personnel hand hygiene. Experience with inpatient hand hygiene suggests that routine dissemination of guidelines may not make any

measurable difference,<sup>8,23</sup> with potential barriers including busy staff, limited infrastructure for systems change, and facilities designed without infection control in mind.<sup>21</sup> Despite these limitations, outpatient hand hygiene is recommended in guidelines.<sup>4,8</sup> Detailed data on particular hand hygiene products (soaps, alcohol-based, chlorhexidine, etc.) are available.<sup>4</sup>

### 3.1.4 | Evaluation of splenic function in heterotaxy patients

Patients with heterotaxy syndrome may have a variety of anatomic findings with respect to the spleen or absence thereof.<sup>24</sup> The features of the heart disease in these patients cannot predict splenic anatomy or function. Splenic anatomy can be assessed by abdominal ultrasound, CT, or MRI. Importantly, the presence of splenic tissue does not rule out hyposplenism and the accompanying risk of infectious complications, and tests of splenic function are thus indicated for patients with identified splenic tissue.<sup>25,26</sup> Tests of splenic function may include assessment of the blood smear for Howell-Jolly bodies, quantification of pitted RBCs by interference contrast microscopy, and heat-damaged <sup>99m</sup>Tc-labelled RBC scan.<sup>27,28</sup> Importantly, both Howell-Jolly bodies and pitted red blood cells can be seen in normal newborns up to 2 months of age. However, the absence of Howell-Jolly bodies does not rule out hyposplenism.<sup>29</sup> Pitted RBC studies and heat-damaged <sup>99m</sup>Tc-labelled RBC scan are more sensitive than peripheral blood smear only and are widely endorsed as the best measures of splenic function, though availability of these tests may be limited and institution dependent.<sup>27,28,30</sup>

### 3.1.5 | Antibiotic prophylaxis (endocarditis, rheumatic fever, and asplenia/hyposplenism)

Guidelines exist in the areas of endocarditis prophylaxis and rheumatic fever secondary prophylaxis; both guidelines had been updated in the 7 years prior to this publication.<sup>2,3</sup> In the case of endocarditis

TABLE 2 Metrics submitted to steering committee

Infection prevention		
Specific metric	Numerator	Denominator
Antibiotic prophylaxis in patients with heterotaxy and asplenia	Patients with a documented recommendation for antibiotic prophylaxis	All patients <5 years old who are diagnosed with heterotaxy and asplenia and followed by pediatric cardiology
Adherence to bacterial endocarditis prophylaxis guidelines	Patients with a documented recommendation for antibiotic prophylaxis	All patients seen with single ventricle congenital heart disease at any stage of palliation
Recommendation of bacterial endocarditis prophylaxis	Patients with a documented recommendation for antibiotic prophylaxis	All patients seen with isolated bicuspid valve and no history of valvular intervention
Influenza vaccination compliance of healthcare personnel	Number of office personnel receiving influenza vaccination in a given year	All office personnel working in patient care areas
Adherence to recommended regimens of secondary prevention of rheumatic fever in patients with a prior history of rheumatic fever	Patients with a documented recommendation for antibiotic regimen consistent with most recent AHA guidelines	All patients seen in pediatric cardiology clinic with a prior episode of rheumatic fever and with residual valvar disease
Recommendation for palivizumab administration	Patients with a documented recommendation for palivizumab	All patients <2 years old with a history of cyanotic congenital heart disease and oxygen saturations <90%
Hand hygiene	Number of appropriate/compliant hand hygiene events before and after patient contact	Total number of eligible hand hygiene encounters before and after patient contact
Recommendation of influenza vaccination	Patients with a documented recommendation for influenza vaccination	All patients >6 months old at the time of pediatric cardiology visit

prophylaxis, the 2007 update to the guidelines included a marked decrease in the number of patients recommended to receive prophylaxis, limiting this to those cardiac conditions with the highest risk of adverse outcomes from endocarditis.<sup>2</sup>

Children with asplenia or hyposplenism from any cause are known to have an increased risk of invasive pneumococcal disease, which is most significant until the age of 5 years.<sup>31</sup> After the age of 5 years, the utility of daily antibiotic prophylaxis against invasive pneumococcal disease is unclear,<sup>32</sup> though some risk of sepsis persists indefinitely in individuals with asplenia.<sup>33</sup> Recommendations differ between countries regarding the appropriate age for discontinuation of routine antibiotic prophylaxis; in the United States, prophylaxis is often recommended until the age of 5 years,<sup>31</sup> while British guidelines suggest a much longer duration of prophylaxis, up to lifelong.<sup>26</sup> Notably, these recommendations are based on data from patients with acquired hyposplenism/asplenia and have been adopted for congenital asplenia (or functional asplenia).

### 3.2 | Key decisions

The committee chose eight metrics to submit to the ACC Quality Metric Expert Panel for review (Table 2). Metrics discarded before submission included intraoperative topics (as discussed earlier, to focus on the ambulatory/outpatient practice) and the topic of testing for splenic function in heterotaxy patients (due to the lack of data or recommendations to guide the metric). However, a metric regarding antibiotic prophylaxis in heterotaxy patients was pursued. Overall, the remaining eight metrics were focused primarily on measuring outcomes in tasks considered standard and also reproducible and feasible to measure.

Endocarditis prophylaxis was a difficult topic for metric design due to wide variability in published clinical adherence to the latest iteration of guidelines,<sup>11,12</sup> as well as wide variability even among the committee members. The committee ultimately decided on two metrics for this topic. The first was assessment of the frequency of documented recommendation for endocarditis prophylaxis prior to dental procedures in patients with single ventricle physiology, a group covered by the 2007 AHA guidelines.<sup>2</sup> The second was assessment of the frequency of documented recommendation for endocarditis prophylaxis prior to dental procedures in patients with isolated, uncomplicated bicuspid aortic valves, a group of patients *not* recommended to receive prophylaxis per the 2007 guidelines.<sup>2</sup> The committee debated which lesion to pick for the negative recommendation arm, ultimately deciding on bicuspid aortic valves over the alternately proposed atrial septal defects due to the feasibility of measurement and high likelihood of available data (higher prevalence).

Finally, the hand hygiene metric was debated widely. The topic cannot be underestimated as a potential contributor to the health of our patients, but the manner in which to measure the outcomes was unclear. The committee decided to submit a metric about hand hygiene to include standard intermittent assessment for the appropriate use of hand hygiene at eligible encounters. However, the committee left the manner and source of assessment data to the protocol at each individual institution.

### 3.3 | Final recommendations and RAND analysis

The final recommendations from the Infection Prevention Committee to the steering committee are listed in Table 2. Metrics regarding hand

hygiene and influenza vaccination recommendation for patients did not pass the RAND analysis.<sup>1</sup> Both endocarditis prophylaxis metrics and the RSV/palivizumab metric passed the RAND analysis but fell out during the open comment period.<sup>1</sup> The three metrics that passed all analyses were those for antibiotic prophylaxis in patients with heterotaxy/asplenia, for influenza vaccination compliance in healthcare personnel, and for adherence to recommended regimens of secondary prevention of rheumatic fever.<sup>1</sup>

## 4 | DISCUSSION

The goal of all healthcare teams caring for pediatric heart patients should be to provide the highest quality of care whenever possible. While this is easily stated, the process of achieving this can be difficult. Standardization of care is ideal when the desired outcome can be linked to a particular intervention. In the case of the infection prevention topics, the linkage of a particular intervention to a particular outcome is often difficult to prove.

The reader will note the marked absence of any metric measuring endocarditis prophylaxis that passed all stages of analysis. This likely results from the relatively recent switch in guideline recommendations in 2007.<sup>2</sup> It is clear that adherence to these regimens is selective at best across the United States and internationally.<sup>10</sup> This metric likely will be reasonable to use in the future as more physicians adapt to the newer guidelines, presuming they remain static over time. Similarly, the RSV/palivizumab prophylaxis metric was not approved, and also was the subject of a guideline change in the last several years prior to this publication.

A metric on hand hygiene was proposed but did not pass the RAND analysis. The metric was given good scores for validity, but very poor scores for feasibility.<sup>1</sup> These low feasibility scores are likely related to the ambiguity behind the metric; as the committee left the manner of assessment to each individual institution, it also allows for variation in the resulting outcome and difficulty in collating data between centers. Furthermore, the scale of such a metric was much larger than any of the other metrics considered by this committee, and this likely factored into feasibility concerns.

Finally, the RAND analysis and final comment period resulted in approval of a metric for influenza vaccination in healthcare workers, but not one for a recommendation of influenza vaccination in patients.<sup>1</sup> While seemingly incongruent, the analysis shows that the expert panel rated recommendations for influenza vaccination in patients to have a very low potential validity. Though scientific evidence may support this metric, and compliance likely confers significant health benefits, the health system and providers unfortunately may not have control over many determinants of adherence in their patient population.<sup>9</sup> This in turn lowered the potential validity of the metric and resulted in its exclusion during the RAND analysis.

### 4.1 | Challenges and barriers to the field

All three approved infection prevention metrics have challenges in terms of implementation logistics. Influenza vaccination for healthcare

workers is already documented at most healthcare institutions and likely will be the easiest of the three to implement. The rheumatic fever secondary prevention metric seems reasonable, though may be more burdensome to some institutions compared to others depending on the incidence of rheumatic fever in the region. The asplenia antibiotic prophylaxis metric may be troubled by several factors. First, there are differing opinions on the manner to diagnosis poor splenic function, which may occur in the heterotaxy patient even in the presence of a spleen or multiple spleens.<sup>31</sup> Second, the overall number of patients will be relatively low, requiring perhaps several years of analysis at most institutions. Finally, the lack of a standard mean to document the recommendations for antibiotic prophylaxis in the medical record may make the assessment of metric adherence cumbersome.

The lack of convincing data to guide quality improvement initiatives in pediatric cardiology is widespread, particularly in infection prevention. The majority of guidelines in pediatric cardiology are currently based in low levels of evidence and expert opinion. The need for rigorous studies in many of these areas is of utmost importance as we attempt to improve the quality of care for our children with heart disease.

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## CONFLICT OF INTEREST

None.

## AUTHOR CONTRIBUTIONS

*Concept/design, data analysis and interpretation, drafting of the article, critical revision, and final approval:* Johnson, Barrett, Franklin, Graham, Halnon, Hattendorf, Krawczeski, McGovern, O'Connor, Schultz, Vinocur, Chowdhury, Anderson

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