

# The Use of Echocardiography for Pediatric Patients Presenting with Syncope

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**Objectives** To assess the frequency, yield, and cost of echocardiograms meeting “rarely appropriate” criteria.

**Study design** Retrospective, single-center study of pediatric patients presenting with syncope. Patients were categorized according to the appropriate use criteria and based upon location of care (emergency department only, primary care setting only, or referred to a pediatric cardiologist). Multivariable regression was used to determine factors associated with performance of a “rarely appropriate” echocardiogram. Costs were calculated using fair market values from the Healthcare Bluebook.

**Results** The cohort included 637 patients presenting with syncope during the 1-year study. Echocardiograms were ordered for 127 of 637 (20.1%) including 0 of 328 emergency department patients, 1 of 66 (1.5%) primary care setting patients, and 127 of 243 (52.3%) patients evaluated by a pediatric cardiologist. Use of echocardiography by pediatric cardiologists was categorized as “appropriate” in 92 of 127 (72.4%), “maybe appropriate” in 6 of 127 (4.7%), and “rarely appropriate” in 29 of 127 (22.8%). Abnormal findings were seen in 6 of 127 (4.7%) echocardiograms but in none of the “rarely appropriate” studies. In multivariable analysis, female sex and younger age were the only factors associated with performance of a “rarely appropriate” echocardiogram. “Rarely appropriate” echocardiograms cost an estimated \$16 704.00 (\$576.00 per patient) in the 1-year study.

**Conclusions** “Rarely appropriate” echocardiograms performed for syncope do not contribute management changing diagnostic information. However, they burden patients with additional cost and perhaps contribute to increased need for follow-up. (*J Pediatr* 2017;■■:■■-■■).

**S**yncope is defined as self-resolving abrupt loss of consciousness and postural tone, and often occurs because of decreased cerebral perfusion.<sup>1,2</sup> Syncope is a common complaint in many pediatric settings.<sup>2-7</sup>

Although syncope is common, cardiac causes are rare. In 2 prior studies, only 2%-6% of patients had a cardiac cause of syncope.<sup>7,8</sup> In patients with syncope, history and physical examination alone are sensitive in identifying cardiac pathology, and other diagnostic testing, including echocardiography, is costly and low yield.<sup>2,9,10</sup>

In an effort to standardize evaluation practices, in 2014 the American College of Cardiology (ACC) published appropriate use criteria guiding the performance of echocardiography for syncope and other common pediatric complaints. The guidelines were specifically formulated to assist clinicians in determining “when a transthoracic echocardiogram is warranted as an initial diagnostic modality in the outpatient setting.”<sup>11</sup> The ACC guidelines sorted patients presenting with syncope based on clinical characteristics and electrocardiogram findings into groups for whom echocardiography was “appropriate,” “maybe appropriate,” or “rarely appropriate.”<sup>11</sup>

The present study was designed to retrospectively review the application of the 2014 appropriate use criteria for patients presenting with syncope to a single major tertiary pediatric center and its affiliated clinics. The goals were to determine the frequency with which “rarely appropriate” echocardiograms are performed in various clinical practice settings, determine the findings of echocardiograms in each appropriate use criteria category, and determine downstream consequences, including costs, of “rarely appropriate” echocardiograms.

## Methods

A retrospective cohort study was conducted of patients ages 0-18 years presenting from January 1, 2015 to December 31, 2015 for initial evaluation of syncope in a pediatric primary care office, emergency department, or ambulatory pediatric cardiology office associated with a tertiary care center. A web-based data query tool was used to identify all initial patient encounters with an *International Classification*

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ACC American College of Cardiology

of Diseases, 9th Edition (ICD-9) visit diagnostic code for syncope. Chart review was performed to extract relevant information into a secure Research Electronic Data Capture study database hosted at Duke University, Durham, NC. Patients who received an echocardiogram underwent further chart review. Patients were excluded if the visit was for near syncope only, an echocardiogram was obtained before the initial visit, the visit was for a complaint other than syncope, there was a known prior cardiac diagnosis, the visit was not an initial evaluation, or there was inadequate documentation to apply appropriate use criteria. Because the 2014 appropriate use criteria were specifically designed for outpatient evaluation, patients seen in the emergency department for syncope and then admitted to the hospital were also excluded. Approval from the local Institutional Review Board was obtained with waiver of informed consent before conducting the study.

Medical records were reviewed with data extracted for demographics, clinical characteristics, further cardiac studies (echocardiogram, computed tomography, magnetic resonance imaging, exercise stress testing, prolonged event monitoring, or cardiac catheterizations) and cardiology follow-up. Patients were classified based upon location of care as (1) emergency department evaluation only; (2) primary care evaluation only; or (3) any pediatric cardiology referral/consultation. Based on published appropriate use criteria, reviewers followed a template to retrospectively classify the indications for echocardiograms as “appropriate,” “maybe appropriate,” and “rarely appropriate” for evaluation with transthoracic echocardiography.<sup>11</sup> Briefly, patients reporting exertional syncope, chest pain with syncope, with a murmur on physical examination, with a family history of cardiomyopathy or sudden cardiac death in a first degree relative, or with an abnormal electrocardiogram (EKG) were classified as “appropriate.” Those with unexplained pre-syncope, or a family history of channelopathy in a first degree relative were classified as “maybe appropriate.” All others were classified as “rarely appropriate.”

Results of all echocardiograms obtained were classified using definitions outlined by the previous appropriate use criteria consensus statement as normal, incidental (findings considered incidental by the ordering provider or requiring follow-up less than annually), or abnormal.<sup>6</sup> Abnormal results were further classified based on severity of findings as minor (requiring at least annual follow-up, but no intervention), moderate (management changing), and severe (requiring urgent medical or surgical intervention).<sup>6</sup> Follow-up encounters were reviewed for determination, if any, of underlying cardiac etiology for syncope if not clearly established in the initial encounter. The cost of echocardiograms in patients with normal or incidental echocardiogram findings and a “rarely appropriate” classification were used to calculate a total cost accrued during the 1-year study period, as well as a per patient cost. The cost of “rarely appropriate” echocardiograms and associated downstream studies (eg, those required as a direct consequence of echocardiographic findings) as well as follow-up clinic visits were estimated from the payer perspective using the Healthcare Bluebook which provides a “total fair price” that accounts for both technical and professional fees.<sup>12</sup>

## Statistical Analyses

Outcomes of interest included the frequency of abnormal echocardiogram findings stratified by appropriate use criteria categories, provider echocardiogram ordering variability, additional cost of a “rarely appropriate” echocardiogram, and factors associated with performance of an echocardiogram with a classification of “rarely appropriate.” For the latter outcome, we used multivariable logistic regression to control for covariates identified a priori including age, sex, race, ethnicity, payer status, patient location (cardiology clinic, emergency department, or primary care physician office) number of syncope patients seen by a given provider, and years of provider experience. Given lack of linearity, age was categorized into 3 prespecified groups: 0-8 years old, 9-13 years old, and 14-18 years old. Discrete variables were expressed as counts and proportions, and compared between groups using the Pearson  $\chi^2$  or the Fisher exact tests where appropriate. Continuous variables were reported as median or mean values with ranges. Comparison of distribution of continuous variables was by 2-tailed Wilcoxon rank-sum test. Data were analyzed using Stata 14.0 (College Station, Texas) and IBM SPSS Statistics v 23 (Armonk, New York). Statistical significance was defined as a *P* value of <.05.

## Results

The final patient cohort included 637 patients presenting for an initial evaluation of syncope including 328 seen only in the emergency department with no cardiology consultation or referral, 66 seen only in a primary care office, and 243 seen by a pediatric cardiologist (224 seen in the outpatient cardiology office and 19 seen in the emergency department as a consultation). Cohort demographics overall and stratified by level of evaluation are presented in **Table I**. The median age was 14 years (range: 0 to 18 years). The majority of patients were white (42.7%) or African American (30.9%). More than one-half of the patients were privately insured (53.8%).

As demonstrated in the **Figure**, 127 of 637 (19.9%) patients presenting with syncope received an echocardiogram. Echocardiograms were performed for 0 of 328 patients seen only in the emergency department, for 0 of 66 patients seen only in a primary care office and for 127 of 243 (52.3%) patients seen by a pediatric cardiologist. One patient had an echocardiogram ordered by their primary care physician, but did not present for their appointment.

Of all echocardiograms performed following evaluation by a cardiologist, 92 of 127 (72.4%) were retrospectively classified as meeting “appropriate” criteria, 6 of 127 (4.7%) as meeting “maybe appropriate” criteria, and 29 of 127 (22.8%) as meeting “rarely appropriate” criteria. The single echocardiogram ordered by a primary care physician was classified as meeting “appropriate” criteria due to exertional syncope. Because this patient was lost to follow up, no result was available.

In patients receiving an echocardiogram, abnormal echocardiogram findings were noted in 6 of 127 (4.7%) and incidental findings in 3 of 127 (2.4%). **Table II** summarizes these results. Of the 6 abnormal echocardiogram findings, 5 of 6

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