Comparison of Initial Pediatric Outpatient Echocardiogram Indications between Community and Academic Practice

Sowmya Balasubramanian, MD[1,*], Faustine D. Ramirez, BA[1], Yen Bui, MD, PhD[2], Elif Seda Selamet Tierney, MD[1], and Sarina K. Behera, MD[1,3]

Objective To compare the appropriateness and diagnostic yield of initial outpatient transthoracic echocardiography (TTE) between a community pediatric cardiology practice and an academic children's hospital.

Study design Initial outpatient pediatric TTE ordered by pediatric cardiologists between January and March 2014 at a community practice (Packard Children's Health Alliance [PCHA]; n = 238) and an academic tertiary center (Lucile Packard Children's Hospital [LPCH]; n = 76) were evaluated based on appropriate use criteria (AUC) released in December 2014. Multivariate logistic regression was used to identify predictors of "rarely appropriate" indications and abnormal TTE findings.

Results Of 314 TTEs, 165 (52.5%) were classified as "appropriate," 40 (12.7%) were classified as "may be appropriate," 100 (31.9%) were classified as "rarely appropriate," and 9 (2.9%) were unclassifiable. The proportion of abnormal findings did not differ between the 2 practice settings (5.3% for LPCH vs 7.6% for PCHA; $P = .61$). TTEs performed at PCHA were significantly more likely to be "rarely appropriate" (OR, 2.57; 95% CI, 1.28-5.15; $P = .008$). Children aged <1 year (OR, 1.90; 95% CI, 1.03-3.50; $P = .04$) and ordering providers with <10 years since the completion of their fellowship (OR, 2.15; 95% CI, 1.20-3.87; $P = .01$) were associated with "rarely appropriate" indications. "Appropriate" TTEs were associated with abnormal findings (OR, 8.69; 95% CI, 1.77-42.68; $P = .008$).

Conclusion The community practice was independently associated with greater inappropriate ordering of initial outpatient pediatric TTEs compared with the academic practice. The assessment of practice patterns following AUC release should account for physician and practice-related factors that could influence differences in TTE ordering patterns. *(J Pediatr 2019;207:23-8).*

Transthoracic echocardiography (TTE) is a commonly used imaging tool for evaluating children with suspected heart disease in the outpatient setting.[1] It is a widely available, cost-effective, and noninvasive test that provides invaluable data regarding initial diagnosis, evaluation, and management of pediatric cardiac conditions.[2] However, for common indications, such as chest pain, syncope, or murmur, it has been shown that TTEs are low-yield and resource intensive.[3-5] In an effort to guide physician decision making, the pediatric appropriate use criteria (AUC) for initial outpatient TTE, published in December 2014, were developed based on scientific evidence, expert opinion, and indirect consideration of health care costs.[6]

A multicenter implementation study that collected data before release of the AUC demonstrated 71% appropriateness in TTE indications.[7] Several studies have documented similar or higher rates of appropriateness[8,9] and have demonstrated no significant changes in physician ordering behavior since publication of the AUC.[10,11] However, all of those studies were performed in academic medical centers that might have been early AUC adopters compared with community-based pediatric cardiology practices.[11] Previous studies have compared different types of ordering providers (ie, pediatric cardiologists and primary care practitioners),[9,12,13] but not specifically different practice environments. Community and academic practices can differ in many ways, including involvement of trainees, physician compensation models, and patient demographics, such as socioeconomic status (SES).

In this study, we compared TTE ordering patterns during initial outpatient evaluation by pediatric cardiologists between a community-based pediatric cardiology practice and an academic children's hospital before release of the pediatric AUC for outpatient TTEs. We hypothesized that TTEs ordered in a community-based pediatric cardiology practice would have a higher prevalence of

AUC	Appropriate use criteria
EMR	Electronic medical record
LPCH	Lucile Packard Children's Hospital
PCHA	Packard Children's Health Alliance
SES	Socioeconomic status
TTE	Transthoracic echocardiography

From the [1]Division of Cardiology, Department of Pediatrics, Lucile Packard Children's Hospital, Stanford School of Medicine, Stanford; [2]Division of Cardiology, Department of Pediatrics, Kaiser Permanente Northern California; and [3]Pediatric Cardiology, Packard Children's Health Alliance, Stanford Children's Health, San Francisco, CA

*Current address: Division of Cardiology, Department of Pediatrics, University of Michigan.

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inappropriate indications compared with TTEs ordered in an academic children's hospital.

Methods

This study was a retrospective chart review of 314 patients aged ≤18 years who underwent initial outpatient pediatric TTE ordered by a pediatric cardiologist between January 1 and March 31, 2014, in 2 practice settings: a group of community-based practices (Packard Children's Health Alliance [PCHA]) and an academic tertiary referral center (Lucile Packard Children's Hospital [LPCH]). This 3-month time frame was selected to represent ordering practices of pediatric cardiologists before publication of the pediatric AUC guidelines in December 2014.[1] PCHA is affiliated with LPCH but is a separate network of community practices without crossover of physicians in respective outpatient clinics. Ordering providers at PCHA also serve as interpreting providers, but this is not the case at LPCH. A list of all consecutive TTEs performed at both sites during the study period was extracted from the echocardiography database shared in the PCHA/LPCH network. Of 703 consecutive TTEs performed during this period at the 2 practice settings, 389 were excluded from our analysis, for any of the following reasons: inpatient TTE, age >18 years, history of previous TTE, TTEs ordered by noncardiologists (ie, primary care providers or noncardiologist specialists), or known cardiac abnormality. The study protocol was approved by the Institutional Review Board at Stanford University School of Medicine.

For each TTE, an appropriateness rating was assigned using the clinic note associated with the TTE order according to AUC definitions as "appropriate," "may be appropriate," or "rarely appropriate." If clinic notes were unavailable in the electronic medical record (EMR), the TTE report was reviewed, and an indication was assigned only if the TTE report contained sufficient information to determine an indication according to the AUC document. TTE reports that contained insufficient details and/or very general descriptions, such as "murmur" or "palpitations," were deemed to be unclassifiable. TTEs were also determined to be unclassifiable if the indication was not included in the AUC document. Indications were reviewed and assigned an appropriateness rating by a single author who was not involved in the ordering or interpretation of the TTEs included in the study. Specific criteria were used to determine whether a murmur was considered "presumptively innocent." In addition to those criteria proposed in the AUC document (ie, consistent with normal blood flow, determined not to be related to any structural abnormalities of the heart or great vessels, soft, grade ≤2/6, heard in early systole, crescendo-decrescendo type, may vary with position), murmurs were considered "presumptively innocent" if they were described in the clinic note as "benign," "innocent," "loudest when supine," "quieter or softer when standing," "low or medium-pitched vibratory murmur," and/or "systolic ejection murmur." Any ambiguity was reviewed and adjudicated by the supervising investigators. If a patient had more than 1 indication listed, the more appropriate rating was assigned. The reviewer was not blinded to the practice setting, because EMRs were unique to each practice setting; however, the reviewer attempted to remain blinded to the TTE findings before assigning the indication even though this information was available in the chart documentation. Patient demographic data, including age, sex, and ZIP code of residence, were obtained from the EMR. To investigate whether SES had any influence on the ordering pattern of TTEs, ZIP code median household income was extracted from the US Census Bureau's 2007-2011 American Community Survey, categorized into income quartiles, and used as a measure of neighborhood SES.[14] Ordering provider characteristics included number of years since completion of pediatric cardiology fellowship and involvement of trainee (resident or fellow) in the clinical encounter.

TTE results were recorded as normal/incidental, including patent foramen ovale and physiologic peripheral pulmonary stenosis, or abnormal.[7] Abnormal findings were further subcategorized by severity according to previously published criteria: minor (may require follow-up, but no intervention is anticipated), moderate (alters patient management, but no urgent intervention is required), and severe (requires urgent hospitalization or intervention).[7] All data were deidentified and entered into a Research Electronic Data Capture system, which was maintained at the Stanford University School of Medicine.[15]

All statistical analyses were performed using Stata version 14.2 (StataCorp, College Station, Texas). Baseline characteristics were compared between practice settings using the 2-tailed t test for continuous variables and the χ^2 test for categorical variables. The proportion of appropriateness ratings, and the proportion of abnormal TTE findings, were compared between practice settings using the χ^2 test and Fisher exact test when appropriate. Multivariate logistic regression models were used to determine whether practice setting (primary predictor) was independently associated with "rarely appropriate" indications (primary outcome) and whether appropriateness rating (primary predictor) was associated with abnormal TTE findings (primary outcome). Multivariate models adjusted for variables selected a priori, including child age (dichotomized as <1 year vs ≥1 year),[9] child sex, neighborhood SES (ZIP code median household income quartiles), and ordering provider number of years since completion of fellowship (dichotomized as <10 years vs ≥10 years).[16]

A subgroup analysis was performed on the TTEs performed at LPCH using the Fisher exact test, to determine whether the proportion of the appropriateness ratings differed between TTEs ordered with and without a trainee involved in the clinic encounter. Finally, a post hoc sensitivity analysis was performed examining the outcome of TTE appropriateness, which excluded the TTEs ordered by the provider with a disproportionally high number of "rarely appropriate" TTEs compared with the other ordering providers. Significance was assessed at the $P < .05$ level.

Results

Among the 314 TTEs, 238 (75.8%) were performed at PCHA and the other 76 (24.2%) were performed LPCH. At both

Table I. Patient and ordering provider characteristics for TTEs performed at LPCH and PCHA

Characteristics	LPCH (n = 76; 24.2%)	PCHA (n = 238; 75.8%)	*P* value*
Patient characteristics			
Mean age, y, mean ± SD	8.7 (5.9)	8.2 (6.0)	.50
Male sex, n (%)	42 (55.3)	120 (50.4)	.46
ZIP code median household income, n (%)†			.003
Income quartile 1 ($18 761-$59 407)	20 (26.7)	64 (27.1)	
Income quartile 2 ($59 407-$71 873)	7 (9.3)	68 (28.8)	
Income quartile 3 ($71 873-$94 957)	23 (30.7)	54 (22.9)	
Income quartile 4 ($94 957-$167 198)	25 (33.3)	50 (21.2)	
Primary ordering provider characteristics			
Years since completion of fellowship, n (%)			.62
<10	40 (52.6)	133 (55.9)	
≥10	36 (47.4)	105 (44.1)	
Involvement of trainee, n (%)‡	37 (48.7)	0 (0.0)	<.001

*Baseline characteristics were compared between practice settings using the 2-tailed *t* test for continuous variables and χ^2 test for categorical variables.
†Data unavailable for 3 TTEs.
‡Resident or fellow.

Table II. Multivariate logistic regression model for "rarely appropriate" indications

Predictors of "rarely appropriate" indications	OR (95% CI)	*P* value
PCHA*	2.57 (1.28-5.15)	.008
Child age <1 y†	1.90 (1.03-3.50)	.04
Female child	1.03 (0.62-1.69)	.92
Neighborhood SES‡		
Income quartile 1	Reference	Reference
Income quartile 2	0.77 (0.38-1.53)	.45
Income quartile 3	0.92 (0.46-1.86)	.82
Income quartile 4	0.89 (0.42-1.92)	.78
Ordering provider <10 y since completion of fellowship§	2.15 (1.20-3.87)	.01

*Compared with LPCH.
†Compared with age ≥1 year.
‡Measured by ZIP code median household income.
§Compared with ≥10 years since completion of fellowship.

practices, the workflow always included a patient evaluation (history and physical) prior to performance of the TTE. Aside from 1 TTE at LPCH ordered by a PCHA provider, there was no provider crossover between the 2 settings. Patient characteristics did not differ between the 2 practice settings, except for neighborhood median household income (**Table I**). Trainee involvement was not observed at PCHA (**Table I**). Of the 25 total ordering pediatric cardiology providers, 19 practiced at LPCH and 6 practiced at PCHA.

Overall, 165 TTEs (52.5%) were categorized as "appropriate," 40 (12.7%) were categorized as "may be appropriate," and 100 (31.9%) were categorized as "rarely appropriate." The proportions of appropriateness ratings differed significantly between practice settings, with a higher proportion of "appropriate" TTEs ordered at LPCH compared with PCHA ($P = .001$; **Figure 1**).

In univariate analysis, TTEs performed at PCHA were significantly more likely to be "rarely appropriate" compared with TTEs performed at LPCH (OR, 2.58; 95% CI, 1.33-4.98; $P = .005$). In multivariate models adjusting for child age and sex, neighborhood SES, and ordering provider years since completion of fellowship, TTEs performed at PCHA were significantly more likely to be "rarely appropriate" (**Table II**). Independent of practice setting, children aged <1 year and ordering providers with <10 years since completion of fellowship were significantly associated with "rarely appropriate" indications (**Table II**). In a sensitivity analysis excluding the TTEs ordered by the provider with a disproportionally high number of "rarely appropriate" TTEs compared with the other ordering providers (55 out of 100 "rarely appropriate" TTEs), the association between practice setting and the ordering of "rarely appropriate" TTEs was qualitatively similar, albeit slightly attenuated, but the CI was wide (PCHA: OR, 2.31; 95% CI, 0.93-5.75; $P = .07$).

Overall, the most common indication for LPCH was for supraventricular tachycardia (15.7%), whereas the most common indication overall for PCHA was a presumptively innocent murmur with no signs, symptoms, or findings of cardiovascular disease and with a benign family history (23.0%). The latter indication was the most common "rarely appropriate" indication for both LPCH and PCHA. The indications in each appropriateness category for LPCH and PCHA are presented

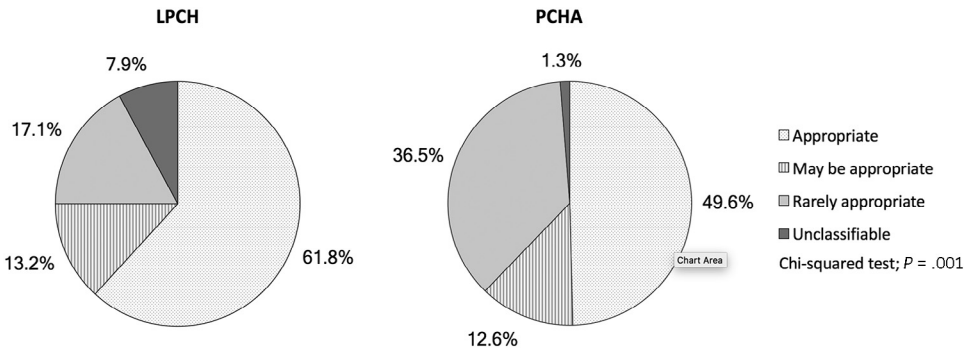

Figure 1. Appropriateness of TTEs by practice setting.

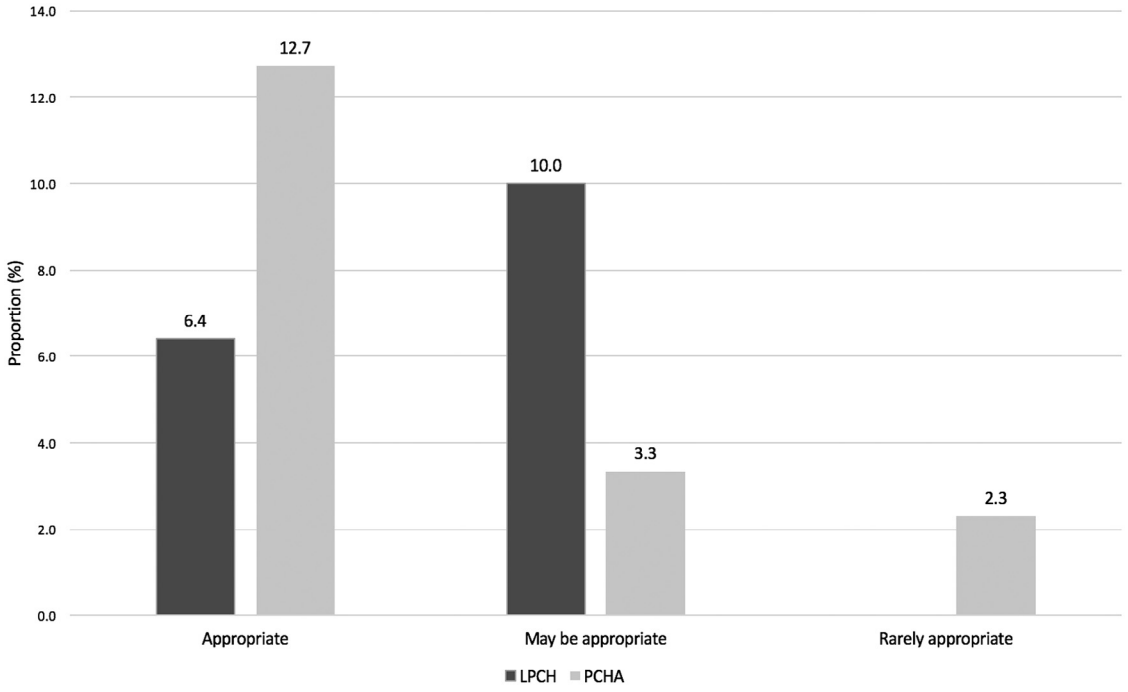

Figure 2. Proportion of abnormal TTE findings by appropriateness rating for each practice setting.

in **Tables III** and **IV** (available at www.jpeds.com), respectively.

Among all 314 TTEs, only 9 (2.9%) were unclassifiable according to the AUC criteria. These included murmur not otherwise specified (n = 5), remote history of Kawasaki disease (n = 2), chest pain not otherwise specified (n = 1), and hypotension with wide pulse pressure (n = 1). The majority of these were performed at LPCH (7.9% vs 1.3% at PCHA; $P = .008$).

Overall, 22 (7.0%) of 314 TTEs were abnormal, and the proportion of abnormal findings did not differ between practice settings (5.3% for LPCH vs 7.6% for PCHA; $P = .61$). The proportion of abnormal findings within each appropriateness rating category did not differ significantly between the 2 sites (**Figure 2**). Of 22 abnormal studies, 18 were categorized as mild (14 at PCHA; 4 at LPCH), 3 were categorized as moderate (PCHA), and 1 was categorized as severe (PCHA). The most common pathologic findings were a small ventricular septal defect (n = 11) and a bicuspid or functionally bicuspid aortic valve (n = 3). Thirty-two studies (10.2%) were categorized as incidental, and the majority of the diagnoses were either patent foramen ovale or physiologic peripheral pulmonary stenosis. Abnormal findings for "rarely appropriate" indications (n = 2) were for functionally bicuspid aortic valves. In univariate analysis, "appropriate" studies were associated with abnormal TTE findings (OR, 6.00; 95% CI, 1.36-26.44; $P = .02$). In multivariate models adjusting for practice setting, child age and sex, neighborhood SES, and ordering provider years since completion of fellowship, "appropriate" studies were independently associated with abnormal TTE findings (OR, 8.69; 95% CI, 1.77-42.68; $P = .008$); however, "may be appropriate" studies were not significantly associated with abnormal TTE findings (OR, 5.09; 95% CI, 0.61-42.14; $P = .13$).

In a subgroup analysis of TTEs performed at LPCH, the proportion of appropriateness ratings did not differ significantly between TTEs ordered with a trainee and those ordered without a trainee involved in the clinic encounter ($P = .94$).

Discussion

Our study demonstrates that initial outpatient pediatric TTEs ordered in a community-based pediatric cardiology practice were more likely to be for "rarely appropriate" indications compared with studies ordered in an academic setting. In addition, TTEs ordered in children aged <1 year and those ordered by physicians with <10 years since completion of fellowship were also associated with "rarely appropriate" study indications. Reassuringly, when abnormal findings were detected, all but 2 of the cases carried an indication that would be classified as "appropriate" or "may be appropriate."

Overall, the proportions of "appropriate" and "rarely appropriate" ordering at LPCH are comparable with those in published academic multicenter studies.[16,17] Indeed, Stern et al examined the pre-AUC use of TTEs in academic centers and reported that 19% of TTEs were ordered for "rarely appropriate" indications,[16] similar to our prevalence of 17%. Our study, consistent with others, found that TTEs ordered in children aged <1 year were more likely to be for "rarely appropriate" indications, presumably related to the higher prevalence of pathology in this age group compared with older children.[7] In addition, TTEs ordered by pediatric cardiologists with <10 years since completion of fellowship were also associated with "rarely appropriate" indications, consistent with previous reports.[8,18] However, our finding of significant differences

in the ordering of "rarely appropriate" indications according to practice setting is a novel finding that has not been reported previously.

Several published studies examining indications for outpatient TTEs in children have proposed influential factors that dictate ordering patterns, including fear of missing a potentially lethal condition in its early stages, expectation from referring physician or family to completely rule out cardiac disease, physician behavior and level of experience, and noninvasive nature and easy availability of TTEs.[13,16] Although all these factors are likely to affect physicians in an academic center as much as in a community practice, several other factors may contribute to the differences observed between the practice settings, including differences in patient SES and physician compensation models. In an adult cardiology study, physicians who billed for technical and professional fees ordered significantly more tests compared with physicians who did not bill for these fees.[19] However, detailed cost analyses between office and hospital-based practices are not reliable, owing to different charges and reimbursement rates.[20] In some radiology-based studies, reasons for overutilization have been attributed to the practice of defensive medicine, capitated care arrangements, parental anxiety, and lack of a collegial network for quick "curbside" opinions.[20] In a recent study, noninvasive imaging specialists within the field of pediatric cardiology were more likely to order a TTE for a "rarely appropriate" indication, which may be related to self-referral or a greater reliance on TTE as a diagnostic modality compared with other types of cardiologists.[16]

The impetus for the development of the pediatric AUC for outpatient evaluation arose from the need to control health care costs by decreasing practice variability, increasing the yield of testing, and improving resource utilization. In pediatrics, the release of the AUC criteria has had only a minimal impact on practice patterns and reduction in the rates of "rarely appropriate" indications thus far in academic settings, emphasizing the need for more than passive release of a document to derive desired results.[21] In the adult cardiology literature, educational intervention strategies with house staff, including the use of lectures, pocket cards, and e-mail feedback on ordering behavior, have been shown to significantly reduce inappropriate ordering of TTEs in academic medical centers.[22,23] An intervention-based study published since the release of the pediatric AUC showed modest improvements in the appropriateness of pediatric TTEs in academic settings.[17] However, there are currently no published pediatric studies have assessed interventions and changes in ordering practices after publication of the AUC among different practice settings. Future research evaluating the impact of AUC publication on community practices, including fee-for-service and managed care practices, is needed and may identify opportunities for targeted interventions to reduce inappropriate ordering of TTEs. In the current climate of excessive health care costs and restricted resources, understanding impediments to adoption of the pediatric AUC is highly relevant. As we evaluate the overall impact of the AUC and consider quality improvement initiatives and interventional strategies, physician-related factors and practice setting should be taken into consideration.

Several study limitations must be acknowledged, notably the small numbers of TTEs and abnormal studies, which limited our ability to use clustered analysis methods to account for the potential correlation of observations within each provider. Of note, the smaller number of TTEs ordered at LPCH relative to PCHA was related to the fact that many LPCH TTEs are ordered by noncardiologist specialists. We considered the possibility that the differences between sites were driven by a single provider who ordered more than one-half of all "rarely appropriate" studies. In a sensitivity analysis excluding this provider's TTEs, we found that the association was slightly attenuated but remained qualitatively similar. Although there was a smaller number of providers at PCHA compared with LPCH, this is representative of community-based private practices which often have fewer than 10 providers practicing within the group. Individual practice styles may play a larger role in a community setting compared with an academic setting, based on the number of total providers. In addition, the period of study was selected to represent ordering practices before release of the pediatric AUC guidelines, and it is possible that rates of inappropriate ordering have improved since its publication. Given that this study examined only practice settings in a specific part of the US, our findings might not be generalizable to all academic and community practices and warrant replication in larger, multicenter studies. Owing to limitations in the integration of EMRs between practice settings, we were unable to extract the list of all consecutive patient encounters and could extract only the list of all consecutive TTEs. This limited our ability to compare the overall presenting indications of all patients at both sites (ie, both those who did and did not receive TTEs), and our analysis is restricted to only those patients who underwent TTE evaluation. Thus, the overall presenting indications at each site are unknown and the conclusions drawn are based on the echocardiograms performed at each center. Though it is unlikely, we cannot fully discount the possibility that rarely appropriate indications compose a significantly larger proportion of patients seen at the community setting, and if so, TTE might not be overused in the community setting for rarely appropriate indications. Given the limitations with the available dataset, we are not able ascertain this. Finally, the number of unclassifiable TTEs was biased toward LPCH; however, the total number was quite small and unlikely to significantly affect the results.

Future efforts evaluating incorporation of AUC into clinical practice should account for these physician- and practice-related factors. ■

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Table III. Indications of all TTEs in each appropriateness category for LPCH (n = 70)

Indications	Number (%) of all TTEs within appropriateness category	Number (%) of abnormal TTEs for each indication
Appropriate (n = 47)		
11—Supraventricular tachycardia	11 (23.4)	—
30—Exertional chest pain	5 (10.6)	—
25—Exertional syncope	3 (6.4)	—
40—Presumptively innocent murmur with signs, symptoms, or findings of cardiovascular disease	3 (6.4)	—
41—Pathologic murmur	3 (6.4)	3 (100.0)
52—Abnormal ECG without symptoms	3 (6.4)	—
73—Muscular dystrophy	3 (6.4)	—
74—Systemic hypertension	3 (6.4)	—
19—Syncope with abnormal ECG	2 (4.3)	—
50—Genotype positive for cardiomyopathy	2 (4.3)	—
65—Connective tissue disorder such as Marfan, Loeys Dietz, and other aortopathy syndromes	2 (4.3)	—
66—Suspected connective tissue disorder	2 (4.3)	—
67—Clinically suspected syndrome or extracardiac congenital anomaly known to be associated with congenital heart disease	2 (4.3)	—
33—Non-exertional chest pain with abnormal ECG	1 (2.1)	—
51—Abnormal chest radiograph findings suggestive of cardiovascular disease	1 (2.1)	—
87—Storage diseases, mitochondrial and metabolic disorders	1 (2.1)	—
May be appropriate (n = 10)		
100—Family history of congenital left-sided heart lesion*	3 (30.0)	—
3—Palpitations with abnormal ECG	2 (20.0)	—
29—Chest pain with other symptoms or signs of cardiovascular disease, a benign family history, and a normal ECG	2 (20.0)	1 (50.0)
101—Family history of congenital heart disease other than the congenital left-sided heart lesions*	2 (20.0)	—
89—Family history of unexplained sudden death before age 50*	1 (10.0)	—
Rarely appropriate (n = 13)		
39—Presumptively innocent murmur with no symptoms, signs, or findings of cardiovascular disease and a benign family history	6 (46.2)	—
2—Palpitations with no other symptoms or signs of cardiovascular disease, a benign family history, and a normal ECG	2 (15.4)	—
4—Palpitations with family history of a channelopathy	1 (7.7)	—
18—Syncope with no other symptoms or signs of cardiovascular disease, a benign family history, and a normal ECG	1 (7.7)	—
23—Probable neurocardiogenic (vasovagal) syncope	1 (7.7)	—
31—Non-exertional chest pain with no recent ECG	1 (7.7)	—
32—Non-exertional chest pain with normal ECG	1 (7.7)	—

ECG, electrocardiogram.
Six TTEs were unclassifiable at LPCH.
*In a patient without signs or symptoms and without confirmed cardiac diagnosis.

Table IV. Indications for all TTEs in each appropriateness category for PCHA (n = 235)

	Number (%) of all TTEs within appropriateness category	Number (%) of abnormal TTEs for each indication
Appropriate (n = 118)		
30—Exertional chest pain	32 (27.1)	—
41—Pathologic murmur	23 (19.5)	11 (47.8)
40—Presumptively innocent murmur with signs, symptoms, or findings of cardiovascular disease	19 (16.1)	1 (5.3)
25—Exertional syncope	6 (5.1)	—
66—Suspected connective tissue disorder	6 (5.1)	1 (16.7)
74—Systemic hypertension	6 (5.1)	—
11—Supraventricular tachycardia	3 (2.5)	—
26—Unexplained post-exertional syncope	3 (2.5)	—
51—Abnormal chest radiograph findings suggestive of cardiovascular disease	3 (2.5)	—
92—Family history of hypertrophic cardiomyopathy*	3 (2.5)	—
19—Syncope with abnormal ECG	2 (1.7)	1 (50.0%)
21—Syncope with family history at a young age (before age 50) of sudden cardiac arrest or death and/or pacemaker or implantable defibrillator placement	2 (1.7)	—
33—Non-exertional chest pain with abnormal ECG	2 (1.7)	1 (50.0%)
34—Chest pain with family history of sudden unexplained death or cardiomyopathy	2 (1.7)	—
67—Clinically suspected syndrome or extracardiac congenital anomaly known to be associated with congenital heart disease	2 (1.7)	—
42—Symptoms and/or signs suggestive of congestive heart failure	1 (0.9)	—
52—Abnormal ECG without symptoms	1 (0.9)	—
57—Chromosomal abnormality known to be associated with cardiovascular disease	1 (0.9)	—
69—Suspected or confirmed Kawasaki disease	1 (0.9)	—
May be appropriate (n = 30)		
29—Chest pain with other symptoms or signs of cardiovascular disease, a benign family history, and a normal ECG	12 (40.0)	—
13—PVCs after the neonatal period	4 (13.3)	—
101—Family history of congenital heart disease other than the congenital left-sided heart lesions*	4 (13.3)	—
86—Failure to thrive	3 (10.0)	—
89—Family history of unexplained sudden death before age 50*	2 (6.7)	—
100—Family history of congenital left-sided heart lesion*	2 (6.7)	—
35—Chest pain with family history of premature coronary artery disease	1 (3.3)	—
77—Obesity with obstructive sleep apnea	1 (3.3)	—
99—Family history of connective tissue disorder other than Marfan or Loeys Dietz syndrome*	1 (3.3)	1 (100.0)
Rarely appropriate (n = 87)		
39—Presumptively innocent murmur with no symptoms, signs, or findings of cardiovascular disease and a benign family history	54 (62.1)	1 (1.9)
23—Probable neurocardiogenic (vasovagal) syncope	16 (18.4)	—
18—Syncope with no other symptoms or signs of cardiovascular disease, a benign family history, and a normal ECG	4 (4.6)	—
32—Nonexertional chest pain with normal ECG	3 (3.5)	—
2—Palpitations with no other symptoms or signs of cardiovascular disease, a benign family history, and a normal ECG	2 (2.3)	1 (50.0)
28—Chest pain with no other symptoms or signs of cardiovascular disease, a benign family history, and a normal ECG	2 (2.3)	—
4—Palpitations with family history of a channelopathy	1 (1.1)	—
9—PACs in the prenatal or neonatal period	1 (1.1)	—
44—Fatigue with no other signs and symptoms of cardiovascular disease, a normal ECG, and a benign family history	1 (1.1)	—
82—Seizures, other neurologic disorders, or psychiatric disorders	1 (1.1)	—
90—Family history of premature coronary artery disease before age 50*	1 (1.1)	—
95—Family history of unspecified cardiovascular disease*	1 (1.1)	—

PACs, premature atrial contractions; *PVCs*, premature ventricular contractions.
Three TTEs were unclassifiable at PCHA.
*In a patient without signs or symptoms and without confirmed cardiac diagnosis.