

# Prevalence of and Factors Associated with Inappropriate Indications for Transthoracic Echocardiography in Adult Outpatients at Siriraj Hospital

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## ABSTRACT

**Objective:** Ordering transthoracic echocardiography (TTE) for inappropriate indications could prolong patient waiting time, increase echocardiography laboratory workload, and compromise the quality of TTE studies. This study aimed to investigate the prevalence of and factors associated with inappropriate indications for TTE in adult outpatients at Siriraj Hospital.

**Methods:** Two cardiologists prospectively and independently evaluated indications for adult TTE scheduled during regular office hours at Her Majesty Cardiac Center, Siriraj Hospital. Cases were classified as appropriate, inappropriate, or uncertain according to the 2011 Appropriate Use Criteria for Echocardiography proposed by a group of American cardiovascular organizations. Agreement between the two cardiologists was measured using weighted kappa statistic, and disagreement was resolved by consensus. Factors were evaluated for association with inappropriate indications for TTE.

**Results:** Four hundred and eighty-two patients were included. Weighted kappa statistic was 0.46 [95% confidence interval (CI) 0.34 to 0.59] for agreement between the two cardiologists. Four hundred and thirty-two TTE were appropriate (89.6%, 95% CI 86.6% to 92.1%), 27 were inappropriate (5.6%, 95% CI 3.9% to 8.0%), and 23 were uncertain (4.8%, 95% CI 3.2% to 7.0%). Neither status of ordering physician (cardiologist, cardiology fellow, or cardiothoracic surgeon) nor payment type was found to be significantly associated with the appropriateness of indications for TTE.

**Conclusion:** The prevalence of inappropriate indications among adult outpatients undergoing TTE during regular office hours at Siriraj Hospital was low. No significant association was observed between the appropriateness of TTE indications and either status of ordering physician or payment type.

**Keywords:** Transthoracic echocardiography; evaluation of echocardiography; appropriate use criteria; appropriateness (Siriraj Med J 2019;71: 74-79)

## INTRODUCTION

Transthoracic echocardiography (TTE) is widely used in clinical practice due to its safe and non-invasive

nature, its wide availability, and its relatively low cost compared to other cardiac tests. The demand for TTE is increasing, and this has resulted in longer waiting

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periods for patients. The number of adult TTE procedures performed during regular office hours at Her Majesty Cardiac Center, Siriraj Hospital, increased from 2,683 per year in 2009 to 3,326 per year in 2012. The average waiting time for a patient scheduled for outpatient TTE was 48.9, 74.5, and 58.4 days in 2009, 2010, and 2011, respectively. This increase in demand for TTE increases the workload of the echocardiography laboratory, and this workload increase could compromise the quality of echocardiographic examinations.

At our echocardiography laboratory, TTE examinations were previously performed only by cardiologists, or by cardiology fellows under the supervision of cardiologists. However, as the number of TTE requests increased over the years, non-cardiologist cardiac sonographers were recruited to cope with the increased demand. Even with the increased number of sonographers, long waiting time is still a frequent complaint from patients and requesting physicians. In routine clinical practice, we observed that some patients were scheduled for TTE with doubtful or inappropriate indications. Reducing the number of TTE procedures that are unnecessarily performed due to inappropriate indications may help to shorten the waiting period for TTE, reduce echocardiography laboratory workload, improve the quality of TTE examinations, and reduce healthcare costs. Experts in echocardiography have proposed clinical situations in which echocardiography should be considered indicated as a guideline for the appropriate and effective use of echocardiography in clinical practice.<sup>1,2</sup> Reports from Western countries showed that 56% to 92% of echocardiographic examinations were considered appropriate,<sup>3-10</sup> and that non-cardiac specialists were more likely to inappropriately request echocardiography.<sup>4,6,8</sup> In Thailand, a study published in 2011 from a university hospital found that 89% of echocardiographic requests among inpatients and outpatients were appropriate<sup>11</sup> when evaluated against the 2007 Appropriateness Criteria for Transthoracic and Transesophageal echocardiography.<sup>1</sup> The aim of this study was to investigate the prevalence of and factors associated with inappropriate indications for TTE in adult outpatients at Siriraj Hospital according to the updated Appropriate Use Criteria for Echocardiography published in 2011.<sup>2</sup>

## MATERIALS AND METHODS

### Methods

We conducted this prospective study to assess the appropriateness of TTE requests among adult outpatients scheduled for TTE at the echocardiography laboratory of

Her Majesty Cardiac Center, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand. The Siriraj Institutional Review Board (SIRB) approved the protocol for this study (Si 067/2013), and all patients provided written informed consent before enrollment into the study.

### Study population

The principal inclusion criterion was adult outpatients electively scheduled for TTE during regular office hours. Patients were prospectively and consecutively enrolled. Patients scheduled for stress echocardiography, transesophageal echocardiography, echocardiography performed for other research purposes, and TTE performed after office hours were excluded.

### Study procedures

Two cardiologists (KU and VC) independently reviewed the medical record of each patient to determine the indication for TTE. Indications were classified as appropriate, inappropriate, or uncertain according to the 2011 Appropriate Use Criteria for Echocardiography proposed by the American College of Cardiology Foundation (ACCF) in collaboration with various other American cardiovascular organizations.<sup>2</sup> There are 98 criteria listed in the appropriate use criteria for TTE, 57 of which are considered appropriate, 29 inappropriate, and 12 uncertain. If the indication for TTE in a particular patient did not match any of the 98 criteria, each of the two reviewing cardiologists used his own judgment to determine the appropriateness of the indication. Disagreement between the two cardiologists was resolved by discussion and consensus. Data relating to the status of the physician that ordered the TTE, and the type of payment to cover the cost of the TTE were also recorded. Regarding physician status, only cardiology fellows, cardiologists, and cardiothoracic surgeons are authorized to order TTE at our center. Payment type was categorized into any one of 3 Thailand health insurance schemes or self-pay.

### Statistical Analysis

The primary objective of this study was to estimate the proportion of TTE that were ordered with inappropriate indications among adult outpatients electively scheduled for TTE during regular office hours. We estimated that a minimum of 480 subjects would be required to ensure that the limits of the 2-sided 95% confidence interval (CI) of this proportion would not exceed  $\pm 0.045$  from the observed proportion. We chose to use an expected proportion of inappropriate TTE of 0.5 in the sample size

calculation, as this value would yield the largest variance of the estimate of proportion, thereby maximizing the required sample size.

Demographic data, status of ordering physician, and payment type were summarized using descriptive statistics. Continuous variables are presented as median and interquartile range (IQR), and Kruskal-Wallis test was used to compare continuous variables between groups. Categorical variables are reported as number and percentage, and Fisher's exact test was used to compare categorical variables between groups. Agreement between the two cardiologists was measured using weighted kappa statistic with linear weights. All statistical tests were carried out at the 2-sided significance level of 0.05.

## RESULTS

A total of 482 patients were consecutively enrolled in this study between March 1 and June 11, 2013. Demographic data, status of ordering physician, and payment type of study participants are shown in Table 1. Almost half (47.1%) of subjects were male. Patient age ranged from 16 to 95 years. Cardiologists or cardiology fellows ordered TTE in about 95% of cases. The Civil Servant Medical Benefits system and the National Health Insurance system covered the cost of TTE in 40.7% and 33.8% of patients, respectively.

The two cardiologists concordantly determined the indications for TTE as appropriate in 409 subjects, as inappropriate in 12 subjects, and as uncertain in 11 subjects, representing the observed agreement of 89.6%. When chance agreement was taken into account, there was moderate agreement between the two cardiologists

regarding the level of appropriateness of TTE indications (weighted kappa 0.46, 95% CI 0.34 to 0.59). Consensus was achieved in all 50 cases where there was initial disagreement between reviewers.

After consensus was reached, the indications for TTE were considered appropriate in 432 patients (89.6%, 95% CI 86.6% to 92.1%), inappropriate in 27 patients (5.6%, 95% CI 3.9% to 8.0%), and uncertain in 23 patients (4.8%, 95% CI 3.2% to 7.0%). There were six patients whose indications for TTE were not specifically listed in the 2011 Appropriate Use Criteria for Echocardiography, so determination of the level of appropriateness was based on judgement of the reviewing cardiologists. Among those 6 indications, 1 was judged appropriate, 2 inappropriate, and 3 uncertain.

There was a statistically significant difference in age among the appropriate, inappropriate, and uncertain TTE indication groups. Subjects in the uncertain group were significantly younger than those in the appropriate and inappropriate groups ( $p = 0.003$ ; Table 2). Females were significantly more likely than males to have TTE with appropriate indications (92.9% vs. 85.9%,  $p = 0.043$ ).

Although cardiology fellows had a higher proportion of appropriate indications for TTE request (92.7%) than cardiologists (86.0%) and cardiothoracic surgeons (85.7%), there was no statistically significant association between the status of the ordering physician and the level of TTE indication appropriateness ( $p = 0.062$ ). Similarly, patient payment type was not found to be significantly associated with the level of indication appropriateness ( $p = 0.071$ ).

**TABLE 1.** Characteristics of study participants.

Variables	Value (n = 482)
Age (years), median (IQR)	61 (50, 71)
Male, n (%)	227 (47.1%)
Ordering physician, n (%)	
Cardiologist	200 (41.5%)
Cardiology fellow	261 (54.1%)
Cardiothoracic surgeon	21 (4.4%)
Payment type, n (%)	
Civil Servant Medical Benefits	196 (40.7%)
National Health Insurance	163 (33.8%)
Social Security	48 (10.0%)
Self-pay	75 (15.5%)

**Abbreviation:** IQR = interquartile range

**TABLE 2.** Comparison of various factors among different levels of appropriateness relative to indications for adult outpatient transthoracic echocardiography during regular office hours at Siriraj Hospital.

Variables <sup>a</sup>	Appropriate	Inappropriate	Uncertain	P-value <sup>b</sup>
Age (years), median (IQR)	62 (50, 72)	61 (54, 72)	43 (33, 63)	0.003 <sup>c</sup>
Gender, n (%)				0.043
Male	195 (85.9%)	17 (7.5%)	15 (6.6%)	
Female	237 (92.9%)	10 (3.9%)	8 (3.1%)	
Ordering physician, n (%)				0.062
Cardiologist	172 (86.0%)	17 (8.5%)	11 (5.5%)	
Cardiology fellow	242 (92.7%)	8 (3.1%)	11 (4.2%)	
Cardiothoracic surgeon	18 (85.7%)	2 (9.5%)	1 (4.8%)	
Payment type, n (%)				0.071
Civil Servant Medical Benefits	176 (89.8%)	14 (7.1%)	6 (3.1%)	
National Health Insurance	150 (92.0%)	6 (3.7%)	7 (4.3%)	
Social Security	38 (79.2%)	3 (6.3%)	7 (14.6%)	
Self-pay	68 (90.7%)	4 (5.3%)	3 (4.0%)	

<sup>a</sup> Percentage data are shown as row percentage. <sup>b</sup> Fisher's exact test, except where indicated otherwise

<sup>c</sup> Kruskal-Wallis test

**Abbreviation:** IQR = Interquartile range

The most frequent indication for TTE, according to the 2011 Appropriate Use Criteria for Echocardiography, was presentation with symptoms or conditions potentially related to suspected cardiac etiology, such as chest pain, shortness of breath, and palpitations (94 patients, 19.5%; [Table 3](#)), followed by initial evaluation for suspected

valvular or structural heart disease (48 patients, 10.0%; [Table 3](#)). Among the 27 patients with inappropriate indications, the most frequently observed indication was routine surveillance of ventricular function in clinically stable subjects with known coronary artery disease (5 patients, 18.5%; [Table 4](#)).

**TABLE 3.** The 10 most common indications for adult outpatient transthoracic echocardiography during regular office hours at Siriraj Hospital.

Indication	n (%) (Total n = 482)
1. Symptoms or conditions potentially related to suspected cardiac etiology including but not limited to chest pain, shortness of breath, palpitations, transient ischemic attack, stroke, or peripheral embolic event	94 (19.5%)
2. Initial evaluation when there is a reasonable suspicion of valvular or structural heart disease	48 (10.0%)
3. Re-evaluation of known valvular heart disease with a change in clinical status or cardiac exam or to guide therapy	36 (7.5%)
4. Prior testing that is concerning for heart disease or structural abnormality including but not limited to chest X-ray, baseline scout images for stress echocardiogram, ECG, or cardiac biomarkers	35 (7.3%)
5. Routine surveillance ( $\geq 1$ year) of moderate or severe valvular regurgitation without change in clinical status or cardiac exam	31 (6.4%)
6. Sustained or nonsustained atrial fibrillation, supraventricular tachycardia, or ventricular tachycardia	30 (6.2%)
7. Initial evaluation of known or suspected heart failure (systolic or diastolic) based on symptoms, signs, or abnormal test results	29 (6.0%)
8. Initial evaluation of ventricular function following acute coronary syndrome	26 (5.4%)
9. Routine surveillance ( $\geq 1$ year) of moderate or severe valvular stenosis without a change in clinical status or cardiac exam	18 (3.7%)
10. Evaluation of suspected pulmonary hypertension including evaluation of right ventricular function and estimated pulmonary artery pressure	15 (3.2%)

**TABLE 4.** Common inappropriate indications for adult outpatient transthoracic echocardiography during regular office hours at Siriraj Hospital.

Indication	n (%) (Total n = 27)
1. Routine surveillance of ventricular function with known coronary artery disease and no change in clinical status or cardiac exam	5 (18.5%)
2. Initial evaluation of ventricular function (e.g., screening) with no symptoms or signs of cardiovascular disease	2 (7.4%)
3. Routine perioperative evaluation of ventricular function with no symptoms or signs of cardiovascular disease	2 (7.4%)
4. Routine surveillance (< 1 year) of moderate or severe valvular stenosis without a change in clinical status or cardiac exam	2 (7.4%)
5. Routine surveillance (< 3 year after valve implantation) of prosthetic valve if no known or suspected valve dysfunction	2 (7.4%)
6. Routine evaluation of systemic hypertension without symptoms or signs of hypertensive heart disease	2 (7.4%)

## DISCUSSION

We evaluated the indications for TTE among adult outpatients undergoing TTE during regular office hours, and determined their appropriateness according to the 2011 Appropriate Use Criteria for Echocardiography. Our findings revealed that most of outpatient TTE examinations performed at our center during the study period were appropriate, regardless of the status of the ordering physician or the payment type used to cover the cost of TTE.

Our result is very comparable to that reported from another university hospital in Thailand (89% appropriate TTE indications) that enrolled both inpatients and outpatients, and that based the appropriateness of TTE indications on 2007 Appropriateness Criteria for Transthoracic and Transesophageal Echocardiography.<sup>11</sup> In that study, the level of appropriateness of TTE requests was similar between inpatients and outpatients. The most common inappropriate indications for TTE were preoperative evaluation (50% of inappropriate TTE), as determined by expert opinion since this indication is not listed as an indication in the 2007 Appropriateness Criteria for Transthoracic and Transesophageal Echocardiography, and evaluation of endocarditis without evidence of bacteremia or new murmur (19% of inappropriate TTE). In our study, the most common inappropriate indications for TTE were evaluation of left ventricular function in clinically stable coronary artery disease patients, and evaluation of asymptomatic individuals without suggestive evidence of cardiovascular disease (26% of inappropriate TTE for both indications combined). TTE performed for perioperative evaluation was found in only 7% of

inappropriate TTE in our study, probably because this indication is clearly listed as inappropriate in the 2011 Appropriate Use Criteria for Echocardiography. We did not have any TTE evaluation for endocarditis in our study, because we included only elective outpatients.

The rate of appropriate TTE requests at our hospital, and probably at most university hospitals in Thailand, is higher than the rates reported from the United States of America (56% to 92%).<sup>3-10</sup> This may be explained in part by the policy imposed at our center, and at other university hospitals in Thailand, to limit the privilege of ordering TTE to only cardiovascular specialists. At many centers in the US, family physicians and general practitioners can order TTE, and the rates of inappropriate requests made by these physicians are usually higher than those made by cardiovascular specialists.<sup>4,6,8</sup> Another possible explanation for the observed high rate of appropriate TTE indications is that ordering physicians may occasionally have to perform echocardiographic examination themselves without being paid extra to do so. This may have the effect of influencing requests for TTE that are more accurately based on guideline recommendations.

The observed tendency of higher rate of appropriate requests among cardiology fellows compared to cardiologists and cardiothoracic surgeons might reflect the nature of practice during training at an academic institution. The management decisions of cardiology fellows are usually monitored by certified cardiologists, and this may inspire them to be more cautious and more likely to consult their mentor before ordering a test.

This study was inspired by the idea that decreasing or eliminating inappropriate TTE requests would lead to

improvement in patient waiting time for, and perhaps the quality of TTE. However, the magnitude of inappropriate requests found in this study was only 5.6%, which indicates that the practice at our center regarding the use of TTE is reasonable, and that only modest improvement would be possible. As such, alternative strategies need to be explored in order to improve outpatient TTE service.

Some limitations of this study need to be mentioned. First, included patients were enrolled over a relatively short 14-week study period, so the indications that were identified may not reflect all of the TTE indications that are used in clinical practice. Second, even though our reviewers are both board-certified cardiologists, which gave our study more credibility than if we had enlisted non-cardiologist reviewers, their agreement was only moderate, which suggests the complexity associated with reviewing medical records to identify TTE indications. The differences between reviewers are likely due to incomplete documentation on echocardiography request forms and/or medical records. Third and last, the results of this study may not be generalizable to other centers with different TTE request system practices, such as non-teaching hospitals or private hospitals.

## CONCLUSION

The prevalence of inappropriate indications among adult outpatients undergoing TTE during regular office hours at Siriraj Hospital was low. No significant association was observed between the appropriateness of TTE indications and either status of ordering physician or payment type.

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## REFERENCES

1. Douglas PS, Khandheria B, Stainback RF, Weissman NJ, Brindis RG, Patel MR, et al. ACCF/AHA/ACEP/ASNC/SCAI/SCCT/SCMR 2007 appropriateness criteria for transthoracic and transesophageal echocardiography. *J Am Coll Cardiol.* 2007;50:187-204.
2. Douglas PS, Garcia MJ, Haines DE, Lai WW, Manning WJ, Patel AR, et al. ACCF/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 appropriate use criteria for echocardiography: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance. *J Am Coll Cardiol.* 2011;57:1126-66.
3. Barbier P, Alimento M, Berna G. Clinical utility of guideline-based echocardiography: a prospective study of outpatient referral patterns at a tertiary care center. *J Am Soc Echocardiogr.* 2008;21:1010-5.
4. Ward RP, Mansour IN, Lemieux N, Gera N, Mehta R, Lang RM. Prospective evaluation of the clinical application of the American College of Cardiology Foundation/American Society of Echocardiography Appropriateness Criteria for transthoracic echocardiography. *JACC Cardiovasc Imaging.* 2008;1:663-71.
5. Kirkpatrick JN, Ky B, Rahmouni HW, Chirinos JA, Farmer SA, Fields AV, et al. Application of appropriateness criteria in outpatient transthoracic echocardiography. *J Am Soc Echocardiogr.* 2009;22:53-9.
6. Willens HJ, Gómez-Marín O, Heldman A, Chakko S, Postel C, Hasan T, et al. Adherence to appropriateness criteria for transthoracic echocardiography: comparisons between a regional department of Veterans Affairs health care system and academic practice and between physicians and mid-level providers. *J Am Soc Echocardiogr.* 2009;22:793-9.
7. Parikh PB, Asheld J, Kort S. Does the revised appropriate use criteria for echocardiography represent an improvement over the initial criteria? A comparison between the 2011 and the 2007 appropriateness use criteria for echocardiography. *J Am Soc Echocardiogr.* 2012;25:228-33.
8. Ballo P, Bandini F, Capecchi I, Chiodi L, Ferro G, Fortini A, et al. Application of 2011 American College of Cardiology Foundation/American Society of Echocardiography appropriateness use criteria in hospitalized patients referred for transthoracic echocardiography in a community setting. *J Am Soc Echocardiogr.* 2012;25:589-98.
9. Bailey SA, Mosteanu I, Tietjen PA, Petrini JR, Alexander J, Keller AM. The use of transthoracic echocardiography and adherence to appropriate use criteria at a regional hospital. *J Am Soc Echocardiogr.* 2012;25:1015-22.
10. Patil HR, Coggins TR, Kusnetzky LL, Main ML. Evaluation of appropriate use of transthoracic echocardiography in 1,820 consecutive patients using the 2011 revised appropriate use criteria for echocardiography. *Am J Cardiol.* 2012;109:1814-7.
11. Satitthummanid S, Songmuang SB, Suithichaiyakul T. Evaluation of the appropriateness request for transthoracic echocardiography at King Chulalongkorn Memorial Hospital. *Thai Heart J.* 2011;24:11-8.