

ORIGINAL ARTICLE

Referral Appropriateness for Transesophageal Echocardiography and its Diagnostic Impact in a Tertiary Care Hospital

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Abstract:

Introduction: This study aimed to evaluate the suitability of referrals for transesophageal echocardiography test in a tertiary care hospital, based on the appropriate use criteria (AUC) established by the American College of Cardiology Foundation and the American Society of Echocardiography, which were released in 2011, and their diagnostic consequences.

Method: A one-year cross-sectional observational study was carried out in a tertiary-level hospital. Adult TEE indications were independently evaluated by two cardiologists using the AUC. Based on the pertinent guidelines, each study was classified as appropriate, inappropriate, or uncertain, and their diagnostic implications for patient management were assessed. Diagnostic impact was defined by any change in diagnostic work-up or therapeutic decisions induced by TEE results.

Result: Of the 120 patients, the mean age of the study patients was 39.6±14.75 years. The study showed a significant correlation between age group and the appropriateness of TEE referrals ($p<0.001$). The younger age group had the highest percentage of suitable referrals (34.6%). The study determined that 65% of the requested TEE were appropriate, 25% were inappropriate and 10% were deemed questionable.

Conclusion: In an ideal scenario, a diagnostic cardiovascular imaging test like a TEE should impact clinical management, provided it is correctly ordered for the appropriate patient. Using AUC in TEE can directly influence diagnostic outcomes since appropriate studies are more likely to uncover significant new insights and lead to healthcare interventions.

Key words: Transesophageal echocardiography (TEE), Appropriate Use Criteria (AUC), Cardiovascular disease (CVD)

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Introduction:

Transesophageal echocardiogram (TEE), is a valuable cardiac imaging modality in the diagnosis and management of cardiovascular disease (CVD) in modern healthcare, due to its user-friendly nature and its capacity to provide clear visualizations of structures, not visible on a standard transthoracic echocardiogram (TTE).¹ Over the last few decades, the use of non-invasive cardiovascular (CVS)

imaging has increased faster than any other form of diagnostic tool.² As a result, The expenditure on cardiovascular imaging in general and particularly echocardiography, has increased significantly. In addition there are growing concerns about the inappropriate use of cardiac imaging.³ Transthoracic echocardiography (TTE) is a fundamental tool in the diagnosis and management of cardiovascular disease (CVD). In 1976,

Frazin et al⁴ first introduced the clinical use of TEE. Its widespread use ranging across a wide spectrum of clinical settings including critical care, others inpatient as well as outpatient. In addition to visualization of important structures not seen on transthoracic echocardiogram (TTE), a TEE can help assess aortic dissection, endocarditis, intracardiac thrombus, intracardiac shunt, and cardiac malignancies among other pathologies relatively at a lower cost compared to cardiac MRI and significantly reduced radiation exposure when compared to cardiac CT scan.⁵ In the last decade, transoesophageal echocardiography (TEE) has become essential in valvular and congenital operative surgery and percutaneous repair procedure.⁶ Transesophageal echocardiography (TEE) is recognized as a semi-invasive technique. Despite TEE's relative safety, physicians should be aware that it can have major, perhaps potentially fatal consequences, and the risks must be weighed against the diagnostic advantages of TEE.⁷ Upper GI complications associated with probe insertion include dental trauma, tonsillar bleeding, jaw subluxation, oesophageal trauma, or perforation, etc.⁸ Therefore, there are risks involved with the TEE method, and the test's ease of use and broad referral have frequently raised doubts about the test's appropriateness. The inappropriate use of TEE unnecessarily increases healthcare expenditures and can expose patients to procedure-related complications that could otherwise be avoided.

A comprehensive literature review indicated that only a limited number of studies have evaluated the performance of overseas medical centers in conducting TEE in accordance with established standards. It is not surprising that many CVS imaging procedures may be ordered for unclear reasons as a result of technology becoming more readily available.⁹ At our institution, a tertiary referral facility with academic faculty and residency and fellowship programs, we were intended to evaluate the appropriateness of referral for TEE. For the purposes of our analysis, we chose to focus specifically on AUC criteria for TEE.

Appropriateness of use criteria (AUC) for echocardiography (ECHO) were developed by the American Society of Echocardiography, the American College of Cardiology, and a number of other American professional organizations in 2007 and have been revised in 2011.¹⁰ These recommendations concern the suitability of transthoracic (TTE), transesophageal and stress echocardiography in a larger number of clinical scenarios. AUC were assigned to echocardiography to direct

physicians when ordering echocardiogram, to improve patient care and health outcomes, and encourage the appropriate use of TEE.¹¹

The purpose of our study was not to reduce the number of the procedure. Hospital records consistently demonstrated a steady increase in the demand of TEE. This will be further enhanced by increasing awareness of clear indications for transesophageal echocardiography, thereby enabling the laboratory to serve a larger portion of patients. More importantly, AUC offers a scenario-specific framework that can provide guidance to supplement the clinician's judgment, rather than being prescriptive.

Materials and methods

2.1 Study design

An observational cross-sectional study was carried out in the department of cardiology, Bangladesh Medical University from July 2023 to July 2024. Explanation of the purpose of the study and informed written consent were taken from the patients. Two cardiologists prospectively and independently assessed indications for adult TEE that were scheduled during routine referral of TEE at echo laboratory. A detailed medical history was taken and the participants' socio-demographic and other relevant data were recorded with appropriate questionnaires. 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

2.2 Study population

Inclusion and exclusion criteria:

Inclusion criteria

All patients above 18 years including hospitalized or outpatients who will be referred for TEE to the Echocardiography Laboratory of the Department of Cardiology, UCC, BSMMU, included in the study.

Exclusion criteria

1. Patients with difficulty swallowing or patients who have suffered from oesophageal varices, stricture, or malignancy.
2. Those patients who will decline participation or will be too sick to give verbal consent on
3. Cervical spine arthritis with reduced range of motion.
4. Severe thrombocytopenia
5. Prolonged partial thromboplastin time (>150 seconds)

Operational definitions :

Appropriate use criteria (AUC) of TEE as initial or supplemental test¹⁰

Appropriate

- Use of TEE when there is a high likelihood of a nondiagnostic TTE due to patient characteristics or inadequate visualization of relevant structures.
- Re-evaluation of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when a change in therapy is anticipated.
- Guidance during percutaneous noncoronary cardiac interventions including, but not limited to, closure device placement, radiofrequency ablation, and percutaneous valve procedures.
- Suspected acute aortic pathology including but not limited to dissection/transection.
- Evaluation of valvular structure and function to assess suitability for, and assist in planning of, an intervention.
- To diagnose infective endocarditis with a moderate or high pretest probability (e.g., staphylococcal bacteraemia, fungemia, prosthetic heart valve, or intracardiac device).
- Evaluation for cardiovascular source of embolus with no identified noncardiac source.
- Atrial fibrillation/flutter: evaluation to facilitate clinical decision making with regard to anticoagulation, cardioversion, and/or radiofrequency ablation.

Uncertain

- Evaluation for cardiovascular source of embolus with a previously identified noncardiac source.

Inappropriate

- Routine use of TEE when a diagnostic TTE is reasonably anticipated to resolve all diagnostic and management concerns.
- Surveillance of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when no change in therapy is anticipated.
- Routine assessment of pulmonary veins in an asymptomatic patient status post pulmonary vein isolation.
- To diagnose infective endocarditis with a low pretest probability (e.g., transient fever, known alternative

source of infection, or negative blood cultures/atypical pathogen for endocarditis).

- Evaluation for cardiovascular source of embolus with a previously identified noncardiac source.
- Atrial fibrillation/flutter: evaluation when a decision has been made to anticoagulate and not to perform cardioversion

Study procedures

Patients were asked to abstain from food consumption for at least four hours prior to their examination. A detailed medical history was recorded by fellows. Anesthesia was induced via the local administration of xylocaine into the oropharynx. Transoesophageal echocardiography done by cardiologists and trained fellows at our echocardiography laboratory (echo lab). Patient remained at the echo laboratory for approximately 20 minutes after the end of the TEE and was under medical surveillance until they had fully recovered.

Statistical analysis

Data entered onto Microsoft Excel. Data process and analyses were done by using SPSS (Statistical Package for Social Sciences) software version 23. The chi-square test and student "t" test was used to analyse the significance level of $p < 0.05$. Continuous scale data was presented as mean standard deviation and Categorical data will be presented as number percentage. The summarize data were present in the table and chart.

Ethics

The study was performed in accordance with the principles of the Declaration of Helsinki and was approved by the local ethics committee. Written informed consent was obtained from all participants.

Result:

Total 120 transesophageal echocardiograms were incorporated into the analysis. Of the 120 patients, the mean age of the study patients was 39.6 ± 14.75 years. The study included more females (69.2%) than males (30.8%). The participants' demographic and clinical characteristics are summarized in Table 1. The study showed a significant association between age group and the appropriateness of TEE referrals ($p < 0.001$). Most appropriate referrals were found in younger age group (34.6%) while 66.7% of uncertain referrals were in patients over 60 years, suggesting a tendency toward diagnostic uncertainty in older individuals. There was also a statistically significant association between sex and referral

appropriateness ($p=0.012$). Among appropriate referrals, 75.6% were female and 24.4% were male. In contrast, males accounted for a higher proportion of uncertain referrals (66.7%) compared to females (33.3%). This suggests that inappropriate or uncertain referrals were more frequent among male patients, while females were more often referred appropriately for TEE.

Table-I

Sociodemographic characteristics of the study patients (n=120)

Variables	Number of patients (%)
Age group (years)	
<20	11(9.2)
21-30	31(25.8)
31-40	25(20.8)
41-50	30(25.0)
51-60	11(9.2)
>60	12(10.0)
Mean $\pm$ SDRange (min-max)	39.6 $\pm$ 14.75(18-71) years
Sex	
Male	37(30.8)
Female	83(69.2)
Male: female ratio	1:2.2

Table I: The percentage of suitable TTE was notably greater in outpatient patients compared to those receiving care as hospitalized patients (72.5 % versus 27.5 %). In terms of referral specialty, cardiology accounted for 72.5% of all referrals. Among non-cardiology departments, internal medicine referred 17.5%, followed by neurology (6.7%), nephrology and hepatology (3.3 %).

Table-II

Distribution of the study subjects by referral source and referral department (n=120)

Variables	Number of patients	Percentage (%)
Referral source		
Indoor	33	27.5
Outdoor	87	72.5
Referral department		
Cardiology	87	72.5
Non-cardiology	33	27.5
Internal Medicine	21	17.5
Neurology	8	6.7
Nephrology	2	1.65
Hepatology	2	1.65

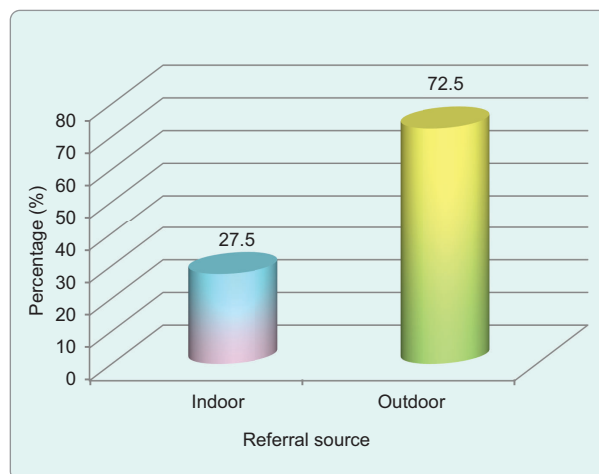
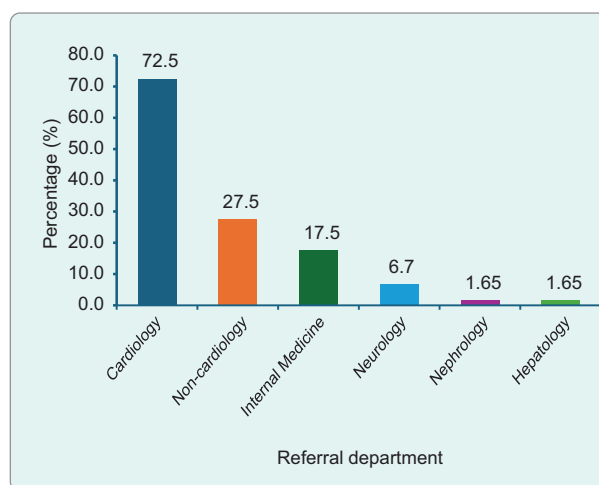
**Figure-1:****Figure-2**

Table-II shows that the majority of patients were referred from outdoor departments (72.5%), while 27.5% came from indoor settings. In terms of referral specialty, cardiology accounted for 72.5% of all referrals. Among non-cardiology departments, internal medicine referred 17.5%, followed by neurology (6.7%) , nephrology and hepatology (3.3 %).

The study showed that the most common indication for transesophageal echocardiography (TEE) was adult congenital heart disease (42.5%), followed by poor transthoracic echo window by TTE (22.5%) and evaluation of intracardiac masses or thrombus(15.8%). Other indications included pulmonary hypertension(9.2%), infective endocarditis(6.7%), and valvular assessment (3.3%).

Table-III
Association of appropriateness with TEE indications (n=120)

TEE indications	Appropriate (n=78) n. (%)	Inappropriate (n=30) n. (%)	Uncertain (n=12) n. (%)	p-value
Evaluation of valvular HD	4(5.1%)	0(0.0%)	0(0.0%)	<0.001*
Evaluation of intracardiac shunt	19(24.4%)	0(0.0%)	0(0.0%)	
Adult congenital HD	33(42.3%)	14(46.7%)	4(33.3%)	
Diagnosis of IE	4(5.1%)	0(0.0%)	4(33.3%)	
Evaluation of pulmonary hypertension	0(0.0%)	7(23.3%)	4(33.3%)	
Poor transthoracic echo window	18(23.1%)	9(30.0%)	0(0.0%)	
Total	78(100.0%)	30(100.0%)	12(100 %)	

p-value obtained by Chi-square test, $p < 0.05$ was considered as a level of *significant

Table-III shows a significant association between TEE indications and referral appropriateness ($p < 0.001$). Indications like evaluation of intracardiac structures (24.4%), adult congenital heart disease (42.3%), and poor transthoracic echo window (23.1%) were most commonly linked to appropriate referrals. Inappropriate referrals were most often associated with pulmonary hypertension (23.3%) and poor transthoracic windows (30.0%), while uncertain referrals were primarily related to diagnosis of infective endocarditis (33.3%) and pulmonary hypertension (33.3%), indicating variation in referral justification based on indication.

The most frequent clinical presentations among patients referred for TEE were palpitation (50.0%), dyspnea (42.5%), and chest pain (29.2%). Other notable presentations included syncope (19.2%), arrhythmia (9.2%), history of chronic rheumatic heart disease (6.7%), myocardial infarction (5.8%), and stroke or TIA (3.3%).

Most common clinical diagnosis among the study subjects was adult congenital heart diseases (30.8%), followed by suspected infective endocarditis (21.7%) and isolated pulmonary hypertension (13.3%). Among the less frequent referral conditions were suspected atrial septal defect (12.5%), valvular heart disease, systemic hypertension, embolic phenomena, and ventricular septal defect (VSD).

The most common findings on transthoracic echocardiography (TTE) were congenital heart disease (28.3%) with pulmonary hypertension (24.2%). Among congenital heart defects, ASD secundum (32.4%) was the most frequent subtype. Intracardiac thrombi were identified in 20.9% of patients (multiple in 14.2%, single in 6.7%). Additionally, about 23 % patients were diagnosed with infective endocarditis. Vegetations were found on the mitral valve (9.2%), both mitral and aortic valves (5.8%),

and the tricuspid valve (8.3%). Cardiac tumors were observed in 7.5%, including myxoma (5.0%), angiosarcoma (2.5%), and papilloelastoma (2.5%). Other findings included aortic valve disease (10.0%), aortic dissection (5.8%), mitral and pulmonary valve lesions due to rheumatic heart disease, and cor-pulmonale, each comprising a small proportion of cases.

Table-IV
Distribution of the study subjects by appropriateness (n=120)

Appropriateness	Number of patients	Percentage (%)
Appropriate	78	65.0
Inappropriate	30	25.0
Uncertain	12	10.0
Total	120	100.0

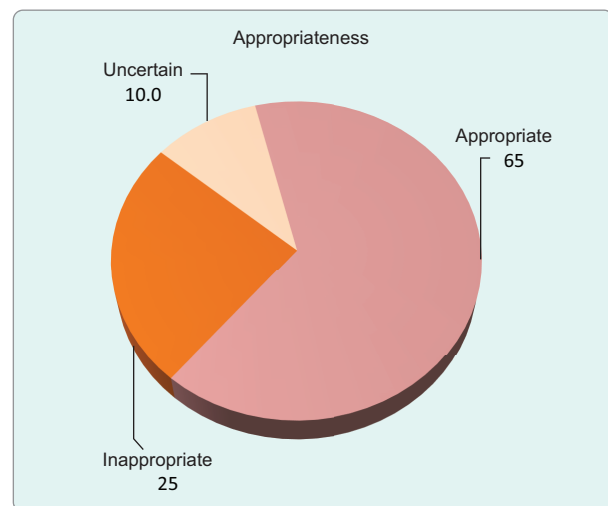


Figure-3

Table-4 showed that among the study subjects, 65.0% of TEE referrals were appropriate, while 25.0% were inappropriate and 10.0% were classified as uncertain. This indicates that the majority of referrals adhered to clinical guidelines, though a notable portion lacked clear justification. There was a significant association between TEE indications and referral appropriateness ($p < 0.001$).

Indications like evaluation of intracardiac structures (24.4%), adult congenital heart disease (42.3%), and poor transthoracic echo window (23.1%) were most commonly linked to appropriate referrals. Requests of inappropriate referrals were mainly related to poor transthoracic windows (30.0%) and pulmonary hypertension (23.3%) and while uncertain referrals were primarily related to diagnosis of infective endocarditis (33.3%) and pulmonary hypertension (33.3%), indicating variation in referral justification based on indication.

Discussion :

The primary goal of the study was to determine how often a tertiary care hospital in Bangladesh uses Appropriate Use Criteria (AUC) for TEE during regular procedures. This was the initial inquiry, as far as we could tell, at a university hospital in Bangladesh. We evaluated the indications for TTE among adult patients undergoing TTE during regular office hours, and determined their appropriateness according to the 2011 Appropriate Use Criteria for TEE.

In this study, we found that there was statistically significant correlation between sex and the appropriateness of recommendations ($p = 0.012$). Females were significantly more inclined than males to undergo TEE test when there were suitable indications (75.6% versus 24.4%, $p = 0.012$). Conversely, males represented a greater percentage of uncertain referrals (66.7%) in comparison to females (33.3%). Age differences between the appropriate, inappropriate, and ambiguous TTE indication groups were statistically significant ($p = 0.001$). The younger age group had the highest percentage of acceptable referrals (34.6%), whereas patients over 60 had the greater percentage of uncertain referrals (66.7%), indicating a propensity for diagnostic doubt among the elderly.

This result was consistent with other research that found younger individuals had a higher TEE yield.¹²

Among the study subjects, 65 % of TEE referrals were appropriate, while 25% were inappropriate and 10 % were classified as uncertain which was inconsistent with previous studies.^{13 14} The proportion of appropriate TTE

was significantly lower compared to all other studies. According to Tripti Gupta et al.¹⁵ TEE was appropriate in 85% of cases, inappropriate in 9%, and unsure in 6% cases. Mohammad Alquarqaz and colleagues¹⁶ reported in their study that 77% of referrals were suitable, 9% were inappropriate, and 14% were uncertain, indicating that adherence to AUC 2011 was important in terms of TEE referrals. Surprisingly, at our center, the majority of patients were referred from outpatient source (72.5%), while 27.5% came from indoor settings during the study period.

The significantly greater percentages of appropriate indications in some earlier studies probably resulted from the inclusion of more individuals who were referred from hospitalized patients, which was not the case in our investigation.

In this cross-sectional observational study, the most common inappropriate indications for TTE was poor transthoracic echo window (30 %), while uncertain referrals were primarily related to diagnosis of suspected infective endocarditis (33.3%) and adult congenital heart disease (33.3%). Since no request was received, we did not conduct any TEE for perioperative evaluation in this study. However, our analysis revealed a high magnitude of inappropriate requests (25%) which suggested that the practice at our center regarding use of the TEE needed modest improvement. Importantly, the role and guidance of AUC should not be underestimated, as such strategies need to be explored in order to improve patients TTE service.

In terms of referral specialty, we found significant discordance between cardiologists and non-cardiologists ordering appropriate TEEs. The vast majority of referrals came from cardiology department, accounted for 72.5% of all referrals, where as only 22% of TEEs ordered by non-cardiologists. TEE referrals were particularly notable from other disciplines when multiple specialties were involved in the patient's care, such as when assessing infectious endocarditis and CVA. Among non-cardiology departments, internal medicine referred 17.5%, followed by neurology (6.7%), nephrology and hepatology (3.3%). It was worthwhile to have cardiologists as gate-keepers for TEE referral in our centre.

In this study, we sought to address the crucial question of whether or not using AUC directly affected patient care from a clinical standpoint. According to our findings, proper recommendations were more likely to be associated with new and noteworthy echocardiogram results. These

provided some evidence of the advantages of incorporating AUC

into standard clinical practice. Ordering a study that was deemed appropriate based on the AUC has a higher chance of supporting the patient's clinical diagnosis, according to the result of transesophageal echo study.¹⁷ More importantly, the AUC could refine cardiac imaging by redirecting its use towards scenarios where it may facilitate cost effective optimal care. Implementing AUC in echocardiography can have a direct clinical impact as the diagnostic accuracy of TEE avoids further unnecessary investigations, enables rapid identification of complications of underlying disease, minimizes the use of empirical treatment, and significantly reduces the average hospitalization. These advantages also apply to outpatients, who mainly require quick and safe diagnosis without the excessive burden of nonspecific tests of uncertain diagnostic results. Because of its intrinsic flexibility, AUC offers a scenario-specific framework that can help physicians make better decisions more quickly, nonetheless, the ordering practitioners still has the say in the decision. As Marwick and Fonseca noted,¹⁸ the use of appropriate criteria in echocardiography should be combined with the physician's knowledge and experience, the available techniques and the willingness to provide high quality medical care to the patient in need.

Clinical implications:

TEE provides diagnostic and prognostic information and is increasingly important in guiding a variety of surgical and percutaneous cardiac procedures. The AUC provides crucial insights into the current patterns of care, highlight areas of possible overuse, and indicate that quality improvement is possible through targeted intervention as inappropriate use was clustered into only a few number of indications.

Conclusion :

The AUC for echocardiography was developed to provide systematic approach for the use of echocardiography in order to ensure the delivery of high-quality care. In an ideal scenario, a diagnostic cardiovascular imaging test like a TEE may impact clinical management, provided it is correctly ordered for the appropriate patient. Using AUC in TEE can directly influence diagnostic outcomes since appropriate studies are more likely to uncover significant new insights and lead to healthcare interventions.

Limitations:

The single-center study design involving just 120 TEEs had some limitations. The research, however, was

observational in nature to gain insight into our institutional use of TEE. The sample size was adequate for the main goal of assessing adherence to suitable TEEs in a multidisciplinary setting where any physician may prescribe the procedure. However, we had performed a few number of TEE in acute settings. We did not conduct any TEE for perioperative evaluation in this study as no request was received. This may result in some underestimation of the overall appropriateness of TEE, as in this group the rate of appropriateness could be higher than our study population.

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