# Comparison of Echocardiography Request Appropriateness between Public and Private Hospitals

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## Abstract

**Background: Aiming at improving the use of echocardiography tests, the Appropriateness Criteria (AC) were created by the American Society of Echocardiography (ASE)/American College of Cardiology (ACC).**

**Objective: To compare the appropriateness profile of transthoracic echocardiography (TTE) requests in accordance with the AC, between a public University Hospital (UH) and a Private Hospital (PH), and verify which characteristics are associated with a better TTE request profile**

**Methods: We prospectively assessed 779 consecutive TTE requests in a PH (49.8%) and a UH (50.2%), with 55.6% of requests for women and 44.4% for men, aged 59.1 ± 15.7 years. The indications were classified as appropriate, inappropriate or non-classified, and adequacy to AC was correlated with age, patient gender, and the time since graduation of the requesting physician. The statistical analysis used Kappa coefficient and chi-square test.**

**Results: There was no significant difference regarding the adequacy profile of appropriate TTE requests in the two institutions (71% vs. 75%, p = 0.3). At PH, the factors associated with higher rates of appropriate tests were: female gender (p = 0.001) and age younger than 60 years (p <0.001). In the UH, physicians who had graduated between 5 and 10 years before had a higher rate of inappropriate requests (p = 0.02). The variables that were independent predictors of appropriate tests in the PH were: female sex (p = 0.001) and age <60 years (p = 0.001).**

**Conclusion: In this evaluation, the PH and the UH profiles showed similar request appropriateness profiles. Female gender, time since graduation of the requesting physician and the patient's age influenced the appropriateness of requests. (Arq Bras Cardiol 2011;97(4):281-288)**

**Keywords: Medical examination/policies; echocardiography; quality; hospitals, public; hospitals, private.**

## Introduction

The development of imaging techniques has revolutionized the diagnosis and management of cardiovascular disease worldwide. As a result, the request for imaging tests in cardiology grows exponentially, and this is one of the factors that lead to an overall increase in health costs[1]. One of the biggest challenges of cardiovascular imaging services is to conciliate the performance of a large number of tests, while maintaining the quality standards[2].

Cardiovascular imaging societies, governmental agencies, medical diagnostic equipment industries and specialists in quality measures have created tools to promote the "sustainable growth" of cardiovascular imaging. In this context, in 2007, the American College of Cardiology (ACC) and the American Society of Echocardiography (ASE) published the Appropriateness Criteria (AC) for requesting transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE)[3]. In this document, there are several clinical scenarios that are classified as appropriate, inappropriate or uncertain, according to a scoring system. Therefore a score 1 to 3 indicates that the request is inappropriate; 4-6 is uncertain, and 7 to 9, the indication is appropriate.

An appropriate imaging study is one in which the incremental information combined with the clinical judgment exceeds the possible negative consequences for a wide margin of specific indications in which the procedure is considered acceptable and reasonable[3].

In Brazil, in spite of the growing number of test requests and the urgent need to optimize health resources, a document has yet to be created by the societies regarding the standardization of the AC to perform TTE and TEE.

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Moreover, there is a lack of studies evaluating the appropriateness of requests to perform TTE, even when based on guidelines published by the Brazilian Society of Cardiology (SBC), which deal with the indications and uses of echocardiography in clinical practice[4].

In addition to the need to construct a pioneer profile of TTE request in our country, considering the discrepant reality between the public and private healthcare systems in our country, when this study was designed, it seemed essential to assess the difference in the degree of adequacy of test requests in both scenarios.

## Objectives

This study aims primarily at comparing the profile of adequacy of outpatient TTE requests, according to the score of appropriateness criteria (AC)[3], carried out in a private hospital, with a public university hospital. Its secondary purpose is to verify which characteristics of hospitals and requesting physicians were associated with a better profile of TTE request.

## Methods

This is an observational and prospective study. The study included consecutive patients older than 18 years who presented to the echocardiography services at Pro-Cardíaco Hospital and the Antônio Pedro University Hospital, to undergo outpatient transthoracic echocardiography and brought the medical request between December 2009 and May 2010. Inpatients and patients whose test request forms issued by the assistant physician were not available or readable were excluded.

The Research Ethics Committees of UFF (130/2010) and the Pro-Cardíaco Hospital (330/2009) approved the study protocol.

### Protocol

The investigator had access to the TTE request made by the requesting physician, collected the patient's clinical history and performed the TTE. The investigator also filled out a form with blind data about the patient and the examination classification according to the AC.

The quality of the examination indication by the requesting physician was evaluated through an interview with the patient, which elucidated the reason for the examination, whether there were clinical changes and his or her pathological history. Thus, it is important to note that for a given patient, there will be two indications for TTE in the data acquisition form (one by the requesting physician and one by the researcher). This protocol was developed as quality control for medical requests. The TTE were performed by the investigator in two aforementioned Echocardiography Services, as established by the ASE. The equipment used were GE Vivid 3™ and GE Vivid 7™ in the public and private hospitals, respectively, both capable of carrying out one- and two dimensional, pulsed and continuous Doppler and color Doppler examinations.

The investigator grouped the medical request for TTE, the completed form after the patient anamnesis and the echocardiography examination report for further classification of the examination indication according to the AC.

In addition to the analysis carried out by the main investigator, a second echocardiographist performed a blind analysis of the data and classified the examinations according to the AC, thus performing the interobserver correlation.

Significant agreement regarding the classification of appropriateness according to the indication of the requesting physician was demonstrated (kappa = 0.788, SE = 0.072, $p < 0.001$) between the two observers.

### Statistical Analysis

The following tests were used in the statistical analysis: Kappa Coefficient, to measure the agreement between the measures of appropriateness classification and chi-square ($\chi^2$) or Fisher's exact test, to compare the classification of appropriateness with the sample characteristics. The logistic regression analysis was performed to identify the independent sample characteristics that predicted (or explained) the classification of appropriateness of the requesting physician. The criterion for determining the level of significance was 5%. The analysis was performed using SAS software, version 6.11 (SAS Institute Inc., Cary, NC).

## Results

### Overall Results

We prospectively evaluated 779 requests for TTE, of which 391 (50.2%) were requested at the public university hospital, and 388 (49.8%) at the private hospital, from December 2009 to May 2010.

It is noteworthy the fact that 15 requests, all from the private hospital (15/388) were excluded from the study because they had no indication for the examination made by the requesting physician, with the latter being an exclusion criterion.

### Agreement of examination indications between the requesting physicians and the investigator

After the statistical analysis of all indications (779), very good agreement was obtained (kappa: 0.874, $p < 0.001$) between the classification of AC, taking into account the medical indication described in the medical request and the classification based on the indication obtained after patient anamnesis in the examining room. Thus, as there was excellent agreement between the measures of the adequacy profile of the examination request between the investigator and the requesting physician, from then on, we will always use the results obtained from the data that came from the requesting physician's indication.

### Characteristics of the studied population

Table 1 shows the demographic characteristics of the sample.

Owe observed in the overall sample a higher proportion of female patients, with 433 (55.6%) *versus* 346 (44.4%)

male patients. This predominance of female individuals persisted when the populations of the two hospitals were evaluated individually.

### Characteristics of the requesting physicians

When evaluating the total sample, we observed that most TTE requests had been made by physicians that had graduated 20 or more years before, 461 (59.2%). This proportion was only maintained for requests from the private hospital, where 311 (80.2%) requests came from doctors that had graduated 20 or more years before. When the analysis was focused on the requests from the public institution, we observed that the total sum of test requests made by physicians that had been graduated for less than 20 years was higher and statistically significant ($p < 0.001$) than the requests made by physicians that had been graduated for 20 years or more (Table 1).

### Characteristics of the medical examination requests

When evaluating the two institutions separately, we observe that the profile for TTE indications is quite different. Chart 1 shows that, in the public hospital, the indications of SAH – systemic arterial hypertension – (32% versus 25%) and especially HF (17.2% versus 3.7%) predominate in relation to the private hospital. However, in the private institution, the TTE indications to evaluate suspected symptoms of cardiac etiology in asymptomatic patients (18.4 *versus* 16.2%), ischemia or AMI (10% *versus* 6.2%), preoperative (9.2 *vs*. 6.3%), arrhythmias (4.8% *versus* 1.3%), mitral valve prolapse (3.9% *versus* 1.5%) are prevalent in relation to the university institution.

### Evaluation between the adequacy of echocardiogram requests according to the appropriateness criteria and patient origin

In the public university institution, excluding 31 (7.9%) requests for examination that were considered "non-classified", 269 (74.7%) were classified as appropriate and 91 (25.2%) as inappropriate. In the private hospital, after excluding 53 (13.6%) "non-classified" requests, we observed that 239 (71.3%) were appropriate and 96 (28.6%) were inappropriate. There was no statistically significant difference between the degree of adequacy of TTE indication between the two studied institutions ($p = 0.359$).

### Evaluation of the appropriateness degree of the examination request according to the demographic characteristics

### Comparison according to patient gender

The examinations requested for female patients in the private institution had a significantly ($p = 0.001$) more appropriate classification than those requested for men (Table 2). When evaluating the requests from the public institution, we observed no significant difference ($p = 0.347$) between the adequacy profile of TTE request and patient gender.

### Comparison according to patient age range

There is a significant association between the classification of the examination request by the appropriateness criteria and patient age at the private institution ($p = 0.000$). In the public institution, there is no significant association ($p = 0.466$) (Table 2).

### Comparison according to time since graduation of the requesting physician

As shown in Table 2, there was no significant association ($p = 0.571$) between the time since graduation of the requesting physician and the classification of examinations according to the AC in the private institution. However, when evaluating the information from the public institution, we observed a statistically significant difference ($p = 0.039$) between the appropriateness profile of the TTE request and the time since graduation of the requesting physician.

When analyzing the categories "time since graduation" with

**Table 1 – Sample description in the total sample and by origin. P value was obtained through the Chi-square test**

| Variables | Total | | Public | | Private | | p value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| **Sex** | | | | | | | 0.33 |
| Female | 433 | 55.6 | 224 | 57.3 | 209 | 53.9 | |
| Male | 346 | 44.4 | 167 | 42.7 | 179 | 46.1 | |
| **Age range** | | | | | | | 0.64 |
| < 60anos | 389 | 49.9 | 192 | 49.1 | 197 | 50.8 | |
| ≥ 60anos | 390 | 50.1 | 199 | 50.9 | 191 | 49.2 | |
| **Time since graduation** | | | | | | | 0.00 |
| Up to 5 years | 128 | 16.4 | 122 | 31.2 | 6 | 1.5 | |
| 5 to 10 years | 72 | 9.2 | 63 | 16.1 | 9 | 2.3 | |
| 10 to 20 years | 118 | 15.1 | 56 | 14.3 | 62 | 16 | |
| >20 years | 461 | 59.2 | 150 | 38.4 | 311 | 80.2 | |

the Chi-square test, we observed that the group of physicians from the public hospital who had graduated between 5 and 10 years had the worst appropriateness profile for TTE request ($p = 0.005$ when analyzing those graduated for less than five years with those graduated between 50 and 10 years and $p = 0.02$ when the analysis was made between those graduated between 50 and 10 years and those graduated more than 20 years before).

### Distribution of the appropriateness of TTE request according to the type of examination indication

When comparing the two institutions, we observe that the appropriateness profile of indication classes was varied. In the public hospital, the term "ischemia or AMI" for TTE performance was appropriate in 83.3% of cases, compared to only 42.1% of the requests with the same indication in the

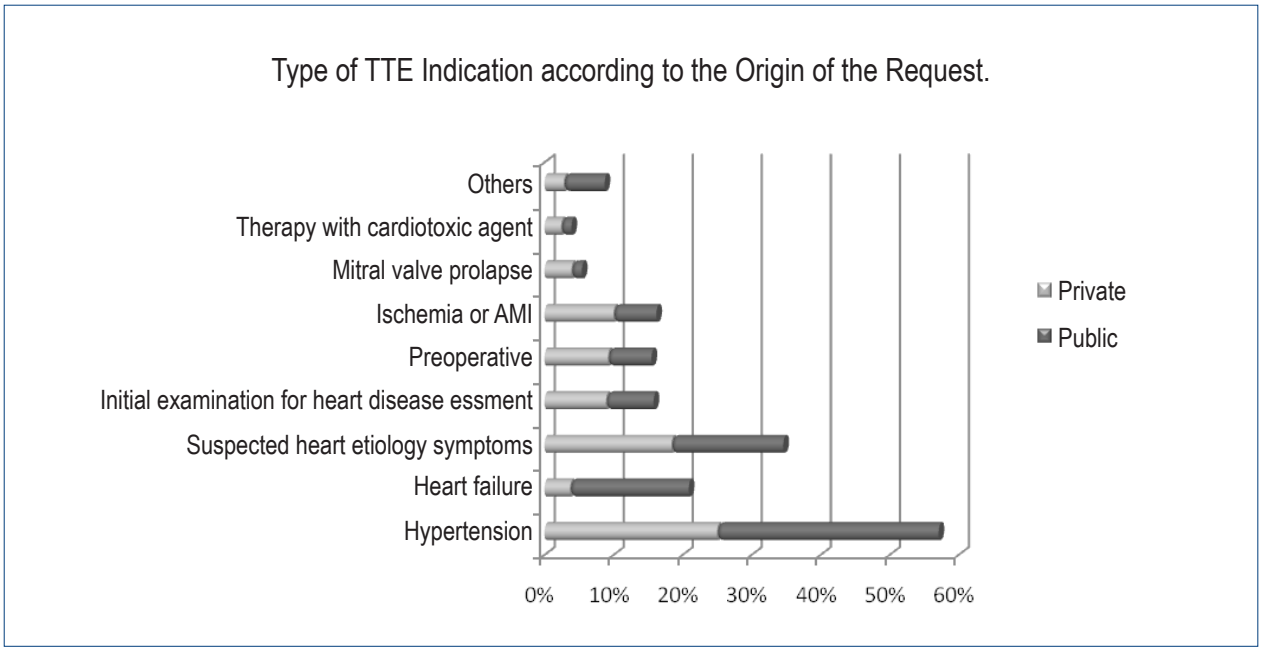


Chart 1 – Description of the type of indication for the examination according to the origin of the request; AMI: acute myocardial infarction.

**Table 2 – Classification of TTE request according to the appropriateness criteria regarding patient sex and age and regarding the time since graduation of the requesting physician in public and private institutions. P value was obtained by Chi-square test; "non-classified" examinations were excluded**

| Variables | Public | | | Private | | |
|---|---|---|---|---|---|---|
| | Appropriate | Inappropriate | p Value | Appropriate | Inappropriate | p Value |
| | n | n | | n | n | |
| Female | 160 | 49 | 0.347 | 143 | 39 | 0.001 |
| Male | 109 | 42 | | 96 | 57 | |
| < 60 years old | 130 | 48 | 0.466 | 138 | 35 | <0.001 |
| ≥ 60 years old | 139 | 43 | | 101 | 61 | |
| Graduated less than 5 years before | 89 | 22 | 0.039 * | 3 | 3 | 0.571 |
| Graduated 5 to 10 years | 35 | 23 | | 5 | 2 | |
| Graduated 10 to 20 years | 37 | 13 | | 37 | 18 | |
| Graduated more than 20 years before | 108 | 33 | | 194 | 73 | |

** significance observed when comparing the group graduated between 5 and 10 years with the others.*

private hospital. A similar profile occurred with "SAH". This indication showed 71.2% of appropriate requests in the public hospital *versus* 58.6% in the private one (Table 3). In the private hospital, the classes of indications that had a higher proportion of "appropriate" indications, when compared to the university hospital, were: arrhythmia (88.9% *versus* 75%), mitral valve prolapse (93.3% *versus* 83.3%) and TTE requests with indication for heart failure assessment (50% *versus* 46.3%). However, one cannot fail to stress that the population that received a request for TTE with a CHF indication in the public hospital was much higher than the one in the private hospital (67 *versus* 14 patients) (Table 3).

The class of indication that had the highest proportion of "inappropriate" classification in the two institutions was CHF (53.7% in public hospitals and 50% in the private hospital).

When evaluating some TTE requests, we find indications that, in spite of being part of the clinical scenarios addressed in the document that contains the AC used in this work, cannot be classified, as they do not fit the published indications (Table 4).

The indication with the highest proportion of "non-classified" was preoperative in both institutions, an indication class that is not addressed in the AC.

### Multivariate analysis

The multivariate analysis was performed to analyze the independent weight of each variable to determine the "appropriate" indication of the TTE request according to the AC.

This evaluation was performed only with the variables that showed a statistically significant difference in the univariate analysis. Therefore, this analysis assessed two variables in the private hospital (sex and age of the patient) and none in the public hospital, as the only univariate that showed statistically significant difference in this institution was the time since graduation of the requesting physician.

**Table 3 – Distribution of the degree of examination request appropriateness according to the appropriateness criteria following the type of indication of the examination in the two assessed institutions (n = 695; "non-classified" indications were excluded)**

| Indications | Public | | | | Private | | | |
|---|---|---|---|---|---|---|---|---|
| | Appropriate | | Inappropriate | | Appropriate | | Inappropriate | |
| | n | % | n | % | n | % | n | % |
| Hypertension * | 89 | (71.2%) | 36 | (28.8%) | 58 | (58.6%) | 41 | (41.4%) |
| Suspected heart etiology symptoms | 63 | (100%) | 0 | (0%) | 69 | (98.6%) | 1 | (1.4%) |
| Initial examination for heart disease assessment in asymptomatic individuals | 25 | (100%) | 0 | (0%) | 20 | (100%) | 0 | (0%) |
| Heart failure | 31 | (46.3%) | 36 | (53.7%) | 7 | (50%) | 7 | (50%) |
| Ischemia or AMI* | 20 | (83.3%) | 4 | (16.7%) | 16 | (16.7%) | 22 | (57.9%) |
| Left ventricular function assessment | 2 | (50%) | 2 | (50%) | 9 | (47.4%) | 10 | (52.6%) |
| Mitral valve prolapse | 5 | (83.3%) | 1 | (16.7%) | 14 | (93.3%) | 1 | (6.7%) |
| Murmur | 6 | (100%) | 0 | (0%) | 4 | (100%) | 0 | (0%) |
| Arrhythmias | 3 | (75%) | 1 | (25%) | 16 | (88.9%) | 2 | (11.1%) |
| Native valvular stenosis | 1 | (25%) | 3 | (75%) | 3 | (60%) | 2 | (40%) |
| Native valvular regurgitation | 3 | (50%) | 3 | (50%) | 1 | (25%) | 3 | (75%) |
| Valvular Prosthesis | 1 | (25%) | 3 | (75%) | 4 | (66.7%) | 2 | (33.3%) |
| Thrombus assessment | 6 | (100%) | 0 | (0%) | 0 | (0%) | 0 | (0%) |
| Pulmonary hypertension | 2 | (100%) | 0 | (0%) | 0 | (0%) | 0 | (0%) |
| Congenital heart disease | 0 | (0%) | 0 | (0%) | 0 | (0%) | 1 | (100%) |
| Hypertrophic cardiomyopathy | 1 | (50%) | 1 | (50%) | 0 | (0%) | 1 | (100%) |
| Other cardiomyopathy | 5 | (83.3%) | 1 | (16.7%) | 2 | (66.7%) | 1 | (33.3%) |
| Therapy with cardiotoxic agent | 6 | (100%) | 0 | (0%) | 9 | (100%) | 0 | (0%) |
| Pacemaker assessment | 0 | (0%) | 0 | (0%) | 3 | (75%) | 0 | (0%) |
| Pulmonary embolism | 0 | (0%) | 0 | (0%) | 0 | (0%) | 2 | (100%) |
| Pericardial disease assessment | 0 | (0%) | 0 | (0%) | 3 | (100%) | 0 | (0%) |
| Aortic disease assessment | 0 | (0%) | 0 | (0%) | 1 | (100%) | 0 | (0%) |
| Total | 269 | (74.7%) | 91 | (25.3%) | 239 | (71.3%) | 96 | (28.7%) |

* $p < 0.05$; AMI: acute myocardial infarction.

The logistic regression showed that female sex (p = 0.001) and age < 60 years (p = 0.001) were significant to predict the "appropriate" classification of the examination request in the assessed private hospital.

## Discussion

Similarly to the literature, our sample showed, in general, more appropriate than inappropriate requests for outpatient TTE, with no statistically significant differences between the two evaluated institutions.

However, in our study, TTE requests are inappropriate in a significant number of cases (25% in the public institutions and 29% in the private hospital). Such high rates of inappropriate TTE requests have only been reported so far in the study by Rao et al[5], who observed 26% of inappropriate requests. Other evaluations in literature[6-9] point to a much smaller percentage of TTE requests classified as inappropriate. However, unlike this study, most of the information already published on this topic included patients admitted at the assessment, which tends to inflate the appropriate use of the procedure, since, being hospitalized, most of these patients has undergone recent changes in the clinical picture, an observation that makes the request appropriate according to the AC.

In relation to the "non-classified" TTE indications, literature indicates very variable percentages (values in studies ranging from 2% to 36%)[1,8-13]. Our sample showed 10.7% of "non-classified" indications in the total sample, and in the private institution this number was 13.6%, *versus* 7.9% in the public hospital.

The studies by Ward et al[8] and Willens et al[9] also compared the degree of adequacy of examination request between an academic and a community institution, and similar to this study, found no statistically significant difference between the TTE request profiles of these two institutions.

In an attempt to correlate the profile of appropriateness of TTE request with the characteristics of the requesting physicians, we observed that, in the PH, there was no significant difference between the time since graduation of the requesting physician and the appropriateness of the request according to the AC. However, when evaluating the requesting physicians from the public university institution, we observed that those who had graduated between 5 to 10 years were responsible for the worst appropriateness profile of the examination request (a statistically significant value). This group probably belongs to physicians with newly completed residencies or post-graduation programs, who already work at the university hospital without supervision, but are still relatively inexperienced. In literature[1,8,13,14] there is no report of difference between the appropriateness of TTE request and level of training of the requesting physician.

Our study also observed that, in the private hospital, the female patients had more appropriate requests than the male patients. Literature data do not show this association[1,8,13,14].

Another important result obtained in our sample was that younger patients from the private institution receiving more appropriate requests for TTE according to the AC. In the literature, data on patient age and degree of appropriateness of the request for TTE are quite variable[6,8,11,12]. In the public hospital evaluated in our sample, there was no significant difference between patient gender and age and the profile of appropriateness of TTE request according to the AC. A discussion on the association of patient gender and age and appropriate requests for TTE, also based on the observations of Maksoud[14] raised the following hypothesis: when treating an elderly male patient, due to the greater chance of his presenting cardiovascular disease, doctors would more frequently and less judiciously request an echocardiography, due to the higher pre-test probability. In addition, the age and gender bias related to the research and medical intervention, observed in some studies may also have been present in our population[15]. This concept is related to the discriminatory practice concerning the elderly, for instance, with regard to the credibility of their complaints and access to research practices and appropriate medical intervention[16].

Regarding the indication for the examination, similar to what was observed in the literature, the most often requested examinations in the overall sample were those related to symptoms of suspected cardiac etiology, hypertension and heart failure[5-7].

When evaluating the institutions separately, we observe that, while in the public hospital about 65% of indications were concentrated in the "SAH", "heart failure" and "symptoms of suspected cardiac etiology," categories, the TTE requests from the private hospital had better distributed information among the categories of our field.

**Table 4 – "Non-classified" indications distributed by the institutions where they were requested**

| "Non-classified" Indications | Public | | Private | |
|---|---|---|---|---|
| | n | % | n | % |
| Preoperative | 25 | 100 | 36 | 100 |
| Hypotension or hemodynamic instability | 3 | 100 | 0 | 0 |
| Initial examination for heart disease assessment | 2 | 7.4 | 14 | 41.2 |
| Arrhythmias | 1 | 20 | 1 | 5.3 |
| Infectious Endocarditis | 0 | 0 | 1 | 100 |
| Pacemaker evaluation | 0 | 0 | 1 | 25 |

The indications "ischemia or myocardial infarction" and "systemic arterial hypertension" showed statistically significant difference in relation to the appropriateness profile between the public and private hospitals. A striking demonstration of the difference between the profiles of these requests according to their origin can be illustrated by the assessment of requests indicating "ischemia or AMI." While in the public hospital, 10 TTE requests with this indication were related to asymptomatic patients and 14 to symptomatic, in the private institution, 32 requests were made for patients with known disease but no clinical symptoms, and there were only six indications for symptomatic patients ($p = 0.001$). This fact highlights a possible 'clinical anxiety' of the requests from the private hospital, in its management of patients known to be ill, through requests for serial examinations.

Although there were no significant differences between the institutions, but according to the available literature on the subject, the most inappropriate type of request, both in the public and private hospitals, was the heart failure evaluation[5,7]. That indication could be reassessed in future documents of appropriateness of examination requests. With new drugs and devices for heart failure (implantable cardioverter defibrillator, cardiac resynchronization devices, for instance), there is greater need for subsequent re-evaluations at regular intervals of left ventricular ejection fraction and ventricular synchrony parameters, even though the patient has shown no clinical changes.

Also according to the profile of studies that have been published[6-8], the indication most often described as "non-classified" was the preoperative. This request is quite common in our country, compelled both by actual clinical issues, but also as a defensive legal action, and it was not addressed in the AC. We suggest the inclusion of this indication in future documents on the subject, so that the type of surgery and patient profile are crucial for determining the degree of appropriateness of this request.

### Recommendations

It is necessary to acknowledge that we are going through a time of transition to determine the true clinical appropriateness of imaging examinations. Caution should be emphasized that the AC are not to be considered a substitute for clinical judgment and practical experience.

Ideally, the AC should be validated in clinical practice in order to demonstrate whether studies classified as appropriate determined the outcome or change in patient management, while the inappropriate ones did not.

## Conclusions

Our study showed no statistically significant difference between the profile of outpatient TTE request according to the AC between the public university and private institutions.

The only variable that was more appropriately correlated, in the public institution, with a request for TTE in this study according to the AC, was time since graduation of the requesting physician, and those who had graduated between 5 to 10 years before had the worst test request profile.

In the private hospital, the study variables that correlated with an appropriate outpatient request for TTE were female patients younger than 60 years of age. It is important to emphasize that the data from this study were obtained exclusively from outpatients, so it is not possible to extrapolate these findings to hospitalized patients, who have more complex disease, with a greater impact on the appropriateness of test requests.

**Potential Conflict of Interest**

No potential conflict of interest relevant to this article was reported.

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**Study Association**

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