Understanding by General Providers of the Echocardiogram Report

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Echocardiograms are the second most frequently utilized cardiac test after electrocardiograms and are most commonly ordered by noncardiology providers. Echocardiogram reports are designed to communicate a comprehensive interpretation of cardiac function; however, it is not known how well these reports are understood by ordering providers. In order to identify gaps in understanding and target potential areas for improvement, we developed a questionnaire testing various topics reported on a standard transthoracic echocardiogram report. This questionnaire was administered to general medicine and cardiology trainees and attending physicians at 2 large academic institutions. Questionnaire response rate was 81%. There were several topics that were not well understood by general providers; these included viability of an akinetic region, pulmonary artery systolic pressure, left ventricular filling pressure, recognition of abnormal structures, and method of identifying of intracardiac thrombus. In conclusion, strategies such as improved communication techniques and adjustment of reporting format should be implemented to increase the clinical value of the echocardiogram. **(Am J Cardiol 2019;124:296−302)**

The use of transthoracic echocardiography has increased markedly over the past 2 decades and is now the second most commonly ordered cardiac test after electrocardiograms.[1] The American Society of Echocardiography provides numerous guidelines on methods for image acquisition, measurement, and interpretation of echocardiograms yet, limited instruction exists for reporting results.[2−4] Currently, it is not known if there are concepts and terminologies in a standard report that are poorly understood by ordering providers and whether this may impact clinical decision making and patient care. Among Medicare beneficiaries receiving transthoracic echocardiograms (TTEs) in 2004, only 29% were ordered by cardiologists while 71% were requested by noncardiology providers. Most (56%) were ordered by internists and general practitioners.[5] Thus, understanding how general providers interpret a report is an important step to enhance techniques for reporting. To identify potential areas for improvement, we developed and administered a questionnaire to assess how ordering providers interpret information presented on a standard TTE report.

Methods

The questionnaire was created by a group of 8 cardiologists. A list of misunderstood TTE report elements was generated by consensus of a subset of investigators based on interactions with general providers and clinical experience. Questions were developed to assess for knowledge gaps in these topics. The survey also collected respondent demographic information including field of practice, level of training/years in practice, average number of TTEs ordered, and self-reported comfort level with understanding TTE reports. We pilot tested preliminary draft questions for content with a focus group of 12 general medicine and cardiology trainees, physicians, and advanced practice providers (physician assistants and nurse practitioners) to ensure consistency across provider specialties and training levels with respect to understanding the intent of the question. The questionnaire was subsequently modified through 3 rounds of revisions based on this pretesting before development of the final version (Figure 1).

We identified participants from 2 institutions and their affiliated hospitals and clinics at the Baylor College of Medicine (BCM) in Houston, Texas and the University of Washington in Seattle, Washington. Accordingly, study sites included providers from multiple healthcare settings including a university hospital, a county hospital, a Veteran's Affairs hospital, and community clinics. We administered the paper-based questionnaire to internal/family medicine and cardiology trainees, attending physicians, and advanced practice providers. Respondents were surveyed during educational conferences, meetings, and clinics. Members of the investigating team were present and

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1. **Please circle your field of practice: Internal Medicine Family Medicine Cardiology (Noninvasive) Cardiology (EP) Cardiology (Invasive)**
2. **Are you a: PA NP MD/DO**
3. **If you are in residency/ fellowship, please indicate your level of training: PGY 1 PGY 2 PGY 3 PGY 4 PGY 5 PGY 6 PGY 7**
4. **If you are in practice, please indicate how many years you have been in practice: 0-5 years 5-10 years 10-15 years 15-20 years >20 years**
5. **On average, how many echocardiograms do you order on a typical week? _____**
6. **Please indicate your comfort level with understanding an echocardiogram report (0-10, 10 being very comfortable): _____**

****Please select the single best answer for all questions. All questions have the option of choosing "I am not sure." Since we are using this survey to gauge your genuine comfort level, please feel free to pick this answer if you truly are unsure. This survey is anonymous and the purpose is to identify areas we can work on to help improve understanding and reporting of an echocardiogram. THANK YOU so much for your participation!**

1. An echocardiogram is ordered for a patient with chest pain and reports that the inferior wall is akinetic. How do you interpret this finding?

a) Akinesis suggests a high likelihood of previous myocardial infarction but this segment may still be viable.

b) Akinesis suggests a high likelihood of previous myocardial infarction which has resulted in a region that is irreversibly scarred.

c) Not sure

2. In a patient with suspected acute pulmonary embolism who cannot undergo CT of the chest with contrast, echocardiogram shows normal right ventricular (RV) size and function. How do you interpret this?

a) Normal RV size and function indicates the patient is unlikely to have a pulmonary embolism

b) Normal RV size and function indicates the patient is unlikely to have pulmonary hypertension.

c) Normal RV size and function does not exclude pulmonary embolism.

d) Not sure

3. An echocardiogram report on a 65 year old male notes "left ventricular ejection fraction (LVEF) of 60% with impaired relaxation and normal filling pressures." How do you interpret this?

a) This indicates the patient has heart failure with preserved ejection fraction or "diastolic heart failure."

b) This indicates the patient likely has age associated changes in diastolic function but may not have heart failure.

c) Diastolic parameters do not change clinical management.

d) Not sure

Figure 1. Questionnaire (correct answer highlighted).

4. A patient admitted for chest pain has an echocardiogram done showing no regional wall motion abnormalities. How do you interpret this finding?

a) Absence of wall motion abnormalities indicates the patient does not have significant coronary artery disease.

b) Absence of wall motion abnormalities does not exclude significant coronary artery disease.

c) Absence of wall motion abnormalities indicates the patient has never had a myocardial infarction in the past.

d) Not sure

5. An echocardiogram shows left ventricular ejection fraction (LVEF) of 40% with global hypokinesis. How do you interpret this finding?

a) The patient has heart failure with reduced ejection fraction, or "systolic heart failure." No further workup is needed.

b) The finding of "global hypokinesis" does not exclude coronary artery disease.

c) The finding of "global hypokinesis" means the patient has non-ischemic cardiomyopathy.

d) Not sure

6. What does "elevated filling pressures" on an echocardiogram report mean?

a) The pulmonary capillary wedge pressure (PCWP) or left atrial pressure is elevated.

b) Left ventricular ejection fraction (LVEF) is depressed.

c) The right atrial pressure (RAP) is elevated.

d) Left ventricular end diastolic pressure (LVEDP) is low.

e) Not sure

7. In a patient with suspected pulmonary hypertension, the echo reports "insufficient tricuspid regurgitation (TR) jet, pulmonary artery systolic pressure (PASP) is at least 30-35 mmHg assuming a right atrial pressure (RAP) of 0-5 mmHg." How do you interpret this?

a) The patient's PASP could be higher than 30-35 mmHg, and therefore pulmonary hypertension is not excluded.

b) Because there is an insufficient TR jet, the patient is unlikely to have significant pulmonary hypertension.

c) The patient's PASP is approximately 30-35 mmHg, indicating the patient has no pulmonary hypertension.

d) Not sure

8. Which of the following are pathologic conditions requiring further cardiology consultation or workup in an otherwise asymptomatic patient?

a) Aneurysmal interatrial septum

b) Patent foramen ovale (PFO)

c) Pseudoaneurysm of the left ventricular wall

d) Mitral annular calcification

e) Not sure

Figure 1. Continued

9. An echocardiogram reports "left ventricular ejection fraction (LVEF) of 60% with impaired relaxation and elevated filling pressures." How would you interpret and manage this?

a) This indicates the patient has heart failure with preserved ejection fraction or "diastolic heart failure" and should be started on a diuretic.

b) This indicates the patient has diastolic dysfunction, which is common in older patients and does not require further evaluation.

c) This indicates the patient may have heart failure with preserved ejection fraction or "diastolic heart failure." A review of systems and physical exam should be performed to clinically correlate.

d) Not sure

10. Which of the following is a condition that may require further cardiology consultation or workup in a patient who recently had a stroke?

a) Fibroelastoma

b) Prominent Eustachian valve

c) False chordae

d) Chiari network

e) Not sure

11. An echo is ordered for patient who presented with acute stroke. Please circle true or false.

True or False: A negative bubble study rules out a patent foramen ovale (PFO), indicating the patient did not have a paradoxical embolism.

True or False: A TTE (transthoracic echocardiogram) can rule out intra-cardiac thrombus as a source for stroke.

12. A TTE (transthoracic echocardiogram) is done to evaluate for left ventricular (LV) thrombus in patient who had a stroke and reports that an "apical thrombus cannot be excluded". What would you do next?

a) Order a transesophageal echocardiogram (TEE)

b) Order a cardiac MRI or CT

c) Not sure

13. Please mark any of the following you are unsure of how to interpret or address in the clinical setting and wished that the echocardiogram report provided more guidance:

□ Impaired relaxation

□ Filling pressures

□ Wall motion abnormalities (akinesis, hypokinesis)

□ Tricuspid regurgitation (TR) jet

□ Right atrial pressure (RAP)

□ Pulmonary artery systolic pressure (PASP)

Figure 1. Continued

collected the questionnaires 10 to 15 minutes after distribution. Participation was voluntary and respondents were not compensated. The protocol was approved by the Institutional Review Board at BCM.

Cross tabulation and distribution plots were used to demonstrate differences in baseline data. The number of TTEs ordered per week and level of training were expressed as means with corresponding standard deviations. The self-reported comfort level with understanding a report was scaled from 0 to 10 (10 being "the most comfortable") and reported as the median and interquartile range. Differences in the proportions of correct answers between general and cardiology providers were estimated using a chi-squared test.

Results

We administered the survey to 367 providers between March 2017 and May 2018. Of these, 297 providers (81%) returned the survey (182 from BCM and 115 from University of Washington).

Among the 297 respondents (Table 1), 68% practice internal or family medicine ("general") and 32% practice cardiology. General medicine trainees and physicians ordered approximately the same number of TTEs and overall fewer than their cardiology colleagues. The median self-reported comfort level with understanding a TTE report was lower in general providers compared with cardiology providers. There was no difference in comfort level between noninvasive versus procedural (electrophysiology or invasive) cardiologists, though noninvasive providers ordered more TTEs. The small number of advanced practice providers in the study (n = 14) ordered fewer TTEs and reported a lower comfort level with understanding reports compared with trainees and physicians.

Table 2 outlines the percentage answered correctly by each provider type for each question. Regarding the clinical implication of regional wall motion abnormalities, more than a third of general trainees and half of general physicians were unable to recognize that an akinetic wall motion abnormality does not necessarily equate to a nonviable segment. The majority of general providers recognized that absence of regional wall motion abnormalities and presence of global hypokinesis do not rule out significant coronary artery disease.

For questions related to diastolic function, a large number of general providers did not know the definition of left sided "increased filling pressures." The answer choice most commonly chosen was "elevated right atrial pressure" and many chose "not sure."

Approximately one quarter of general providers were unfamiliar with the topic of tricuspid regurgitant jet and estimation of pulmonary artery systolic pressure. However, a much higher percentage were able to recognize that normal right ventricular size and function on TTE do not rule out a pulmonary embolism.

A question that was commonly misunderstood asked which echocardiographic structure would require cardiology consultation in an asymptomatic patient. Only about half of general providers chose the option of "pseudoaneurysm of the left ventricular wall;" the most commonly chosen answer was "aneurysmal interatrial septum." For the question asking which structure would require consultation in a patient with recent stroke, less than 20% of general providers chose "fibroelastoma" while the majority responded "not sure." The question most commonly misunderstood by both general and cardiology providers tested the knowledge of which imaging modality to pursue if TTE cannot rule out apical thrombus. Of the possible options, which included "cardiac MRI/CT," the majority of respondents answered "transesophageal echocardiogram." The final question on the

Table 1
Characteristics of the study participants

Characteristic	Participants, n = 297
Provider specialty/category	n (%)
Internal medicine	176 (59%)
Trainee	117 (67%)
Physician	57 (32%)
Advanced practice provider	2 (1%)
Family medicine	27 (9%)
Trainee	12 (44%)
Physician	13 (48%)
Advanced practice provider	2 (8%)
Cardiology	94 (32%)
Trainee	43 (46%)
Physician	41 (43%)
Noninvasive	24 (59%)
Electrophysiology	8 (19%)
Invasive	9 (22%)
Advanced practice provider	10 (11%)
Postgraduate training year for trainees	Mean (SD)
Medicine	2.2 (0.9)
Cardiology	5.6 (1.4)
Years in practice for physicians	n (%)
Medicine	
0-5	26 (38%)
5-10	15 (22%)
10-15	9 (13%)
15-20	11 (16%)
>20	8 (11%)
Cardiology	
0-5	11 (27%)
5-10	11 (27%)
10-15	7 (17%)
15-20	4 (10%)
>20	8 (19%)
Self-reported number of echocardiograms ordered per week	Mean (SD)
Medicine trainees	1.8 (1.6)
Medicine physicians	1.8 (1.6)
Medicine advanced practice provider	0.7 (0.3)
Cardiology trainees	6.9 (4.6)
Cardiology physicians	8.6 (10)
Cardiology advanced practice provider	4.9 (5.6)
†Self-reported comfort level with echocardiogram report interpretation	Median (IQR)
Medicine trainees	6 (4,7)
Medicine physicians	7 (5,8)
Medicine advanced practice provider	3 (3,6)
Cardiology trainees	10 (8,10)
Cardiology physicians	10 (9,10)
Cardiology advanced practice provider	5.5 (5,8)

IQR = interquartile range; SD = standard deviation.
† On scale of 0-10, 10 being most comfortable.

Table 2
Comparison of participant responses to questions by topic and provider type

Question topic	General trainees (n = 129)	General physicians (n = 70)	Cardiology trainees (n = 43)	Cardiology physicians (n = 41)
Percent answered correctly				
Recognition that akinesis does not equate to a nonviable segment* (Q1)	62	43	81	85
Knowledge that normal RV size/function by echo does not rule out PE* (Q2)	91	84	100	93
Knowledge that lack of regional wall motion abnormalities does not rule out CAD (Q4)	93	86	95	98
Knowledge that global hypokinesis does not rule out CAD* (Q5)	83	80	100	100
Definition of LV filling pressures* (Q6)	62	41	91	78
Understanding of how an incomplete TR jet affects estimation of PASP* (Q7)	74	67	88	93
Ability to recognize abnormal structures* (Q8)	51	43	98	100
Clinical meaning of impaired relaxation* (Q3)	78	67	98	88
Ability to identify structural abnormality as cause of stroke* (Q10)	14	19	91	90
Knowledge that negative bubble study by TTE does not rule out PFO* (Q11a)	45	30	72	71
Knowledge that negative TTE does not rule out intracardiac thrombus* (Q11b)	85	76	95	95
Knowledge of correct imaging modality for diagnosis of LV thrombus* (Q12)	11	9	51	37

CAD = coronary artery disease; LV = left ventricle; PASP = pulmonary artery systolic pressure; PE = pulmonary embolism; PFO = patent foramen ovale; RV = right ventricle; TR = tricuspid regurgitation; TTE = transthoracic echocardiogram.
* $p < 0.05$ for difference in proportions between general providers (trainees + physicians) and cardiologists (trainees + physicians).

survey allowed respondents to mark which topics they were unsure of how to interpret or address in the clinical setting; the topic chosen most was "filling pressures."

For almost all questions, a higher proportion of noninvasive cardiology providers answered correctly when compared with procedural cardiology providers, however our study was not powered to examine these differences. Advanced practice providers in both general and cardiology fields had a lower number of correct responses compared with their trainee and physician counterparts, but again our study was not powered to test for these differences. Among attending physicians, there did not appear to be any correlation between proportion of correct answers and number of years in practice.

Discussion

Our results suggest that several concepts on a standard TTE report are misunderstood and further work is needed improve communication of findings. Among general providers, the most misunderstood concepts included viability of an akinetic region, pulmonary artery systolic pressure, diastolic function, recognition of abnormal structures, and method of identifying of intracardiac thrombus. General trainees had a higher percentage of correct answers compared with general physicians on almost all questions. One possibility for this finding is that echocardiography is an evolving field and proximity to training may allow for familiarity with newer topics such as diastolic function.

Limited resources exist to help referring physicians extract clinically useful information from echocardiogram reports,[6] a notion supported by general providers' lower self-described comfort level with interpreting reports. Proposed strategies to improve provider understanding include didactic sessions, educational materials, and adjustment of reporting format.

One method would be to modify reporting format to utilize terminologies that are simpler to understand for those not formally trained in cardiology and echocardiography. Alternatively, a "key" to the report could be inserted; for example, a finding of "global hypokinesis" could automatically generate text stating that this does not exclude ischemia. Another example would be to note that "elevated left ventricular filling pressures" suggests high left atrial pressure and to clinically correlate for signs and symptoms of congestive heart failure. Study readers could also provide more assistance regarding the next diagnostic or treatment steps in order to avoid unnecessary tests or guide further consultation. For example, when left ventricular apical thrombus cannot be excluded by TTE, the reader may recommend a repeat limited TTE with ultrasound contrast or a cardiac CT or MRI. Although a personal discussion with the ordering provider to delineate next steps might be optimal, it may not always be possible. From the perspective of the ordering provider, it could be useful to give more clinical information when ordering the study so that the reading physician can provide more targeted information in the report.

Although the feasibility of teaching general providers how to interpret TTE reports may be limited, access to further guidance can be provided. Resources can be developed by national societies to help providers understand the terminologies frequently used in a TTE report. Another option is to embed a simple website link within the report to click for further information. Additionally, providing a means to contact the reading physician in the readers" signature line (whether via email, message, or electronic consult) may be helpful.

The American Society of Echocardiography guidelines contain recommendations for a standardized TTE report and include which core measurements and structures should be described.[7] The recommended report structure includes the broad sections of demographic information, echocardiographic findings, and a summary. However, no specific suggestions on reporting format tailored to referring providers are included. A wealth of literature exists in the radiology field addressing imaging study reporting format.[8] Radiologists have even published "style guidelines" to improve clarity, brevity, and readability of reports.[9] Some data have found that referring clinicians are more satisfied with the content and clarity of structured versus free-form radiology reports.[10] Perhaps, some of the principles employed in the field of radiology can be applied to echocardiography.

Of note, we conducted our study at 2 different institutions from distinct geographic regions of the United States and found similar results at both sites, increasing the generalizability of our findings. Nevertheless, reporting and provider understanding will certainly vary depending on practice setting, location, and institution. A larger investigation conducted at additional sites could provide additional insight and applicability.

Our study does have some other limitations—to preserve integrity, participants were only allowed 10 to 15 minutes to complete the survey while the administrant was present. It is possible their responses may have been different if participants were given more time to contemplate the questions. In clinical practice, providers do have the opportunity to consult with outside resources, though clinical demands may limit time that would be needed to research routinely reported findings. Furthermore, in that situation one may have expected respondents to pick the "not sure" answer option. Additionally, both general and cardiology providers were given the same amount of time to complete the questionnaire. The multiple-choice answer format also carries the possibility that respondents may correctly guess the answer through process of elimination or random chance. Lastly, we have no information on whether misunderstanding of TTE reports has any adverse impact on patient care.

In summary, our study identifies many aspects of a TTE report that are not optimally understood by general providers and in some cases, cardiology providers. Strategies are needed to improve the clinical value of TTE reports; potential approaches include improving communication with ordering providers concerning abnormal findings, recommending further steps, and providing a means to directly address queries. A specifically formed task force may be useful to design TTE report templates. Given that required elements in a report are standardized by accreditation societies, those entities could help influence the format of the report to make them more understandable and clinically useful to the ordering provider.

Disclosures

None related to this manuscript. These views represent those of the authors and not necessarily those of the Department of Veterans Affairs.

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