

Saving Time and Money: Effectiveness of Outpatient Echocardiogram Utilization Review at an Academic Safety Net Hospital

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Abstract

Background: The COVID-19 pandemic exacerbated a preexisting backlog of outpatient echocardiogram orders at our academic safety-net healthcare system. We developed a unique model of utilization review for outpatient echocardiogram orders using appropriate use criteria (AUC) to improve health system-wide efficiency of cardiovascular imaging delivery and resource management.

Methods: Senior cardiology fellows were hired to prospectively review 4075 outpatient echocardiogram orders placed between January 1, 2020 and April 1, 2021. The order date, specialty and clinical setting of the ordering provider, and rationale for each order were determined, and orders were approved or canceled based on our AUC. Ordering providers received individualized messages informing them of the order review outcome and rationale for each decision. The resultant cost savings were estimated based on publicly available data. Average wait times from order to completion of the study were noted at the beginning and end of the study period.

Results: Of all reviewed orders, 32% (n=1304) were deemed inappropriate and 68% (n=2771) were deemed appropriate based on our proprietary AUC. Primary care accounted for the largest proportion of ordered exams (54%, n=2225), followed by cardiology (28%, n=1151). Average time from order placement to completion fell from 6mo at the onset of the study to 1.5mo at end of the study period. An institutional cost analysis demonstrated realized cost savings of \$61,328.75 during the study period and projected savings of \$107,637.60 annually if echocardiogram volumes were to return to pre-pandemic levels.

Conclusion: Our utilization review significantly improved appropriateness of studies performed while reducing echocardiography volume, wait times, and expenditures. This approach may be generalizable to other resource-limited healthcare systems and has potential to have an enduring impact on the practice of echocardiography even in a post-pandemic era.

Keywords: Utilization review • Appropriate use criteria • Echocardiography • Cardiovascular imaging

List of abbreviation: AUC: Appropriate Use Criteria; TTE: Transthoracic Echocardiography; TEE: Transesophageal Echocardiography; SE: Stress Echocardiography

Introduction

Echocardiography is the diagnostic cornerstone of contemporary cardiology; its widespread availability and minimal risk have resulted in increased utilization over the past two decades [1-4]. In response to concerns regarding overuse of echocardiography, the American College of Cardiology Foundation collaborated with other imaging societies to publish the 2007 Appropriate Use Criteria (AUC) to guide echocardiography imaging practices [5]. Subsequent investigations have shown that adherence to the AUC criteria paired with an AUC-based educational and feedback intervention has improved cardiac imaging ordering practices among physicians-in-training and attending physicians [1,6, 7].

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Reducing low-value echocardiography is of paramount importance to our large, urban medical center serving a largely indigent population. In response to the coronavirus disease 2019 (COVID-19) pandemic, the delivery of medical services at our institution, as with many others, was impacted and required significant changes in work-flow protocols to best allocate resources in a system already facing high volumes and a preexisting backlog. In such an environment, AUC to guide the use of echocardiography has significant cost-savings and resource allocation benefits [8]. Shortly after the onset of the pandemic, all non-urgent outpatient echocardiograms were postponed to mitigate the risk of exposure of patients, cardiac sonographers, and other staff to COVID-19 in the outpatient setting. Given the growing backlog of exams, a solution was urgently needed to triage orders and reduce exam volume.

We discuss a novel internal utilization review approach for outpatient echocardiography using our institution's proprietary AUC (Figure 1) and perform a cost analysis on maintaining such a protocol.

Methods

Study environment

This study was conducted at Los Angeles County + University of Southern California (LAC+USC) Medical Center, a tertiary care academic medical institution in Los Angeles, California. 4074 outpatient echocardiogram orders, including transthoracic echocardiograms (TTE), transesophageal

No longer necessary:

1. Original indication has resolved (ex. study was ordered for preoperative evaluation and the operation has already been performed or complaint for which study was ordered has spontaneously resolved on subsequent clinic visits)
2. Patient no longer cared for by Los Angeles County Department of Health Services (LAC DHS)
3. Study has already been done at an outside facility or under a separate order at LAC DHS
4. Requested information is available from an alternative study (e.g. CTA to look at ascending aorta, nuclear scan for ejection fraction, nuclear stress test or coronary angiogram for coronary artery anatomy negating need for stress echo)

Not essential:**General Evaluation of Cardiac Structure and Function****Arrhythmias**

1. Infrequent APCs or infrequent VPCs without other evidence of heart disease based on history, physical exam and EKG.
2. Asymptomatic isolated sinus bradycardia.
3. Symptoms of palpitations with unremarkable CXR/EKG or other work-up and low suspicion for structural heart disease

Lightheadedness/Presyncope/Syncope

4. Lightheadedness/presyncope when there are no other symptoms or signs of cardiovascular disease

Ventricular Function

5. Initial evaluation of ventricular function (e.g. screening) with no symptoms or signs of cardiovascular disease
6. Routine surveillance of ventricular function with known CAD and no change in clinical status or cardiac exam
7. Evaluation of LV function with prior ventricular function evaluation showing normal function (e.g. prior echocardiogram, left ventriculogram, CT, SPECT MPI, CMR) in patients in whom there has been no change in clinical status or cardiac exam

Perioperative Evaluation

8. Routine perioperative evaluation of ventricular function with no symptoms or signs of cardiovascular disease

Pulmonary hypertension

9. Routine surveillance (<1 year) of known pulmonary hypertension without change in clinical status or cardiac exam
10. Routine surveillance (<3 years) of known risk factor for pulmonary hypertension (ex. Interstitial lung disease, scleroderma, COPD) without change in clinical status or cardiac exam

Pulmonary embolism

11. Routine surveillance of prior pulmonary embolism with normal right ventricular function and pulmonary artery systolic pressure

Valvular Function**Murmur or click**

12. Initial evaluation of 1 or 2 over 6 murmur when there are no other symptoms or signs of valvular or structural heart disease
13. Reevaluation in a patient without valvular disease or prior echocardiogram and no change in clinical status or cardiac exam

Native valvular stenosis

14. Routine surveillance (<3 years) of mild valvular stenosis without a change in clinical status or cardiac exam
15. Routine surveillance (<1 year) of moderate or severe valvular stenosis without a change in clinical status or cardiac exam

Native valvular regurgitation

16. Routine surveillance of trace valvular regurgitation
17. Routine surveillance (<3 years) of mild valvular regurgitation without a change in clinical status or cardiac exam
18. Routine surveillance (<3 years after valve implantation) of prosthetic valve if no known or suspected valve dysfunction
19. Routine surveillance of mechanical prosthetic valves with no change in clinical status on adequate anticoagulation.

Infective endocarditis (native or prosthetic valves)

20. Transient fever without evidence of bacteremia or new murmur
21. Transient bacteremia with a pathogen not typically associated with infective endocarditis and/or documented nonendovascular source of infection
22. Routine surveillance of uncomplicated infective endocarditis when no change in management is contemplated

Intracardiac and extracardiac structures and chambers

23. Routine surveillance of known small pericardial effusion with no change in clinical status
24. Routine reevaluation for surveillance of known ascending aortic dilation or history of aortic dissection without a change in clinical status or cardiac exam when findings would not change management of therapy

Hypertension, HF, Cardiomyopathy**Heart Failure**

25. Routine surveillance of HF (systolic or diastolic) when there is no change in clinical status or cardiac exam

Device evaluation (pacemaker, ICD, CRT)

26. Routine surveillance of implanted device without a change in clinical status or cardiac exam

Cardiomyopathies

27. Routine surveillance (<1 year) of known cardiomyopathy without a change in clinical status or cardiac exam

Adult Congenital Heart Disease

28. Routine surveillance (<2 years) of adult congenital heart disease following complete repair without residual structural or hemodynamic abnormality

Figure 1. Modified appropriate use criteria for echocardiography. Outpatient echocardiogram orders meeting listed criteria were cancelled.

echocardiograms (TEE), and stress echocardiograms (SE) ordered between January 1, 2020 and April 1, 2021 were reviewed.

Data collection and echocardiography appropriateness classification

We designed and implemented a new work-flow protocol to guide the practice of echocardiography at our institution. Senior cardiology fellows were hired to prospectively review outpatient echocardiograms orders during the study period. The fellows underwent standardized training and carried out the review under the supervision of an attending faculty. The order date, specialty and clinical setting of the ordering provider, and clinical rationale for each echocardiogram

order were determined via thorough review of the Electronic Medical Record (EMR). Echocardiographic studies were approved or canceled based on our institution's modified AUC for echocardiography (Figure 1). Ordering providers received individualized messages in the EMR (linked to the patient's chart) either approving or denying the echocardiogram order, along with a rationale for this classification. Clinical decision support was provided in cases requiring alternative diagnostic workup or not meeting modified AUC criteria. Time from echocardiogram order placement to study completion was also noted.

Outcome measures

The primary outcome measure was estimated total savings per year

that resulted from instituting an outpatient echocardiogram internal utilization review. Secondary outcome measures included average wait time from order to completion of the echocardiographic study and rates of appropriate vs. inappropriate echocardiogram orders.

Results

Order characteristics

4075 orders placed between January 1, 2020 and April 1, 2021 was reviewed, including 3846 TTEs, 87 TEEs, and 141 SEs. Primary care accounted for the largest proportion of ordered exams (54.61%, n=2225), followed by cardiology (28.25%, n=1151). All other specialties accounted for the remainder of the studies ordered (17.14%) (Figure 2).

Appropriateness classification

Of reviewed orders, 32% (n=1304) were determined to be inappropriate and 68% (n=2771) were determined to be appropriate based on our institution's modified AUC (Figure 1).

Wait time analysis

During the review process, echocardiogram orders that were identified as high priority, i.e. that would change management immediately, were scheduled to be done within one month. The average wait time between order to completion of the echocardiographic study, including those that were approved as per our institution's modified AUC for echocardiography but not deemed high priority, decreased to 1.5 months from approximately six months by the end of the study period.

Cost analysis

Senior cardiology fellows from the sponsoring program were recruited to perform utilization review at a rate of \$110 per hour under the direct supervision of attending cardiology faculty. The compensation for attending supervision was included in their annual salary, which

remained static. An average of ten echocardiogram orders were reviewed by each reviewer per hour resulting in a marginal cost of \$11 per order reviewed. The marginal cost of a technician performing an echocardiogram and an attending cardiologist reading the study at our institution is \$81.40. Orders that were cancelled resulted in a savings of \$70.40 (marginal cost of performing and interpreting a study minus the marginal cost of order review). Orders that were approved incurred the marginal cost of review (\$11), resulting in a total cost of \$92.40 per order.

Given that 68% of orders were approved and 32% were cancelled, averaged savings per order reviewed was \$15.05 ($[0.32 \times \$70.40] - [0.68 \times \$11]$).

During the study period, 4075 orders were reviewed, resulting in realized savings of \$61,328.75 during the study period. Assuming that echocardiogram order volumes return to pre-pandemic levels (7152 outpatient echocardiograms were ordered on average each year from 2016-2019 at our institution) and a cancellation rate of 32%, approximately 2289 orders would be canceled resulting in projected annual savings of \$107,637.60 (Table 1).

Discussion

We developed an internal utilization review protocol for outpatient echocardiograms performed at our large urban medical center in Los Angeles, California, an epicenter for COVID-19. Our intervention resulted in significant decreases in exam volume and improved appropriateness of studies performed. This may be attributable to the combination of ongoing provider education as part of the review process. While case-specific feedback is resource-intensive, we believe it leads to sustained results and can improve clinical decision-making beyond appropriateness of diagnostic testing. Reducing the number of inappropriate echocardiogram orders has mitigated echocardiogram wait times, overall costs and false positives requiring further potentially invasive testing.

Prior to initiation of our utilization review, the average wait from order to completion of an echocardiogram was approximately six months;

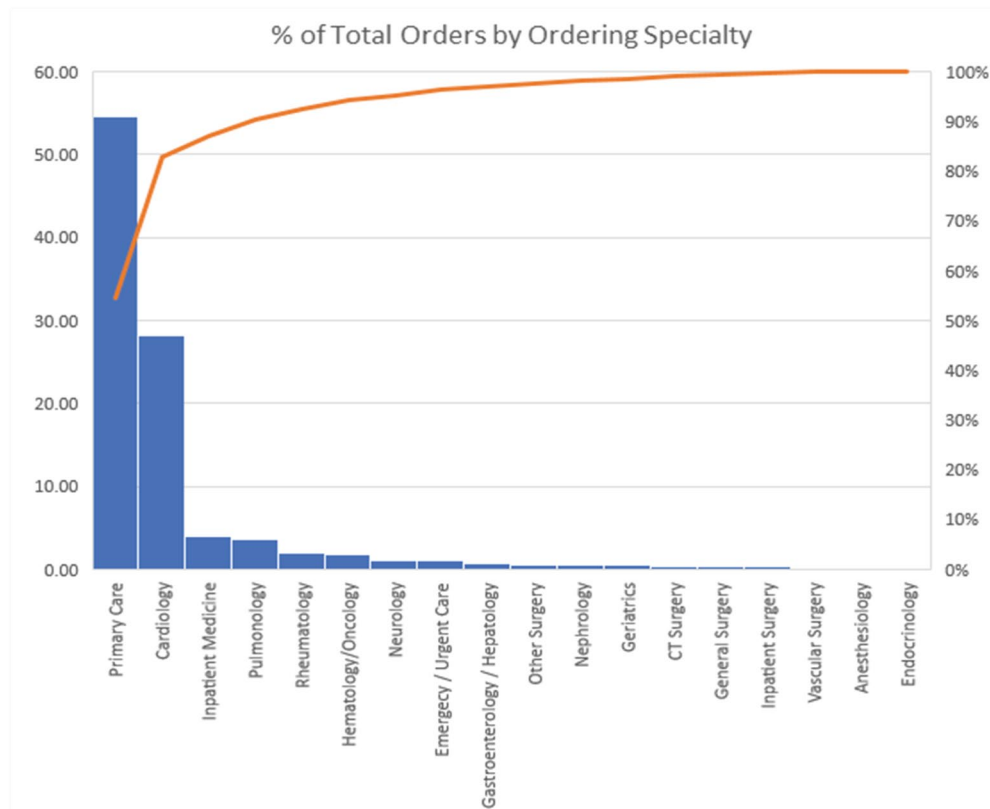


Figure 2. Echocardiogram orders by specialty and clinical setting. X-axis represents medical specialties ordering outpatient echocardiograms. Y-axis represent percentage of total outpatient echocardiogram orders by specialty (left; blue bars) and cumulatively (right; orange line).

Table 1. Order Review Cost Effectiveness.

	Mean Hourly Pay (USD\$)	Expected Productivity Per Hr (# of Echos) ^a	Cost per study (\$USD)
Echo Technologist	\$45.09	0.88	\$51.40
Cardiology Faculty	\$180	6	\$30
Cardiology Fellow Reviewer	\$110	10	\$11
Marginal cost of performing and reading an echo: ^b			\$81.40
Per unit marginal cost of echo order review:			\$11
Per Unit Cost Savings of Echo order canceled: ^c			\$70.40
Savings per hour of echo order review: ^d			\$150.50

^aEcho technologist: Echo studies completed

Cardiology Faculty: Echo studies read

Cardiology fellow reviewer: Echo order requests reviewed

^bCost of echo tech to complete + cardiology faculty to read

^cCost of performing and reading one echo - cost of reviewing one echo

^dMarginal cost of 3 orders - 1 hour reviewer pay

Mean 3 orders were canceled per hour of order review

by the end of the study period, the wait time had been reduced to approximately 1.5 months. The etiology for this change in wait time is suspected to be multifactorial. The majority of providers had fewer in-person visits during the peak of the pandemic and may have ordered fewer exams as a result. In addition, an additional echocardiogram technician was hired during the study period (increasing the total number of technicians from 6 to 7). Finally, providers may have ordered fewer inappropriate exams during the study period as a result of ongoing feedback and education.

Cost analysis for our internal utilization review for outpatient echocardiograms demonstrated projected annual savings of \$107,637.60 per year, assuming pre-pandemic exam volumes. This amount is likely an underestimate, as equipment and administrative costs were not included in the marginal cost per echocardiogram. Hiring specialist physicians as independent reviewers of all outpatient echocardiogram orders at our institution significantly reduced low value studies and allowed for the prioritization of those studies that could change clinical management. Furthermore, we expect improved provider education to result in fewer ordered echocardiograms, which would continue to decrease costs; additional analysis is necessary to determine whether our utilization review has affected echocardiogram ordering patterns at our institution.

Limitations include the study period taking place during the COVID-19 pandemic, a time when individuals were more likely to change practice patterns to adapt to a harrowing situation and in the context of a research protocol. Furthermore, significantly fewer outpatient echocardiograms were noted to be ordered during the study period compared to an equivalent period in the pre-pandemic era, which may be due to multiple factors including a decrease in face-to-face patient visits and desire to minimize exposure to COVID-19 by physicians and patients.

In summary, our internal utilization review for outpatient echocardiograms relied on individual case-by case feedback and education by a trained specialist and resulted in an overall decrease in the number of inappropriate echocardiogram orders and waitlist times. While our method is more resource intensive when compared to other utilization review protocols or automated clinical decision support tools embedded within the EMR, we believe that it will lead to more effective and sustainable results even in a post-pandemic era. Via our educational component, we hope to create

a better systems culture to sustain an increased percentage of appropriate echocardiogram orders over time.

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