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ORIGINAL PAPER

Addition of price transparency to an education and feedback intervention reduces utilization of inpatient echocardiography by resident physicians

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Abstract

Previous studies have demonstrated the impact of appropriate use criteria (AUC) education and feedback interventions in reducing unnecessary ordering of transthoracic echocardiography (TTE) by trainees. To our knowledge, no study has evaluated the impact of the addition of price transparency to this education and feedback model on TTE utilization by resident physicians. We performed an education and feedback quality improvement initiative combining charge transparency data with information on AUC. We hypothesized that the initiative would reduce the number of complete TTE ordered and increase the number of limited TTE ordered, anticipating there would be substitution of limited for complete studies. Residents rotating on inpatient teaching cardiology ward teams received education on AUC for TTE, indications for limited TTE, and hospital charges for TTE. Feedback was provided on the quantity and charges for complete and limited TTE ordered by each team. We analyzed the effects of the intervention using a linear mixed effects regression model to adjust for potential confounders. The post-intervention weeks showed a reduction of 4.6 complete TTE orders per 100 patients from previous weekly baseline of 31.3 complete TTE orders per 100 patients (p value = 0.012). Charges for complete TTE decreased $122 from baseline of $980 per patient (p value = 0.040) on a per-week basis. Secondarily, there was no statistically significant change in limited TTE ordering during the intervention period. This initiative shows the feasibility of a house staff-driven charge transparency and education/feedback initiative that decreased medical residents' ordering of inpatient TTE.

Keywords Quality improvement · Charge-transparency · Echocardiography · Graduate medical education

Introduction

The American College of Cardiology (ACC), the American Society of Echocardiography (ASE), and other professional societies have established appropriate-use criteria (AUC) to reduce inappropriate ordering of transthoracic echocardiography (TTE) [1]. Previous studies have demonstrated the impact of AUC education and feedback interventions in reducing unnecessary ordering of TTEs by medical residents and cardiology fellows [2–6]. It has also been shown that a large portion of TTEs may not change clinical management and therefore may represent wasted healthcare resources [7].

Two systematic reviews have suggested that providing physicians with charged prices may modestly reduce ordering of laboratory and diagnostic tests [8, 9]. However most studies included in these analyses focused on laboratory tests [10–14]. One randomized study in 2013 found that providing physicians with Medicare charges for 5 different imaging

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studies did not decrease utilization [15]. To our knowledge, no study has evaluated the impact of price transparency on inpatient TTE utilization by resident physicians.

We therefore conducted a prospective, non-randomized study to test the effectiveness of a quality-improvement intervention targeting inpatient TTE ordered by residents. The intervention consisted of an education and feedback program combining charge transparency data with information on AUC. We hypothesized that the initiative would reduce the number of complete TTEs ordered. We also hypothesized that our intervention would increase the ordering of limited echocardiograms, which have been suggested as cost-effective and efficient alternatives to complete TTE to answer simple clinical questions or for short interval follow-up [16, 17].

Methods

Context

We performed a quality improvement initiative on the 3 adult teaching cardiology ward teams at a tertiary-care academic medical center in the Southern United States over 34 weeks in 2017. The teams consisted of 1 attending cardiologist, 2–3 post-graduate year (PGY) 1–4 residents, and 1–2 medical students. Patients admitted to these services have a range of cardiac conditions including arrhythmias, acute coronary syndrome, congestive heart failure (CHF), and pericardial disease. We did not collect data on specific diagnosis codes. There were no specifically excluded conditions. All patients were inpatients. Patients may or may not have had previous TTEs in the outpatient setting or on prior admissions. We targeted residents because they are the front-line providers on these teaching teams. We excluded orders for stress echocardiography and transesophageal echocardiography (TEE) from this study. Additionally, as the intervention was focused on resident teams, teams led by fellows or advanced-practice nurses (APRN), such as those caring for cardiac intensive care unit (ICU) patients, ventricular assist device patients, or heart transplant patients, were excluded from the intervention.

Intervention

Our institution's house staff-led committee for high value care designed and implemented this quality improvement intervention. Previous initiatives of our group have included an education and feedback initiative to reduce unnecessary daily laboratory test ordering, limit telemetry use on stable patients, and reduce daily chest radiographs in the ICU [18, 19].

We reviewed ACCF/ASE/AHA/ASNC/HFSA/SCAI/SCCM/SCCT/SCMR 2011 appropriate use criteria (AUC) for echocardiography, paying special attention to scenarios in which house staff and other trainees may order TTEs inappropriately [1, 2, 20]. In consultation with the medical director of VUMC's echocardiography lab and stakeholders from the Cardiovascular Medicine division and the Internal Medicine training program, we developed an educational document (Supplementary material 1) that outlined the AUC, reviewed several inappropriate indications frequently encountered on the cardiology wards (e.g. asymptomatic sinus bradycardia), and highlighted the option of ordering a limited echocardiogram as a follow-up study or to address a specific clinical question (e.g. change in left ventricular ejection fraction) [17]. The document also showed charges by the hospital for complete and limited TTEs. Charges were obtained from the hospital "chargemaster" and represent the hospital's listed price for a given service to private-insurance, public payers, or self-payers. The percentage of this charge collected by the hospital varies by payer and is not publically available. We use "charge" and "price" to refer to the amount billed for a healthcare good or service [21]. We sent an introductory email containing the educational document, the 2011 AUC guidelines, and a link to a previously-existing phone application developed by the ASE containing the AUC to the house staff rotating on the 3 cardiology teams at the start of each 2-week rotation [22]. Although attending physicians were included on the introduction email, education was explicitly addressed to the residents.

Each week, intervention teams received a feedback email detailing team-specific numbers of complete and limited TTEs billed, the associated charges, and comparison to their team's previous 12-week average. To account for weekly variations in patient census, we presented data in patient/week format. Reports were presented using charts and graphs generated with data-visualization software (Tableau Software, Seattle WA).

Study of the intervention

To establish whether a change in usage of TTE was attributable to the intervention, we compared 34 weeks of post-intervention data to 10 weeks of pre-intervention data for each team. Intervention end time was pre-determined based on the timing of a planned electronic health record system switch. Study of the intervention was reported according to revised Standards for QUality Improvement Reporting Excellence (SQUIRE) 2.0 guidelines [23].

Measures

We used current procedural terminology codes (CPT) to track the number of limited and complete TTEs performed

before and during the intervention. The primary outcome was the number of TTEs per 100 patients. This was measured once per week per clinical team. A patient could have more than one TTE per admission. Charges were reported in United States Dollars for the period of study intervention (March–October 2017). To avoid counting TTEs that were ordered but not performed (e.g. order canceled because patient discharged or transferred), we only recorded tests sent for billing. TTE counts and charges were displayed using Tableau Software, with data updating weekly. We reviewed data each week to generate feedback reports for the teams and to ensure that the data collection software was functioning.

Analysis

Linear mixed effects regression was used to evaluate the effect of intervention on average weekly charges and rate of full echo and (separately) limited echo use, adjusting for clinical team and average case mix index (CMI) on the team in the corresponding month to account for possible variation in the number of TTEs ordered based on the severity of illness of the patients. Because house staff, rather than attending physicians, were the targets of the intervention, we attempted to control for the possibility of effects on resident ordering behavior by the team's attending provider. Heterogeneity among specific provider teams was modeled using a random intercept, indexed by attending provider for a given week. Effects were summarized using estimates and Wald-type 95% confidence intervals and p-values. Graphical regression diagnostics were evaluated, and alternative model formulations were considered as necessary.

Ethical considerations

This was a quality-improvement initiative delivering education on established guidelines and publically-available chargemaster data. As such, our institution granted an IRB-approval exemption. The introduction email emphasized that education and feedback was informational only, without any target rate of TTE ordering. House staff and student performance evaluations were not linked to this intervention.

Results

According to the model discussed above, there was a statistically significant change in the rate of ordering and associated charges with complete TTE use during the intervention period. The post-intervention weeks showed a reduction of 4.6 complete TTE per 100 patients from a previous weekly baseline of 31.3 complete TTEs per 100 patients (p = 0.012).

Table 1 Change in rate of complete TTE ordering and associated charges during the 34-week intervention period compared to 10 weeks of baseline data

	Baseline	Change from baseline during intervention period	p value
TTE per 100 patient (per week)	31.3	−4.6	0.012
Charge per patient (USD per week)	980	−122	0.040

Table 2 Change in rate of limited TTE ordering and associated charges during the 34-week intervention period compared to 10 weeks of baseline data

	Baseline	Change from baseline during intervention period	p value
TTE per patient 100 patient (per week)	4.9	1.5	0.108
Charge per patient (USD per week)	47	15	0.088

Charges for complete TTEs decreased $122 from baseline of $980 per patient (p = 0.040) on a per-week basis (Table 1).

Secondarily, there was no statistically significant change in the rate of ordering or associated charges with limited TTE use during the intervention period (Table 2). The post-intervention weeks showed an increase of 1.5 limited TTEs per 100 patients from previous weekly baseline of 4.9 limited TTEs per 100 patients (p = 0.108). Charges for limited TTEs increased $15 from baseline of $47 per patient (p = 0.088) on a per-week basis.

For perspective on the scale of the project and absolute effect size of the intervention, we recorded team censuses before and after the intervention. During the 10-week baseline, the average census was 82 unique patients per week, compared to 80 patients per week during the intervention period. The intervention effect of a weekly decrease of 4.6 complete TTEs per 100 patients equates to 3.8 complete TTEs per week at the baseline census level. The intervention effect of a weekly decrease of $122 charged per patient equates to $10,004 decrease in total charges for complete TTEs at the baseline census level. For limited TTEs, the intervention effect of a weekly increase of 1.5 limited TTEs per 100 patients equates to 1.2 limited TTEs per week at the baseline census level. The intervention effect of a weekly increase of $15 charged per patient equates to $1230 increase in total charges for limited TTEs at the baseline census level. Assuming that the entire increase in limited TTE charges

($1230) is due to substitution for complete TTEs not performed (−$10,004), the net effect on charges was −$8774 per week, equating to $298,216 over 34 weeks.

We also collected data on length average length of stay (LOS) before and after the start of the initiative. Average LOS was 5.85 days during the 10 week baseline period and 5.7 days during the intervention period, which we did not interpret as a clinically meaningful difference.

Discussion

This education and feedback intervention providing charge transparency and test ordering patterns to medical residents was associated with a statistically significant decrease in the quantity of complete TTEs ordered and associated charges. Furthermore, while not reaching statistical significance, there was increased utilization of limited TTEs during the intervention period. Increased charges for limited TTEs did not negate the charge savings from complete TTEs. Although the charged prices used in this study do not directly reflect the costs to deliver the health care service or the final costs paid by patients or other payers (due to confidential negotiated payment agreements or billing by diagnosis-related groups), these charges often represent the "sticker price" presented to self-paying patients or insurers [21]. The uninsured or those with significant co-insurance requirements may have financial liability for a significant percentage- or all- of this "sticker price," making the charge decreases particularly relevant in these patient populations. Besides direct monetary effects, we hypothesize there could be other, less tangible benefits, to improved quality of TTE ordering, including more rapid performance of appropriate testing, improved turn-around times for acquisition and interpretation of appropriate TTEs, or earlier hospital discharge. However, evidence for these benefits is lacking in the literature and our intervention did not show significant change in length of stay.

That our education and feedback model resulted in a decrease in the number of complete TTEs is consistent with the findings of other studies using similar intervention methods [2]. Our group has successfully used this model in reducing unnecessary laboratory ordering [18]. Others have used decision-support at point of ordering [24]. However, the long-term durability of our education and feedback method is potentially compromised by the fact that it relied on a regular time commitment of a team member to extract data weekly and send feedback emails to and route to clinical teams. Additionally, intervention effects may wane over time due to "email fatigue" or house staff turnover [25].

This intervention should be interpreted within its limitations. We did not track the charges for other alternative diagnostic studies that could have been ordered in place of TTE such as TEE or cardiac magnetic resonance imaging. Our use of chargemaster prices is an imperfect measure of the true monetary cost to perform the procedure, which includes both fixed (e.g. capital costs for equipment and building space) and variable costs (e.g. hourly wages for sonographers and support staff). The chargemaster price may not reflect the amount finally collected by the hospital for the services rendered as discussed above. However, despite the limitations given, charges have been demonstrated to reasonably correlate with costs. Furthermore, charges are relatively easy to obtain compared with other metrics of cost, and also relatively stable over time for a given institution. Therefore, we would argue that charges are a reasonable proxy of costs for institutions seeking to track and reduce costs of care over time [26, 27]. The true "value" of a test to a patient is not only measured in monetary charges or collections from payers, but also in the clinical benefit achieved for that given expenditure, which is difficult to quantify for one particular study such as a TTE in the context of an entire hospitalization. Although we attempted to correct for attending physician input using our model, it is possible that specific attending providers may have instructed their teams to ignore the educational initiative. While the model adjusted for CMI, unmeasured patient factors not captured by the metric may have influenced the results. We are not aware of any changes to the patient mix or team compositions during the study period. We also did not grade the appropriateness of the ordered TTE because this has been well-evaluated by others [2, 6, 7]. The relative contribution of our intervention's price transparency element compared to other factors (e.g. AUC education) was not quantified. A future study randomizing teams to either AUC education alone or AUC education plus price transparency may help answer this question.

In conclusion, this initiative shows the feasibility of a house staff-driven initiative targeting medical residents' ordering of inpatient TTE and should be generalizable to other institutions. While per-patient charge decreases were relatively modest, these may be particularly relevant to the uninsured or those with significant out-of-pocket liability.

Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest relating to this project.

Ethics approval As this was a quality-improvement initiative, our institution granted an IRB-approval exemption.

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