Pre-operative echocardiograms in acute fragility hip fractures
How effective are the guidelines?
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Abstract
In 2014, the American College of Cardiology/American Heart Association (ACC/AHA) released guidelines for ordering pre-operative echocardiograms in patients undergoing non-cardiac surgery. The purpose of this study is to determine if pre-operative echocardiograms ordered prior to fragility hip fracture repair are ordered according to these guidelines, change anesthetic management or affect patient outcomes. In addition, we attempted to evaluate the efficacy of the ACC/AHA guidelines.

We conducted a 4-year retrospective chart review of acute fragility hip fractures at a single institution. Charts were reviewed to determine which patients met criteria for a pre-operative echocardiogram. Within this group we then compared patients who received a pre-operative echocardiogram to those who did not. Comparisons were made with regard to time to surgery, changes from standard anesthetic management, major adverse cardiac events, length of hospital stay, and 1-year mortality. We also examined which patients received postoperative echocardiograms and the incidence of adverse cardiac events in this group.

Of 402 patients, 87 (22%) had ACC/AHA indications for pre-operative echocardiogram, and 42 (48%) of them received one. The indication to order a pre-operative echocardiogram in stable heart failure or valve disease patients if their last echo was greater than 1 year was only followed 23% of the time. In the pre-operative echocardiogram group, anesthetic management was adjusted more frequently ($P = .025$), and average time to surgery was greater ($P < .001$). The incidence of a major adverse cardiac event was 10% in the ACC/AHA echocardiogram indicated group and 3% in the non-indicated echocardiogram group. An equal number of echocardiograms were completed postoperatively as were completed under ACC/AHA pre-operative guidelines. Sixty-seven percent of the postoperative echocardiograms did not have ACC/AHA pre-operative indications.

Our data demonstrates that pre-operative echocardiograms for “stable heart failure and valvular disease with greater than 1 year from last echocardiogram” is infrequently performed without significant adverse cardiac outcomes. Pre-operative echocardiography was associated with more anesthetic adjustments and longer time to surgery. Postoperative echocardiograms were done for cardiopulmonary complications. Studies need to examine and refine clinical parameters that would improve the selection of patients who would benefit from pre-operative echocardiograms.

Abbreviations: ACC/AHA = American College of Cardiology/American Heart Association, ASA = American Society of Anesthesiologist Physical Status, CHF = congestive heart failure, Class of Recommendation for Procedure: I = should be performed; IIa = reasonable; IIb = may be considered; III = no benefit, possible harm, COPD = chronic obstructive lung disease, CVA = cerebral vascular accident, HF = heart failure, LOE = level of evidence: A = multiple randomized control trials; B = one randomized trial or nonrandomized studies, C = consensus of expert opinion, LOS = length of hospital stay, LV = left ventricular, MACES = major adverse cardiac events, MI = myocardial infarction, PEA = pulseless electrical activity, pre-op echos = pre-operative echocardiograms, RCRI = Revised Cardiac Risk Index.

Keywords: fragility hip fractures, guidelines, pre-operative echocardiogram
1. Introduction

Pre-operative echocardiograms (pre-op echos) are commonly performed in patients undergoing non-cardiac surgery.\(^1\) However, when they are used and how they impact management has yet to be fully investigated.\(^2\) Studies indicate that the use of pre-op echos in non-cardiac surgery is often not consistent with the American College of Cardiology/American Heart Association (ACC/AHA) guidelines.\(^3,4\)

In 2014, the ACC/AHA released guidelines for ordering pre-op echos in patients undergoing non-cardiac surgery. These guidelines recommend pre-op echos in patients who had a change in clinical status or who have stable valvular heart disease and 1 year since their last echocardiogram. The guidelines find it reasonable to perform a pre-op echo in patients with dyspnea of unknown origin. A pre-op echo may be considered for patients with stable heart failure who are greater than 1 year from their last echo. The ACC/AHA do not recommend routine pre-op echos\(^5\) (Table 1).

The impact of pre-op echos on the management of patients undergoing hip surgery is unclear. Some studies suggest significant impact on management, while others have demonstrated low cardiac intervention rates.\(^6-8\) Studies have shown that unnecessary pre-op echos can delay time to surgery, increase length of hospital stay, and increase costs.\(^9\)

We analyzed the use of pre-op echos in acute fragility hip fractures at a single academic institution and aimed to determine if pre-op echo ordering is in line with the 2014 ACA/AHA guidelines, and what impact echo ordering has on patient management and outcomes.

Study outcomes include indications for pre-op echo, adherence to the 2014 ACC/AHA guidelines, perioperative anesthesia adjustments, length of hospital stay (LOS), time to surgery, incidence of major adverse cardiac events (MACEs) in the perioperative period, and 1-year mortality. Additional study outcomes examined which patients received postoperative echocardiograms and the incidence of MACE in this group.

2. Methods

This study was approved by the College of Medicine Institutional Review Board (IRB). The study was a retrospective chart review of all (402) patients admitted to a single academic medical institution with acute fragility hip fractures between years 2015 and 2019. Patients were identified retrospectively from Current Procedural Terminology (CPT) codes. Patient charts were examined. Information gathered from patient charts included:

- Patient characteristic (age, sex, past medical history, medications, cardiac and physical risk assessments);
- Echocardiogram study;
- Documented indication for echocardiogram;
- Clinically important echocardiogram findings;
- Perioperative changes from standard anesthesia;
- Perioperative major adverse cardiac events (MACE);
- Time to surgery;
- Length of hospital stay (LOS);
- Year mortality.

Of the 402 charts studied, 87 had indications for pre-op echo per the 2014 ACC/AHA guidelines. Of these, 42 received a pre-op echo, and this group of patients was compared to the 45 who despite having indications for a pre-op echo, did not receive one. Comparisons were made with regard to time to surgery, changes from standard anesthetic management, MACE, LOS, and 1-year mortality.

Time to surgery was defined as the time from hospital admission to the time of anesthetic induction. At our hospital, echocardiograms were readily available Monday through Friday, 9AM to 5PM and after hours and weekends by special request.

Standard anesthesia was considered to be general anesthesia using induction agents such as propofol, sodium thiopental, methohexitol or ketamine, opioid analgesics, and neuromuscular blocking agents with endotracheal intubation or a laryngeal mask airway. Standard monitors include continuous electrocardiogram, blood pressure measurements at 5-minute intervals, continuous pulse oximetry, capnography temperature monitoring, and inspired and exhaled oxygen concentration.

Perioperative changes from standard anesthetic management included any unplanned alterations to standard perioperative management made for cardiac reasons. Pre-operative change in management would include further cardiac testing or intervention such as angiogram or valve surgery. Intraoperative changes included preplanned adjustments to anesthetic technique such as neuraxial blockade vs. general anesthesia, the use of etomidate, norepinephrine, an arterial line or intraoperative transesophageal echocardiography. Postoperative changes included preplanned transfer to a surgical intermediate care unit or an intensive care unit.

MACE was defined by any of the following: myocardial infarction (MI), hypotensive shock, cardiac arrhythmia, hypoxic respiratory failure, pulseless electrical activity (PEA), or cardiopulmonary arrest that occurred during the index hospitalization.

LOS is defined as the time from hospital admission to the time of hospital discharge. One-year mortality was defined as all-cause mortality.

The inclusion criteria for the study were patients ≥50 years of age, admitted to the hospital and surgically treated between 2015 and 2019 for fragility hip fractures (defined as a fracture sustained from any fall from a standing height or less). CPT codes 27236, 27245, 27234, 27235, 27125, or 27130 and procedure codes 78.55, 79.15, 79.35, 81.52 captured fractures, dislocations, repairs, and reconstructions of the hip and pelvis.

Exclusion criteria included patients with non-operative hip fractures; patients <50 years of age; patients with a hip fracture

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**Table 1**

Summary of 2014 ACC/AHA guidelines for pre-operative echocardiogram.

| Recommendation                                      | Class     | Level of evidence |
|-----------------------------------------------------|-----------|-------------------|
| Pre-op echo for valvular heart disease              | I         | C                 |
| • One year since last echo                          |           |                   |
| • Change in clinical status                         |           |                   |
| • Since last evaluation                             |           |                   |
| Echo to assess left ventricular function            | IIa       | C                 |
| • Dyspnea of unknown origin or h/o heart failure    |           |                   |
| • Worsening dyspnea                                 |           |                   |
| • Stable CHF >1 yr since last echo                  | IIb       | C                 |
| • Routine pre-op                                   | III       | B                 |

ACC/AHA = American College of Cardiology/American Heart Association, pre-op echo = pre-operative echocardiogram, CHF = congestive heart failure, Class = Class of Recommendation for Procedure: I = should be performed; IIa = reasonable; IIb = may be considered; III = no benefit, possible harm, Level of evidence: A = multiple randomized control trials; B = 1 randomized trial or nonrandomized studies; C = consensus of expert opinion.
from a high-energy mechanism or from a traumatic accident; patients with pathologic fractures; or patients with a previous history of a hip fracture of the same extremity.

2.1. Statistics

Basic statistical analysis was conducted using online statistical software “Social Science Statistics.”\(^{[10–12]}\) Mann–Whitney \(U\) test was used to ensure normal distribution. Two tailed \(Z\)-score tests, and \(t\)-score test were used to establish comparison between independent means and proportions of the various study groups.

3. Results

A total of 402 patient charts were reviewed, 264 (66%) were female, 138 (34%) were male, and a mean age of 80 years old. Eighty-seven (22%) patients had indications for pre-op echo per the 2014 ACC/AHA guidelines. Of these, 42 (48%) received a pre-op echo and 45 (52%) did not. Only 20 patients out of the 87, (23%) received a pre-op echo for stable heart failure or valve disease with no echo in the past year. The pre-op echo indication for the 45 patients who did not receive one was “stable heart failure or valvular heart disease greater than 1 year since last echo.” Changes in clinical status were more frequent reasons for ordering the pre-op echo (25/87, 29%), including change in murmur, previous myocardial infarction, syncope, dyspnea, and atrial fibrillation (Table 2).

Comparing patients with ACC/AHA indications for an echo who did not receive a pre-op echo to those who did, there were no comparable differences in gender \((P=0.66)\), age \((P=0.23)\), Revised Cardiac Risk Index for pre-operative risk (RCRI) score \((P=0.19)\) or American Society of Anesthesiologists physical status classification (ASA) class \((P=0.71)\). There was no significant difference between the 2 groups in the incidence of hypertension, coronary artery disease, diabetes mellitus, history of myocardial infarction, valvular heart disease, chronic obstructive lung disease, or cerebral vascular accidents. Interestingly, there were more heart failure patients in the group who did not receive a pre-op echo \((P=0.02)\) (Table 3).

Compared to the group who did not receive the indicated pre-op echo, the group that did receive a pre-op echo had a significant increase in changes to standard anesthesia \((P=0.025)\) but also a significant 6-hour delay to surgery \((P<0.001)\). Differences in LOS, occurrence of MACE, and 1-year mortality were not statistically significant (Table 4).

Fourty-two echocardiograms were ordered postoperatively. Fourteen had indications for a pre-op echo, 8 of which were ordered pre-operatively but did not get done until after surgery (Fig. 1). Of these 14, 2 suffered an MI and 2 suffered hypotensive shock in the postoperative period. One MI and 1 hypotensive shock occurred in the 8 patients whose echo was ordered pre-

### Table 2

| Indication                        | Number | Percent |
|----------------------------------|--------|---------|
| Chronic stable heart failure     | 11     | 24      |
| Chronic stable valve disease     | 9      | 20      |
| New murmur                       | 10     | 22      |
| Previous myocardial infarction   | 6      | 13      |
| Syncope                          | 5      | 11      |
| Dyspnea                          | 2      | 4       |
| Atrial fibrillation              | 2      | 4       |

### Table 3

| Characteristics                  | All surgical fragility hip fracture patients | Patients who received pre-op echo (42 with ACC/AHA indications, 3 without) | Patients with ACC/AHA indications who did not receive pre-op echo | \(P\)  |
|----------------------------------|--------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------|------|
| Total patients                   | 402                                        | 45                                                          | 45                                                           | .66  |
| Female/male                      | 265/138                                    | 28/17                                                      | 30/15                                                        |      |
| Mean age                         | 80.4                                       | 85                                                         | 83                                                           | .23  |
| Mean ASA score                   | 2.9                                         | 2.8                                                      | 3.2                                                          | .71  |
| Mean RCRI score                  | 1.60%                                       | 2.40%                                                      | 3.45%                                                        | .19  |
| Hypertension                     | 271 (67%)                                  | 32 (71%)                                                  | 36 (80%)                                                     | .32  |
| Coronary artery Disease          | 92 (23%)                                   | 16 (35%)                                                  | 15 (33%)                                                     | .83  |
| Diabetes                         | 93 (23%)                                   | 12 (27%)                                                  | 12 (27%)                                                     | 1    |
| Previous myocardial infarction   | 41 (10%)                                   | 11 (24%)                                                  | 10 (22%)                                                     | .80  |
| Heart failure                    | 55 (14%)                                   | 7 (16%)                                                   | 17 (38%)                                                     | .02  |
| Valvular heart disease           | 39 (10%)                                   | 11 (24%)                                                  | 14 (31%)                                                     | .48  |
| COPD                             | 55 (14%)                                   | 3 (7%)                                                    | 7 (16%)                                                      | .18  |
| Previous CVA                     | 69 (17%)                                   | 7 (16%)                                                   | 14 (31%)                                                     | .08  |

### Table 4

| A total of 87 patients had pre-operative ACC/AHA indications for echocardiogram | Received pre-op echo | Did not receive pre-op echo | \(P\)  |
|-------------------------------------------------------------------------------|----------------------|-----------------------------|------|
| Number of patients                                                           | 42 (48%)            | 45 (52%)                    | .025 |
| Anesthetic adjustments                                                       | 25 (59%)            | 16 (35%)                    |      |
| Average time to surgery (h)                                                  | 16.0                | 10.1                        | <.001|
| Average length of hospital stay (d)                                          | 6.8                 | 5.5                         | .137 |
| Major adverse cardiac event (MACE)                                           | 5 (12%)             | 4 (9%)                      | .741 |
| One-year mortality                                                           | 14 (33%)            | 7 (16%)                     | .052 |

**ACC/AHA** = American College of Cardiology/American Heart Association.
operatively. Sixty-seven percent of the postoperative echocardiograms did not have ACC/AHA pre-operative indications but echos were ordered due to cardiopulmonary concerns. Echo findings included reduced ejection fraction, tricuspid and mitral regurgitation, and increased pulmonary arterial pressures. Ten MACE occurred in patients who did not have ACC/AHA indications for a pre-op echo. The incidence of a major adverse cardiac event was 10% in the ACC/AHA echocardiogram indicated group and 3% in the non-indicated echocardiogram group (Table 5).

4. Discussion

Few studies to date have looked at adherence to the 2014 ACC/AHA guidelines for pre-operative cardiac evaluation in non-cardiac surgery. Many of the studies that investigated adherence to the published guidelines were based on web based and simulated patient scenarios, finding guideline adherence rates ranging between 40% and 78%. We looked at all fragility hip fracture patients who had an indication for a pre-op echo according to the 2014 ACC/AHA echocardiogram guidelines and found a 48% adherence rate. The ASA and RCRI scores were compatible between the 2 groups as were the co-morbidities and age, except that heart failure was a more common diagnosis in the non-echo group. The criteria that was not followed consistently was the “greater than 1 year since last echo in patients with heart failure or valvular heart disease.” In the 45 patients who did not receive a pre-op echo, this was the indication not followed. Changes in clinical status were more frequent reasons for ordering the pre-op echo.

![Table 5](image)
Another focus of our study was to investigate the role of pre-op echos in guiding perioperative management and thereby affecting outcomes. In the patients who received a pre-op echo, we noted a significant increase in changes to standard anesthesia (39% vs 33%), consistent with Canty et al results that pre-operative cardiac investigation increased changes to management.[13] None of our patients underwent cardiac interventions such as angiography or valve repair. We found an average of a 6-hour delay to surgery in patients receiving a pre-op echo. Previous studies are inconsistent, some finding no delay and others finding a 1.5-day delay to the time to surgery.[7,10] We did not find any significant difference in outcomes between the 2 groups as measured by the incidence of MACE, LOS, or 1-year mortality. In contrast, Canty et al found a lower mortality rate in those who received a pre-op echo[13] and Marcantonio et al found that pre-op echos increased length of stay and increased costs.[9]

A near equal number of echocardiograms were performed postoperatively as pre-operatively. Ninety percent of the ACC/AHA indicated echocardiograms were ordered pre-operatively but not done until after surgery, indicating that echocardiography was not always easily readily available. Sixty-seven percent of the postoperative echocardiograms did not have ACC/AHA pre-operative indications. These echocardiograms were performed in response to postoperative cardiopulmonary concerns. Although these patients did have significant abnormal postoperative echo findings, it was difficult to determine if these findings were present pre-operatively. These findings highlight that there are missed clinical indications for a pre-op echo that are not captured by the ACC/AHA guidelines.

Our patients who received a pre-op echo had more changes from standard perioperative anesthesia, longer time to surgery, yet no significant difference in MACE events, 1-year mortality or LOS compared to those who had indications and did not receive a pre-op echo. The 2014 ACC/AHA indication of obtaining a pre-op echo in a patient with stable heart failure or valve disease if it’s been greater than 1 year since their last echo, was infrequently followed. The current guidelines are based on consensus of expert opinion and class I should be performed) for valvular disease and IIb (may be considered) for heart failure.[5] Our data demonstrates that a pre-op echo for these indications are infrequently followed without significant adverse outcomes.

5. Limitations

This is an observational study, with small sample size, done at a single institution. Our inclusion criteria only captured patients with fragility hip fractures who underwent a surgical repair. Therefore, if there were any patients who underwent a pre-op echo but were deemed too ill to undergo an operation, they were not captured in our study. This could introduce bias in our study, but the number would have been very small. As a retrospective study it was difficult to assess the clinical nuances of each patient. It was also difficult to assess the communication between the orthopedic, medicine, anesthesia, and cardiology specialties. We could only identify 1-year all-cause mortality and could not identify cardiac vs non-cardiac causes of 1-year mortality.

6. Conclusions

This study highlights that adherence to the 2014 ACC/AHA pre-op echo guideline of obtaining a pre-op echo in stable heart failure or valvular heart disease patients who have not had an echo in the past 1 year, is low. The low adherence rate did not affect outcomes. However, if the pre-op echo was ordered for changes in a patient’s clinical status, anesthetic management was adjusted and the delay to surgery was a few hours. Echocardiograms performed postoperatively in patients who had adverse cardiac events but no pre-operative ACC/AHA indications suggest that the current guidelines miss important clinical indications. Further studies need to examine and refine clinical parameters that would improve the selection of patients who would benefit from pre-operative echocardiograms.

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