Preoperative Echocardiography in Hip Fracture Patients: A Waste of Time or Good Practice?

Stavros G. Memtsoudis, MD, PhD, MBA

The debate surrounding the value of preoperative testing is as old as the field itself. However, few discussions have highlighted the issues involved as extensively as the perioperative management of patients with hip fractures.[1] The affected patient population represents a major challenge to health care systems worldwide both from a medical as well as an economic point of view.[2,3]

As the current treatment paradigm focuses on early surgical intervention and avoidance of unnecessary delays in an attempt to speed rehabilitation and improve outcomes, the role of traditional preoperative medical evaluation and optimization strategies has been put into question.[1,4]

Faced with a nonelective procedure that most commonly will need to be performed irrespective of patient comorbidities and risk of complications (unless nonsurgical or end of life care is deemed viable alternatives), a delay in the definitive treatment of a hip fracture patient has been suggested to be unnecessary and often unethical as it does not materially change management or/and may worsen outcome.[5]

Caught in this dilemma is the anesthesiologist who has to balance the need for expedient surgery on one side and sufficient information gathering and patient status optimization of immediately addressable problems on the other.

In this context, it is not uncommon that patients with significant chronic and acute cardiac disease processes are encountered leading to requests for further workup. Echocardiography for routine assessment of suspected cardiac disease is often performed with the goal of identifying pathology that might alter treatment.[5,6] However, there is little evidence to date that such practice alters outcomes.[7,8] The paucity of data on this topic is partially to blame on the fact that randomized controlled trials may be difficult (although not impossible) to undertake in a heterogeneous population such as hip fracture patients.

In an attempt to add to our knowledge, Yonekura et al[9] seek to address the association of preoperative echocardiography on perioperative outcomes in hip fracture patients using a population scientific approach. For this purpose, the authors utilized a large nationwide database from Japan and included records from tens of thousands of individuals over a time period of 8 years.

In their sample, approximately half of the patients underwent echocardiographic examination preoperatively. As expected, this patient population tended to be older and has higher comorbidity burden compared to those who did not receive the intervention, suggesting the presence of indication bias. After applying propensity score-matching methodology, the investigators failed to show a difference in the rates of in-hospital mortality, complications, and intensive care unit admissions leading them to conclude that there was no association between the use of preoperative echocardiography and in-hospital outcomes.[9]

While these findings derived from data collected from "real-world" practice without the confines of strict inclusion and exclusion criteria—as is common with randomized clinical trials—are highly important, population-based analyses such as these leave the reader not only with insights but also with unanswered questions.[10]

As stated by the authors carefully and correctly, one cannot draw firm conclusions from the data beyond determining associations. Causal relationships cannot be definitively determined as residual confounding remains. It therefore remains speculative what lead physicians to request an echocardiographic evaluation of their patients before surgery. We cannot know from these data if routine protocols were followed, if evaluations were based on abnormal clinical exams or history, or if other concerns were drivers for such an examination. However, these data clearly suggest that older age and increased comorbidity burden may have affected this decision. While statistical methodologies, like propensity score matching, are used to control for differences in covariates, matching remains incomplete and relies solely on variables available. Unmeasured variables containing clinical details and decision-making processes are not taken into consideration.

The inability to establish causal relationships leaves the possibility of an entirely different interpretation of results open. It is possible that no difference in outcomes was found between those who did and those who did not receive a preoperative echocardiogram, precisely because the use and findings of the echocardiographic intervention lead to care that improved outcomes in a population that would have otherwise fared worse. In this context, it is important to

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mention that it is not the test that changes outcome but the decisions made based on the findings derived from the examination. It is of note that there is some indication that patients who received an echocardiogram did indeed receive different care. This group was associated with a more frequent use of hemiarthroplasties versus internal fixations, blood transfusions as well as general versus neuraxial anesthesia—all which may be related to the patient's pathology but nevertheless reported to possibly affect outcomes.[11] A longer length of stay was also associated with the use of echocardiography, posing the question if such intervention is a surrogate marker for changes in perioperative care,[9] further suggesting the possibility that the use of this test delayed surgery and/or prolonged hospitalization due to logistic reasons.

In conclusion, Yonekura et al[9] present important information and incrementally add to our current knowledge of the subject. Just as with all population-based studies, where definitive causality cannot be established, one must apply the measure of logical plausibility and examine possible explanations for the various findings. These then become the basis for specific hypotheses for targeted mechanistic studies that can individually address the questions unearthed by observational data. Thanks to investigations such as the one presented by Yonekura et al,[9] we gain insights into the realities of daily practice leaving us with the opportunity to study why we see what we see.

Until such answers can be produced allowing us to more definitively determine if and which patients benefit from perioperative echocardiography, its utility in patients with hip fractures awaiting surgery remains elusive. However, concerns purely related to cost and logistics related to echocardiography may be addressable with advances in technology and education in the form of point-of-care ultrasonography.[12] Anesthesiologists who do not just want to assume the worst when proceeding to the operating room and have reason to suspect cardiac abnormalities that might change their management or raise their level of vigilance may be able to deploy this cost-effective diagnostic tool at the bedside without significant delay. But once again, we will have to wait for evidence for this assumption as well.

DISCLOSURES

Name: Stavros G. Memtsoudis, MD, PhD, MBA.
Contribution: This author helped conceptualize this editorial, prepare the manuscript, and solely responsible for its content.
Conflicts of Interest: S. G. Memtsoudis is a one-time consultant for Teikoku and Sandoz. He is a patent holder for Multicatheter Infusion System [US Patent No. US-2017-0361063]. He is a owner of SGM Consulting, LLC. He is a co-owner of FC Monmouth, LLC and FC Monmouth Academy, LLC. None of these relationships have influenced the work presented here.
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Preoperative Echocardiography for Patients With Hip Fractures Undergoing Surgery: A Retrospective Cohort Study Using a Nationwide Database

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BACKGROUND: The effect of preoperative transthoracic echocardiography on the clinical outcomes of patients with hip fractures undergoing surgical treatment remains controversial. We hypothesized that preoperative echocardiography is associated with reduced postoperative morbidity and improved patient survival after surgical repair of hip fractures.

METHODS: Drawing from a nationwide administrative database, patients undergoing hip fracture surgeries between April 1, 2008 and December 31, 2016 were included. We examined the association of preoperative echocardiography with the incidence of in-hospital mortality using propensity score matching. Secondary outcomes included postoperative complications, the incidence of postoperative intensive care unit admissions, and length of hospital stay. For sensitivity analyses, we restricted the overall cohort to include only hip fracture surgeries performed within 2 days from admission.

RESULTS: Overall, 34,679 (52.1%) of 66,620 surgical patients underwent preoperative echocardiography screening. The screened patients (mean [SD] age, 84.3 years [7.7 years]; 79.0% female) were propensity score matched to 31,941 nonscreened patients (mean [SD] age, 82.1 years [8.7 years]; 78.2% female). The overall in-hospital mortality, before propensity matching, was 1.8% (1227 patients). Propensity score matching created a matched cohort of 25,205 pairs of patients. There were no in-hospital mortality differences between the 2 groups (screened versus nonscreened: 417 [1.65%] vs 439 [1.74%]; odds ratio, 0.95; 95% confidence interval, 0.83–1.09; $P = .45$). Preoperative echocardiography was not associated with reduced postoperative complications and intensive care unit admissions. In sensitivity analysis, we identified 25,637 patients from the overall cohort (38.5%) with hip fracture surgeries performed within 2 days of admission. There were no in-hospital mortality differences between the 2 groups (screened versus nonscreened: 1.67% vs 1.80%; odds ratio, 0.93; 95% confidence interval, 0.72–1.18; $P = .53$). Findings were also consistent with other sensitivity analyses and subgroup analyses.

CONCLUSIONS: This large, retrospective, nationwide cohort study demonstrated that preoperative echocardiography was not associated with reduced in-hospital mortality or postoperative complications. (Anesth Analg 2019;128:213–20)

KEY POINTS

- **Question:** What is the effect of preoperative transthoracic echocardiography on mortality and morbidity in hip fracture surgery in real-world practice?
- **Findings:** Preoperative transthoracic echocardiography was not associated with reduced in-hospital mortality or postoperative complications.
- **Meaning:** Preoperative transthoracic echocardiography does not seem to affect clinical outcomes after hip fracture surgery.

Worldwide, the number of individuals with hip fractures is rapidly increasing due to the increasing age of the population; these injuries are becoming a public health burden. In Japan, the number of people ≥65 years of age had almost doubled over the preceding 20 years, resulting in the world's highest proportion of elderly individuals.[1] Among this rapidly expanding elderly population, the incidence of new hip fractures was estimated to be approximately 190,000 in 2012, anticipated to rise to 320,000 by 2040.[2] Most hip fractures are age related, and, therefore, these patients are more likely to have additional risks associated with their advanced age including high systemic burdens and high operative risks.[3] Patients with hip fractures frequently experience multiple

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comorbidities, especially cardiovascular disease, and are at risk for cardiovascular and pulmonary complications that result in postoperative mortality.[4] Previous studies have demonstrated that 39% of patients undergoing hip fracture surgeries had elevated troponin levels, suggesting perioperative myocardial injuries.[5] Thus, hip fracture surgery is associated with a high morbidity and is a frequent cause of mortality among elderly patients. In fact, 5.1% (United Kingdom)[6] and 2.1% (Japan)[7] of these patients die within 30 days of their hip fracture surgeries. Alarmingly, few interventions have been shown to decrease the high perioperative morbidity and mortality rates of these surgeries.

According to the 2014 American College of Cardiology/American Heart Association practice guidelines,[8] a patient's functional capacity plays an important role in their perioperative cardiovascular evaluation. However, patients with hip fractures often have high burdens of existing comorbidities, dementia, immobility, and/or frailty,[3] therefore hampering accurate clinical assessments. In these patients, preoperative diagnostic testing may prove beneficial by allowing preoperative identification of cardiac abnormalities.

Transthoracic echocardiography (TTE) allows for a qualitative and quantitative assessment of cardiac morphology and function and helps diagnose specific cardiac pathologies, such as cardiac failure and aortic stenosis, and the patient's hemodynamic status, including volume status, which cannot be reliably diagnosed through clinical examination. In elderly patients with hip fractures, the prevalence of moderate or severe aortic stenosis may be as high as 8%, and it is difficult to detect through physical examination alone.[9] A recent systematic review of echocardiography in anesthesia and critical care[10] demonstrated that underlying cardiac pathology, detected by echocardiography, might change the diagnosis in 17%–78% of cases. Thus, preoperative identification of cardiac abnormalities may improve perioperative management, leading to reduced postoperative morbidity and mortality.[11]

Despite its clinical and public health importance, there is a dearth of results available regarding whether preoperative TTE is associated with improved survival for patients undergoing surgical treatment of hip fractures. If preoperative TTE does not provide clinical benefits, this would warrant a reconsideration of the clinical utility of this technique which is costly and time consuming. Our primary objective was to determine whether preoperative TTE improves in-hospital mortality rates among elderly patients undergoing hip fracture surgery using data from a large, nationwide database.

METHODS

This retrospective cohort study conforms to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[12] Further, this study was approved by the Ethics Committee of Kyoto University Graduate School and Faculty of Medicine (approval number: R0724-1; April 26, 2017), which waived the need for informed consent due to the anonymized nature of the data.

Data Source

Using a multihospital claims database provided by Medical Data Vision (Tokyo, Japan), we collected Japanese diagnosis, procedure, and combination (DPC) inpatient data.[13] The majority of acute care hospitals in Japan have introduced the DPC/per diem payment system, which is similar to the US prospective payment system that uses diagnosis-related groups.[14] The database used is one of the largest databases available in Japan, and between 2008 and 2017, had accumulated DPC data for 20 million patients admitted to >270 acute care hospitals, representing approximately 16% of DPC hospitals in Japan.[15] This database contains patient demographic information; clinical summary data (clinical diagnoses on admission, comorbidities on admission, complications after admission, using the *International Classification of Diseases, 10th Revision* [ICD-10]); claims data for medication and devices used; medical and surgical procedures defined using Japan-specific standardized codes (K codes); lengths of stay; and discharge status. The diagnoses and procedures are directly linked with the Japanese fee schedule for reimbursement,[16] and the disease diagnoses were recently validated.[17]

Study Population

The study population included elderly patients (>60 years of age) undergoing hip fracture surgeries between April 1, 2008 and December 31, 2016. Hip fractures were defined using ICD-10 codes S72.0 (fracture of the femoral neck) or S72.1 (intertrochanteric fracture). We restricted the patients to those who had been surgically treated and assigned at least one of the following treatment codes: open reduction of fracture with internal fixation (K0461, K0731), hemiarthroplasty (K0811), or total hip arthroplasty (K0821). We excluded patients with ICD-10 codes suggestive of multiple trauma, concomitant with other fractures and injuries (S02, S06, S12, S22, S26, S27, S32, S36, S37, S42, S52, S62, S82, S92) and accidents (V01–V99). We also excluded patients who were treated conservatively or had missing information pertaining to survival to discharge. For patients undergoing multiple episodes of hip fracture surgeries, only the first episode was included.

Outcomes

The primary outcome was in-hospital mortality. Secondary outcomes included postoperative complications (cardiac and pulmonary) (Supplemental Digital Content 1, Table 1, http://links.lww.com/AA/C623),[18] the incidence of postoperative intensive care unit (ICU) admissions, and length of hospital stay.

Exposure Variables and Covariates

We used claims information to identify the principal exposure to TTE performed between admission and the index surgery.

Covariates included variables that were specified, a priori, as potential confounders based on clinical plausibility.[19] We extracted data, including patient demographics (age and sex), comorbidities, type of fracture, type of admission (ie, via ambulance service), Japan Coma Scale score on admission, preoperative medical intervention (transfusion, dialysis, ICU admission, and mechanical ventilation), type of anesthesia, type of hip fracture surgery, and hospital status and type.

The comorbidities were assessed using the selected Charlson and Elixhauser comorbidity measures.[20] The Charlson comorbidity index (CCI) score has been validated in large administrative databases used in Japan.[21] The Japan Coma Scale score, which is a neurological dysfunction score, correlates with the Glasgow Coma Scale: 0 (alert), 1–3 (drowsy), 10–30 (somnolence), and 100–300 (comatose).[16] Based on the claims codes, the anesthesia type was categorized as either general or regional. Each hospital status was classified according to its number of beds (<199, 200–499, or ≥500 beds), and the hospital type was categorized as either teaching or nonteaching.

Statistical Analysis

Patients, surgical, and hospital characteristics were summarized for both patients who underwent or did not undergo TTE. To assess the degree of imbalance between the TTE and non-TTE groups, we used standardized mean differences (SMDs). We applied propensity score matching to balance the covariates between the groups, control for selection bias, and enable study groups to be comparable.[22,23] The propensity score was defined as each patient's probability of undergoing preoperative TTE based on his/her individually observed covariates. We used a nonparsimonious multivariable logistic regression model to estimate a propensity score for preoperative TTE based on the previous covariates. Missing data were treated as a separate category, which were excluded from regression models.[18] Patients in the TTE and non-TTE groups were matched using a 0.2 SD caliper of the log odds of the propensity score, without replacement; an absolute SMD >10% indicates meaningful imbalance.[24,25] After confirming this, the associations between preoperative TTE and in-hospital mortality, postoperative complications, and postoperative ICU admission were assessed using constructed binomial models that used matched-set conditional logistic regression to estimate the adjusted odds ratio (OR) and 95% confidence interval (CI). The continuous outcomes, namely lengths of hospital stay, were compared using paired *t* tests to estimate differences in days with 95% CI.

Sensitivity analyses were also performed to test the robustness of our results. First, we restricted the overall cohort to include only hip fracture surgeries performed within 2 days from admission because the recommended timing for surgery is within 48 hours of hospital admission, according to US practice guidelines.[26] We repeated the propensity matching analysis of preoperative TTE and in-hospital mortality in this subcohort. Second, we performed another propensity score approach,[27] with stratification of the propensity score to minimize the selection bias. After stratifying by quintiles of propensity for TTE, within each quintile, patients managed with preoperative TTE were compared with patients managed without TTE for each of the covariates. Finally, we performed a multiple imputation method to impute the missing variables by fully conditional specification.[28]

In addition, we tested the potential for effect modification in several subgroup analyses (the type of anesthesia, the type of hip fracture, CCI score, and propensity score quintile). In each subgroup characteristics, we repeated the propensity score matching analysis of preoperative TTE and in-hospital mortality. In these subgroups, we used the CCI score and propensity score quintile for proxies of systemic burden. Higher CCI scores or higher propensity scores (ie, high possibility of receiving preoperative TTE) could indicate more comorbidity burden in patients, suggesting that there could be subgroups considered as high risk.

Sample size justification was performed. Based on 66,620 patients who would be eligible for our study and previous data[7] (in-hospital mortality in non-TTE groups was set to be 2.1%), we could detect an improved in-hospital mortality of 1.8% in TTE groups with 90% power and the α level at 5%. Thus, the number of cases in the database during the study period was sufficient to estimate the primary objective of this study. A 2-sided α level of .05 was considered statistically significant. All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC).

RESULTS

Study Cohort and Patient Characteristics

The Figure shows the study flow diagram. Between April 1, 2008 and December 31, 2016, we identified 86,532 patients with hip fractures. After excluding 19,912 patients, the final cohort consisted of 66,620 patients with hip fractures who underwent surgery. Overall, 34,679 (52.1%) of the 66,620 surgical patients were screened using preoperative TTE. The median number of days (interquartile range) when TTE was performed after hospital admission was 1 (0–2). The proportion of patients receiving postoperative TTE in the TTE groups and non-TTE groups was 4.5% and 4.2%, respectively.

Tables 1 and 2 show the baseline patient characteristics. Missing values accounted for <1% of all variables. Patients undergoing TTE screening were older, more likely to have cardiac comorbidities (eg, arrhythmia, valvular disease, or congestive heart failure) on admission, higher burdens of systemic disease (higher CCI scores), more likely to have received preoperative interventions (especially transfusions), more likely to have undergone general anesthesia, and more likely to have received hemiarthroplasty. After propensity score matching, the baseline characteristics between the 2 groups were well balanced, as assessed by an absolute SMD of <10%.

Primary and Secondary Outcomes

The overall in-hospital mortality was 1.84% (1227/66,620). Before the adjusted analyses, the incidence of in-hospital mortality among patients undergoing preoperative TTE was 2.02% (701/34,679), which was significantly higher than the 1.65% (526/31,941) incidence among those not undergoing TTE (unadjusted OR, 1.23; 95% CI, 1.10–1.38; P = .0003). After propensity score matching, the incidence of in-hospital mortality in patients undergoing TTE was 1.65% (417/25,205), which was not significantly different from the incidence of 1.74% (439/25,205) among those not undergoing TTE (adjusted OR, 0.95; 95% CI, 0.83–1.09; P = .45). The postoperative complications and ICU admissions were not significantly different between the 2 groups. The overall lengths of hospital stay were significantly longer for patients undergoing TTE than for those not

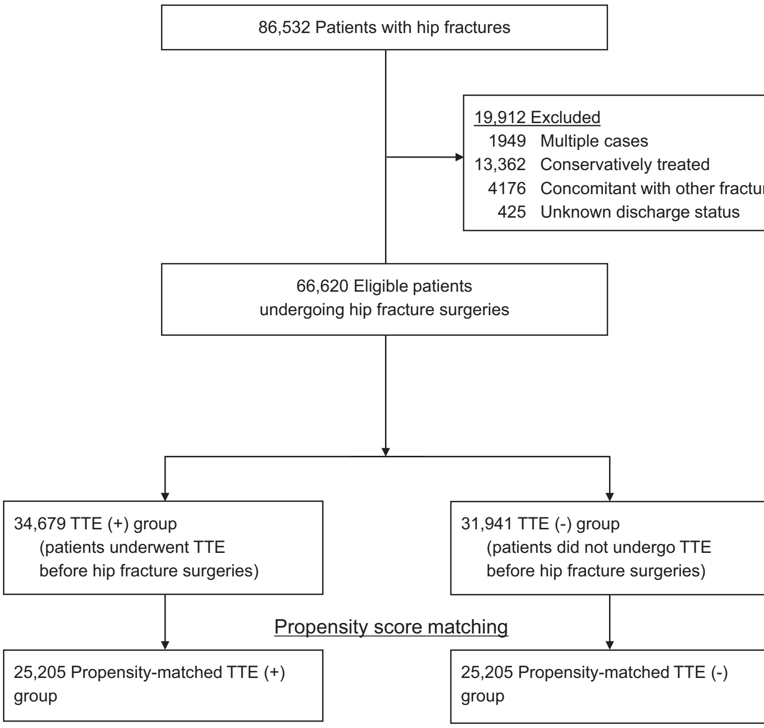

Figure. Study flow diagram. TTE indicates transthoracic echocardiography.

Table 1. Characteristics of Patients With Hip Fractures Undergoing or Not Undergoing Preoperative TTE

	Before Propensity Matching			After Propensity Matching		
Characteristic	**TTE (+) (N = 34,679)**	**TTE (−) (N = 31,941)**	**Standardized Difference, %**	**TTE (+) (N = 25,205)**	**TTE (−) (N = 25,205)**	**Standardized Difference, %**
Age, y, mean (SD)	84.3 (7.7)	82.1 (8.7)	26.0	83.3 (7.9)	83.4 (8.1)	1.6
Age, y, n (%)						
<70	1713 (4.9)	3356 (10.5)		1598 (6.3)	1750 (6.9)	
70–79	6521 (18.8)	7314 (22.9)		5443 (21.6)	5199 (20.6)	
80–89	17,532 (50.6)	14,887 (46.6)		12,736 (50.5)	12,492 (49.6)	
≥90	8913 (25.7)	6384 (20.0)		5428 (21.5)	5764 (22.9)	
Sex, women, n (%)	27,406 (79.0)	24,963 (78.2)	2.1	19,794 (78.5)	19,886 (78.9)	0.9
Comorbidities on admission, n (%)						
Hypertension	16,542 (47.7)	14,282 (44.7)	6.0	11,728 (46.5)	11,744 (46.6)	0.1
Diabetes mellitus	6494 (18.7)	5557 (17.4)	3.5	4581 (18.2)	4576 (18.2)	0.1
Any cardiac arrhythmia	4023 (11.6)	2262 (7.1)	15.6	2168 (8.6)	2104 (8.3)	0.9
Cardiac valvular disease	3676 (10.6)	1065 (3.3)	28.8	1175 (4.7)	1052 (4.2)	2.4
Myocardial infarction	900 (2.6)	426 (1.3)	9.1	440 (1.7)	404 (1.6)	1.1
Congestive heart failure	5204 (15.0)	2978 (9.3)	17.5	2863 (11.4)	2705 (10.7)	2.0
Peripheral vascular disease	906 (2.6)	629 (2.0)	4.3	576 (2.3)	545 (2.2)	0.8
Cerebrovascular disease	5492 (15.8)	4440 (13.9)	5.4	3791 (15.0)	3734 (14.8)	0.6
Chronic pulmonary disease	2298 (6.6)	1983 (6.2)	1.7	1615 (6.4)	1609 (6.4)	0.1
Chronic renal failure	2198 (6.3)	1591 (5.0)	5.9	1374 (5.5)	1319 (5.2)	1.0
Dementia	7169 (20.7)	5878 (18.4)	5.7	4977 (19.7)	4963 (19.7)	0.1
Charlson comorbidity index score, median (IQR)	1 (0–2)	1 (0–2)	NA	1 (0–2)	1 (0–2)	NA
Charlson comorbidity index score, n (%)			11.1			2.9
0–1	22,292 (64.3)	22,192 (69.5)		16,843 (66.8)	17,184 (68.2)	
2	6383 (18.4)	5139 (16.1)		4390 (17.4)	4209 (16.7)	
≥3	6004 (17.3)	4610 (14.4)		3972 (15.8)	3812 (15.1)	

Values are presented as frequencies (%) unless stated otherwise.
Abbreviations: IQR, interquartile range; NA, not available; SD, standard deviation; TTE, transthoracic echocardiography.

undergoing TTE (difference, 3.54 days; 95% CI, 3.10–3.98; $P < .0001$). The preoperative length of stay was longer for patients undergoing TTE than for those not undergoing TTE (difference, 2.05 days; 95% CI, 1.98–2.12; $P < .0001$) (Table 3).

We performed 3 sensitivity analyses. After restricting the overall cohort to include only hip fracture surgeries performed within 2 days of admission, we identified 25,637 patients among the overall cohort (38.5%). Among these, 7600 pairs of patients (a total of 15,200 patients) were

Table 2. Surgical and Hospital Characteristics of Patients With Hip Fractures Undergoing or Not Undergoing Preoperative TTE

Characteristic	Before Propensity Matching TTE (+) (N = 34,679)	Before Propensity Matching TTE (−) (N = 31,941)	Before Propensity Matching Standardized Difference, %	After Propensity Matching TTE (+) (N = 25,205)	After Propensity Matching TTE (−) (N = 25,205)	After Propensity Matching Standardized Difference, %
Type of fracture, n (%)			11.1			2.9
Femoral neck fracture	18,618 (53.7)	16,387 (51.3)		13,113 (52.0)	13,023 (51.7)	
Intertrochanteric fracture	16,061 (46.3)	15,554 (48.7)		12,092 (48.0)	12,182 (48.3)	
Type of admission, n (%)						
Emergency department via ambulance	18,885 (54.5)	17,206 (53.9)	1.2	13,744 (54.5)	13,740 (54.5)	0.03
Japan Coma Scale on admission, n (%)			1.5			0.8
0 (alert)	30,048 (86.6)	27,671 (86.6)		21,837 (86.6)	21,861 (86.7)	
1–3 (drowsy)	4447 (12.8)	4116 (12.9)		3254 (12.9)	3220 (12.8)	
10–30 (somnolence)	153 (0.4)	136 (0.4)		100 (0.4)	111 (0.4)	
100–300 (comatose)	31 (0.1)	16 (0.1)		14 (0.1)	13 (0.1)	
Missing	0 (0)	2 (0.0)				
Preoperative management, n (%)						
Transfusion	4602 (13.3)	2049 (6.4)	23.2	2077 (8.2)	2017 (8.0)	0.9
Dialysis	724 (2.1)	408 (1.3)	6.3	392 (1.6)	373 (1.5)	0.6
ICU admission	57 (0.2)	21 (0.1)	2.9	19 (0.1)	19 (0.1)	0
Mechanical ventilation	70 (0.2)	23 (0.1)	3.5	20 (0.1)	22 (0.1)	0.3
Type of anesthesia, n (%)			3.5			0.3
General anesthesia	21,778 (62.8)	15,431 (48.3)		14,031 (55.7)	13,986 (55.5)	
Regional anesthesia	12,813 (36.9)	16,328 (51.1)		11,174 (44.3)	11,219 (44.5)	
Missing	88 (0.3)	182 (0.6)				
Type of surgical procedure, n (%)			16.0			0.7
Internal fixation	21,460 (61.9)	22,162 (69.4)		16,461 (65.3)	16,403 (65.1)	
Hemiarthroplasty	12,979 (37.4)	9550 (29.9)		8557 (33.9)	8624 (34.2)	
Total hip arthroplasty	240 (0.7)	229 (0.7)		187 (0.7)	178 (0.7)	
Teaching hospital, n (%)	1909 (5.5)	1570 (4.9)	2.7	1359 (5.4)	1337 (5.3)	0.4
Beds, n (%)			23.2			0.6
<199	3062 (8.8)	2510 (7.9)		2192 (8.7)	2170 (8.6)	
200–499	23,849 (68.8)	18,994 (59.5)		16,425 (65.2)	16,495 (65.4)	
≥500	7767 (22.4)	10,435 (32.7)		6588 (26.1)	6540 (25.9)	
Missing	1 (0.0)	2 (0.0)				

Values are presented as frequencies (%) unless stated otherwise.
Abbreviations: ICU, intensive care unit; TTE, transthoracic echocardiography.

matched; the incidence of in-hospital mortality among patients undergoing TTE was 1.67%, which was not significantly different from the 1.80% of those not undergoing TTE (adjusted OR, 0.93; 95% CI, 0.72–1.18; P = .53). Results of the other sensitivity analysis were consistent with the main results for propensity score stratification (adjusted OR, 0.95; 95% CI, 0.83–1.08; P = .43) and imputation analysis (adjusted OR, 0.98; 95% CI, 0.86–1.12; P = .82). The potential effect modification in several subgroup analyses was not observed (Table 4).

DISCUSSION

We investigated the association between preoperative TTE screening and in-hospital mortality in patients undergoing surgical treatment of hip fractures. Using a propensity score-matched cohort that included >50,000 patients from a nationwide Japanese inpatient database, we found that preoperative TTE was not associated with mortality or postoperative complications.

No published trials have investigated TTE screening for patients with hip fractures, and comparative data examining TTE effectiveness are limited. Although a few observational studies have examined the effect of TTE on perioperative outcomes, their different types of echocardiography examination and population heterogeneity, compared with those in the present study, may partially explain the conflicting results.[29,30] One retrospective observational study involving 130 participants reported that preoperative TTE may have some benefits for patients with cardiac risk undergoing surgical hip fracture treatment.[29] The authors reported changes in cardiac diagnosis and management in 78% and 52% of the patients, respectively. The 30-day mortality was significantly lower in the preoperative focused TTE group (4.7% vs 15.2%). In our study, preoperative TTE required a standard comprehensive examination performed by trained technicians, unlike focused TTE. Focused TTE is a point-of-care procedure, performed in real time at the patient's bedside, which allows for a quick assessment of cardiac function. Our study captured data from a larger number of patients with sufficient power to investigate association with in-hospital mortality. Moreover, we used propensity score matching to minimize bias from nonrandomized intervention.

Evidence was also provided by an observational study involving a Canadian population-based cohort that suggested routine preoperative TTE is not associated with improved mortality after noncardiac surgery, including hip fracture surgery.[30] The authors suggested that information

Table 3. Primary and Secondary Outcomes, According to the Propensity Score Matching Analysis

Outcomes	Overall Cohort Analysis					Matched Cohort Analysis[a]				
	TTE (−) N = 31,941	TTE (+) N = 34,679	Odds Ratio (95% CI)	Difference in Days (95% CI)	P Value	TTE (−) N = 25,205	TTE (+) N = 25,205	Odds Ratio (95% CI)	Difference in Days (95% CI)	P Value
In-hospital mortality	526 (1.65)	701 (2.02)	1.23 (1.10–1.38)		.0003	439 (1.74)	417 (1.65)	0.95 (0.83–1.09)		.45
Postoperative cardiac complications	112 (0.35)	142 (0.41)	1.17 (0.91–1.50)		.22	102 (0.40)	99 (0.39)	0.97 (0.74–1.28)		.83
Postoperative pulmonary complications	1459 (4.57)	1749 (5.04)	1.11 (1.03–1.19)		.0042	1242 (4.93)	1158 (4.59)	0.93 (0.85–1.01)		.077
Postoperative ICU admission	111 (0.35)	221 (0.64)	1.84 (1.46–2.31)		<.0001	93 (0.37)	117 (0.46)	1.26 (0.96–1.66)		.097
Length of hospital stay, estimate (95% CI) (d)[b]	32.9 (32.6–33.2)	38.6 (38.4–38.9)		5.73 (5.35–6.12)	<.0001	34.1 (33.8–34.4)	37.6 (37.3–38.0)		3.54 (3.10–3.98)	<.0001
Preoperative length of stay	3.18 (3.14–3.22)	5.49 (5.44–5.54)		2.31 (2.25–2.37)	<.0001	3.29 (3.25–3.34)	5.34 (5.29–5.39)		2.05 (1.98–2.12)	<.0001

Abbreviations: CI, confidence interval; ICU, intensive care unit; TTE, transthoracic echocardiography.
[a]Propensity score model included all covariates listed in Tables 1 and 2.
[b]Patients who died before discharge were excluded from the analysis of length of stays.

obtained from preoperative TTEs did not add effective information beyond that provided by the patient's clinical symptoms. Our population included a homogeneous population of patients with hip fractures, which are more common in older patients and women. This is important because the prevalence of comorbidities, including cardiac pathology, and low activity of daily living and frailty[3] are expected to increase with increasing age. In a nationwide study in Japan,[7] the mean age for patients with hip fractures was 83 years, and 36% of the patients had ≥1 medical comorbidity, consistent with our population. Therefore, our study on the impact of preoperative TTE in elderly patients with hip fractures had high internal validity.

Our study demonstrated that preoperative TTE is not associated with reduced postoperative complications or postoperative ICU admissions. Although TTE could change the clinical course, these data were not available in our data set. Therefore, we have examined postoperative ICU admission as a proxy of the effect of preoperative TTE. In addition, preoperative TTE was not associated with a reduced incidence of postoperative cardiac and pulmonary complications, which were clinically relevant complications that could result in postoperative mortality.

Our study also demonstrated that preoperative length of stays in TTE groups increased by 62% compared with those of the non-TTE groups. These results should be interpreted with caution. Previous studies suggested that patients with multiple comorbid illnesses need medical optimization preoperatively.[31,32] As a consequence, preoperative TTE screening and following tests or treatments might lead to surgical delay. Alternatively, as a previous study has demonstrated,[29] focused TTE may have some benefits for patients with hip fractures, without delaying intervention. An upcoming randomized control study, "Trial of Focused Cardiac Ultrasound for Fractured Neck of Femur Surgery (ECHONOFII)," will investigate the benefits of focused echocardiography before hip fracture surgery.[19] Although randomized clinical trials provide strong evidence, they may also lack generalizability and may not reflect real-world settings because of their strict exclusion criteria. The results of our study are expected to be complementary to the upcoming clinical trial. Results of retrograde and prospective studies may influence clinical practice in the context of a rapidly expanding population of patients requiring hip fracture surgeries worldwide. Our study provides important lessons for other countries that will likely face similar challenges.

This study has limitations. It may have limited generalizability to other countries with different types of health services. There are broad discrepancies between Japan and Western countries regarding clinical practice and outcomes. According to an international survey, the lengths of hospital stays in Japan are twice the lengths of those in other developed countries,[33] consistent with our results. Although the mean preoperative length of stay (4.4 days) in our study was longer than that previously reported in Canada (38.8 hours),[18] in-hospital mortality (1.8%, consistent with a previous study[7]) was much lower than that reported in the United Kingdom (5.1%)[6] and Canada (7.0%).[18] In accordance with US guidelines,[26] we examined a subcohort that included only hip fracture surgeries performed within 2

Table 4. Subgroup Analyses: Number of Events and Risk of In-Hospital Mortality in Patients Undergoing Hip Fracture Surgery With or Without Preoperative TTE

	No. In-Hospital Deaths/No. Patients (%)			
	TTE (−)	TTE (+)	Odds Ratio (95% CI)	*P* Value
Main Analysis	439/25,205 (1.74)	417/25,205 (1.65)	0.95 (0.83–1.09)	.45
Subgroup Analyses				
Type of anesthesia				.41[a]
General	231/13,844 (1.67)	213/13,844 (1.54)	0.92 (0.76–1.11)	
Regional	214/11,293 (1.89)	234/11,293 (2.07)	1.10 (0.91–1.32)	
Type of hip fracture				.63[a]
Femoral neck	204/12,976 (1.57)	220/12,976 (1.70)	1.08 (0.89–1.31)	
Intertrochanteric	239/12,213 (1.96)	229/12,213 (1.88)	0.96 (0.80–1.15)	
Charlson comorbidity index score				.78[a]
0–1	232/16,872 (1.38)	236/16,872 (1.40)	1.02 (0.85–1.22)	
2	92/4336 (2.12)	100/4336 (2.31)	1.09 (0.82–1.46)	
≥3	131/3979 (3.29)	109/3979 (2.74)	0.83 (0.64–1.07)	
Propensity score quintile[b]				.21[a]
Q1 (lowest)	41/4155 (0.99)	48/4155 (1.16)	1.17 (0.77–1.78)	
Q2	82/5755 (1.42)	79/5755 (1.37)	0.96 (0.71–1.31)	
Q3	88/6248 (1.41)	112/6248 (1.79)	1.29 (0.97–1.72)	
Q4	110/5271 (2.09)	97/5271 (1.84)	0.88 (0.67–1.16)	
Q5 (highest)	116/3574 (3.25)	93/3574 (2.60)	0.80 (0.61–1.05)	

Abbreviations: CI, confidence interval; Q, quintile; TTE, transthoracic echocardiography.
[a]*P* for interaction.
[b]Stratifying by quintiles of propensity score for preoperative TTE.

days of admission, but still found no statistically significant difference in in-hospital mortalities between patients in both groups. The cause of this discrepancy between Japan and Western countries remains unknown and is difficult to explain. Socioeconomic development, free access to health care under universal health coverage, and progress in health technologies may contribute to the lower mortality rate in Japan, compared with that in other developed countries.[1]

Second, our study does not imply causation between preoperative TTE and outcome. This potential confounding by indication may make our study difficult to interpret. We used propensity score matching to adjust for all relevant confounders and their proxies that might be associated with the choice of TTE tests and to minimize selection bias. We also performed several sensitivity analyses and subgroup analyses to test the robustness of our results. Despite these efforts, some information on some potential confounding factors, such as relevant clinical information (functional status before the injury, assessment of frailty, cardiopulmonary function, and pain management) and clinical indication of diagnostic tests, may have resulted in residual confounding to the extent that these factors could not be fully accounted for through adjustment for relevant confounders and their proxies used in our study.

Finally, the anonymous nature of our database prevents identification of the physician ordering TTE screenings or the hospitals at which they occurred. Both might have influenced ordering a preoperative TTE. We cannot adjust for clustering effects within perioperative teams or institutions. However, we attempted to mitigate the effect of unmeasured institution-related confounders by matching other hospital factors, such as the number of beds and teaching hospital status.

In conclusion, our results did not show an association between preoperative TTE and in-hospital mortality in hip fracture patients. Further research is needed to see if a relationship exists.

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