

Integrated Fragility Hip Fracture Program: A Model for High Quality Care

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BACKGROUND: Hip fractures are a significant cause of morbidity and mortality among elderly patients. Coordinated multidisciplinary care is required to optimize medical outcomes.

OBJECTIVE: To determine the effect of the implementation of standardized, evidence-based protocols on clinical outcomes and mortality in patients with fragility hip fractures.

INTERVENTIONS: A multidisciplinary group was convened to define best practices in fragility hip fracture care and implement a fragility hip fracture clinical protocol at Yale-New Haven Hospital. Clinical outcomes in 2015, prior to program initiation, were compared with 2018, after the program was well established.

MAIN OUTCOMES AND MEASURES: Measured outcomes included 30-day mortality, blood transfusion utilization, adverse effects of drugs, venous thromboembolic complications, sepsis, myocardial infarction, mechanical

surgical fixation complications during the index admission, length of stay, 30-day readmission, unexpected return to the operating room (OR) and time to the OR.

RESULTS: The implementation of the Integrated Fragility Hip Fracture Program was associated with significant reductions in 30-day mortality from 8.0% in 2015 to 2.8% in 2018 ($P = .001$). Significant reductions were also seen in use of blood transfusions (46.6% to 28.1%; $P < .001$), adverse effects of drugs (4.0% to 0%; $P < .001$), length of stay (5.12 to 4.47 days; $P = .004$), unexpected return to the OR (5.1% to 0%; $P < .001$), and time to the OR <24 hours (41.8% to 55.0%, $P = .001$).

CONCLUSIONS: An Integrated Fragility Hip Fracture Program using multidisciplinary care, physician and nursing engagement, evidence-based protocols, data tracking with feedback, and accountability can reduce mortality and improve clinical outcomes in patients with hip fractures. *Journal of Hospital Medicine* 2020;15:461-467. © 2020 Society of Hospital Medicine

Hip fractures are a significant cause of morbidity and mortality among elderly patients. Patients with fragility hip fractures often carry multiple comorbid diagnoses with a significant risk of perioperative complications. After hip fracture, 30-day mortality has been reported as 3.3% to 17.2% with one-year mortality as high as 50%.¹

Multidisciplinary care,²⁻⁵ surgery within 24 hours (h),⁶⁻¹² use of regional peripheral nerve blocks,¹³⁻¹⁶ restrictive blood transfusion strategies,^{17,18} tranexamic acid (TXA) use,¹⁹ pharmacologic deep venous thrombosis (DVT) prophylaxis,²⁰ surgical site infection prevention protocols,²¹ early mobilization,²² and nutritional optimization²³⁻²⁵ have been individually shown to improve outcomes in hip fracture patients.

Our program sought to define, standardize, and implement evidence-based best practices to improve clinical care and

outcomes of patients with hip fractures. We convened a Center for Musculoskeletal Care (CMC) Hip Fracture Oversight Group that included surgeons and advanced practice providers from Orthopedics; physicians from Internal Medicine Hospitalist, Geriatrics, Emergency Medicine, and Anesthesia; and representatives from rehabilitation services, nursing, care management, pharmacy, and performance improvement. With clinical input from all involved services, we developed evidence-based protocols to standardize the care of patients with fragility hip fractures from the time of the patient's evaluation in the emergency room to discharge and outpatient rehabilitation. The program was operationalized in February 2016.

This project was considered by the Yale University institutional review board (IRB) to be a quality improvement and, therefore, exempted from IRB approval.

MATERIALS AND METHODS

Yale-New Haven Hospital is composed of two main campuses. The York Street Campus (YSC) is the Level 1 Trauma Center. The St. Raphael's Campus (SRC) houses the CMC nursing units for elective lower extremity arthroplasty and spine procedures. Prior to 2016, patients with hip fractures were cared for equally at both Yale-New Haven Hospital campuses. Patients were

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TABLE 1. Care Processes Included in the Integrated Fragility Hip Fracture Program

Care Process	Description
Preoperative	
ED order set	ED order set for suspected hip fracture includes ED protocols, staphylococcus PCR screening, and vitamin D assay to ensure early availability of tests for inpatient team
Standardized, magnification controlled, ED radiography	AP pelvis, hip AP and lateral films, and femur AP and lateral films to evaluate for hip fracture
Hip fracture alert	Communication from ED staff to orthopedics, anesthesia, and internal medicine hospitalist of hip fracture patient in the ED
Femoral nerve block	Single-shot femoral nerve block offered in the ED to all eligible patients
Admission order set	Orthopedic hip fracture order set including all hip fracture protocols
Medical comanagement	All patients admitted to on-call orthopedic surgeon service with medical attending comanaging from admission to discharge
Surgical site infection prevention bundle	Staph PCR screening, nasal decontamination, chlorhexidine bath, and perioperative antibiotic algorithm
Pain management protocol	Pain medications selected and dosed for the geriatric population and integrated into order sets
Preoperative checklist	Review of all necessary preoperative steps
Patient engagement	Verbal counseling and written brochures provided to patient and family; Patient engagement survey at discharge
Intraoperative	
Hip fracture on-call surgeon	Shared community and faculty orthopedic hip fracture call schedule
Hip fracture OR block time	Dedicated hip fracture OR block assigned daily
Tranexamic acid administration	Perioperative tranexamic acid protocol to reduce blood loss
Postoperative	
Postoperative order set	Orthopedic hip fracture order set including all postoperative hip fracture protocols and standardized radiographic imaging for quality assessment
Standardized DVT prophylaxis	Sequential compression devices unless ambulating. Preoperative SC heparin and postoperative enoxaparin.
Blood management protocol	Restrictive blood transfusion protocol and perioperative tranexamic acid use
Nutritional optimization	Malnutrition screening, reduced NPO time, preoperative carbohydrate loading, and high protein nutritional supplementation
Pneumonia prevention bundle	Interventions to reduce perioperative pneumonia: early mobilization, avoidance of PPIs, out of bed for meals, and daily teeth brushing
Early mobilization	Out of bed before breakfast the morning after surgery
Abbreviations: AP, anterior posterior; DVT, deep vein thrombosis ED, emergency department; NPO, nil per os; OR, operating room; PCR, polymerase chain reaction; PPI, proton pump inhibitor; SC, subcutaneous.	

admitted to both medical and surgical services with no standardization of hip fracture care processes. Surgeons were assigned based on availability. Frequently, patients were added on to the operating room (OR) schedule and did not undergo surgery until off-hours and after a prolonged waiting period.

Medical comanagement of patients with fragility hip fractures at our institution predated the start of our CMC Integrated Fragility Hip Fracture Program (IFHFP). Comanagement was instituted in 2012 at YSC and in 2014 at SRC but without standardized protocols. The IFHFP began in February 2016 with the centralization of all patients with fragility hip fractures to the SRC at Yale-New Haven Hospital. Emergency medical services directed patients with suspected hip fractures to the designated campus. A dedicated hip fracture OR was allocated daily with a hip fracture surgeon assigned by a shared community and faculty surgeon call schedule. Patients were

encouraged but not required to accept care from the on-call hip fracture surgical attending. Anesthesia was notified of the arrival of a patient with a hip fracture in the emergency department, and if the patient consented and qualified, a single-shot femoral nerve block was performed. Patients were screened for nasal staphylococcal colonization and treated with povidone-iodine nasal decolonization, chlorhexidine wash, and antibiotics determined by staphylococcal status and type of surgical procedure planned. Preoperative and postoperative order sets were implemented that dictated the care processes as outlined in Table 1. Surgeons determined the choice of operative intervention as per usual; this included internal fixation and partial or total hip replacement. Detailed medical and surgical protocols are included in Appendix A.

Since the initiation of the IFHFP on February 1, 2016, the program has continued to advance with our experience. We used

TABLE 2. Demographic Data

	Baseline Year 2015	Intervention Year 2018	P Value
Total volume	275	434	
Average age [mean (SD)]	82.0 (11.0)	80.9 (11.4)	.18
Female	210 (76.4%)	313 (72.1%)	.21
Male	65 (23.6%)	121 (27.9%)	.21
Ethnicity			.52
Black or African American	14 (5.1%)	21 (4.8%)	
White or Caucasian	253 (92.0%)	393 (90.6%)	
Other/unknown	8 (2.9%)	20 (4.6%)	
Body mass index [mean (SD)]	24.4 (5.3)	24.8 (5.5)	.28
ASA score			.14
ASA 1	3 (1.3%)	5 (1.7%)	
ASA 2	54 (23.3%)	57 (19.3%)	
ASA 3	145 (62.5%)	209 (70.9%)	
ASA 4	30 (12.9%)	24 (8.1%)	
Missing	43	139	

Abbreviations: ASA, American Society of Anesthesiologists; SD, standard deviation.

the year preceding the start of the program as our baseline year (January 1, 2015, through December 31, 2015). The following years, 2016 and 2017, were a transition time during which our protocols were implemented. The intervention year was defined as January 1, 2018, through December 31, 2018. The outcomes during the intervention year were compared with the baseline year. It is important to note that our program has been in continuous evolution, including during the intervention year, with protocols created and refined as we gain experience.

Outcomes include 30-day mortality, transfusions, adverse effects of drugs, venous thromboembolic complications, sepsis, myocardial infarction, mechanical surgical fixation complications, length of stay, 30-day readmission rate, unexpected return to the OR, and time to operative intervention. Definitions of the outcome variables are reviewed in Appendix B.

RESULTS

There were 275 consecutive patients with hip fractures admitted to SRC in the baseline year (January 1, 2015, to December 31, 2015) and 434 patients with hip fractures admitted in the intervention year (January 1, 2018, to December 31, 2018) after consolidation of the program to the single Yale-New Haven Campus and implementation of standardized care processes. Patient demographic data including age, sex, ethnicity, body mass index, and American Society of Anesthesiologists physical status classification were evaluated for the baseline year and intervention year and reported in Table 2. There were no differences in the demographics of patients between baseline and intervention years.

From baseline year to intervention year, 30-day mortality, transfusion, adverse effects of drugs, length of stay, unexpected return to OR, and time to OR were all significantly reduced. Mortality within 30 days decreased from 8.0% to 2.8%. The

results are displayed in Table 3. No significant difference was seen in the incidence of venous thromboembolism, sepsis, myocardial infarctions, readmission at 30 days, or mechanical surgical fixation complications.

The Figure shows the 30-day IFHFP mortality rate as reported on a monthly basis starting on January 1 of the baseline year, 2015, and continuing through December 31 of the intervention year, 2018. The process interventions are mapped according to the date of initiation. The median mortality rate (including all data from January 1, 2015, to December 31, 2018) is indicated by the dotted line. From May 2018 to December 2018, each monthly mortality rate was recorded below the four-year median, a visual demonstration of the statistical significance seen in our mortality reduction from 8.0% in the baseline year to 2.8% in the intervention year.

DISCUSSION

Patients with fragility hip fractures are a medically complex and vulnerable population. The goal of the CMC IFHFP was to standardize the care of these high-risk patients in an effort to reduce time to the OR, perioperative medical complications, time spent in the hospital, and ultimately mortality.

The barriers to implementing coordinated, multidisciplinary care are significant. In our case, we had a fragmented care model with fragility hip fracture patients cared for at two campuses, on different nursing units, with both community and faculty surgeons providing operative care, and with no predesignated primary team. We structured our program for equal sharing of call between community and faculty surgeons. However, there was distrust among the physician groups: Primary care physicians were concerned that their referral lines with orthopedic surgical colleagues would be fractured by the new shared call. Surgeons doubted that patients would be distributed equally

TABLE 3. Results

	Baseline Year 2015	Intervention Year 2018	P Value
Total volume	275	434	
30-day mortality	22 (8.0%)	12 (2.8%)	.001
Transfusion	128 (46.6%)	121 (28.1%)	<.001
Adverse effect drugs	11 (4%)	0 (0.0%)	<.001
Venous thromboembolic events	6 (2.2%)	5 (1.2%)	.35
Sepsis	3 (1.1%)	1 (0.2%)	.30
Myocardial infarction	3 (1.1%)	1 (0.2%)	.30
Mechanical surgical fixation complications	2 (0.7%)	0 (0.0%)	.15
Length of stay, days			
Mean (SD)	5.12 (3.31)	4.47 (2.12)	.004
Median (Range)	4.0 (1-31)	4.0 (1-19)	<.001
Readmission 30-day	25 (9.1%)	54 (12.5%)	.16
Unexpected return to OR	14 (5.1%)	0 (0.0%)	<.001
Time to OR (h)			.001
<24 h	115 (41.8%)	238 (55.0%)	
>24 h and <36 h	93 (33.8%)	125 (29.0%)	
>36 h	67 (24.4%)	70 (16.2%)	

Abbreviations: h, hours; OR, operating room; SD, standard deviation.

among community and faculty practices. Hospitalists feared that comanagement would mean surgeons abdicating responsibility for care. Surgeons worried that routine medical involvement would delay surgery and prolong the length of stay with excessive testing. In order to achieve consensus, address concerns, and allay fears, we engaged the primary care and surgeon leadership for their support at the onset of the program and held monthly large group meetings and many smaller sessions to advance objectives. We meticulously tracked data and frequently reported out to the involved groups.

As it is well established that operative intervention on a hip fracture is best completed within 24 h to optimize a patient's clinical outcomes, critical interventions were the designation of a hip fracture OR starting midday and expectation that surgery be performed the day after admission for medically cleared patients. Surgeons were able to book elective cases or outpatient clinic time in the morning. The morning hours prior to surgery allowed time for any final medical optimization, preoperative nursing care, and family discussions. Most surgeries were then completed by the primary OR staff during standard operating hours. Patients were out of the postanesthesia care unit and settled back on the orthopedic nursing unit in the early evening without a prolonged period of nil per os, bed rest, or sleep interruption.

While our protocol expected surgery the day after admission for medically cleared patients, we used surgery within 24 h as a simple metric to compare baseline with intervention

outcomes. With our hip fracture OR block time beginning midday, the majority of our medically cleared hip fracture patients would receive surgical treatment within 24 h of admission. Our data show a significant improvement in timeliness of surgical intervention from 41.8% of patients to the OR within 24 h in 2015 to 55% in 2018. In 2017, we conducted an interval four-month audit involving a detailed chart review of all patients for whom surgery was delayed beyond 24 h from hospital admission. Chart review identified anticoagulation as the primary reason for surgical delay. Of patients who were eligible for surgery (medically stabilized and not therapeutically anticoagulated), 90% underwent surgery within 24 h during this four-month period in 2017. This compares to an overall rate of surgery within 24 h of 57% during the calendar year 2017. We did not perform a subgroup analysis of outcomes in patients with time to OR of 24–36 h. From this study, we are therefore unable to draw any conclusion regarding time to surgery and mortality.

Our dedicated OR hip fracture block time was changed from 7:30 AM to 12:30 PM during 2016 per surgeon request (Figure). Patients admitted within the 24-hour time period from 7 AM the day prior to 7 AM the day of the OR block time undergo surgery in the 12:30 PM time slot. Any patient admitted from 7 AM until 12:30 PM is not scheduled until the following day's OR block time and would hence have a surgical delay of 30 h or more. To better understand the impact of the later OR block time, we included the outcome variable of time to OR of greater

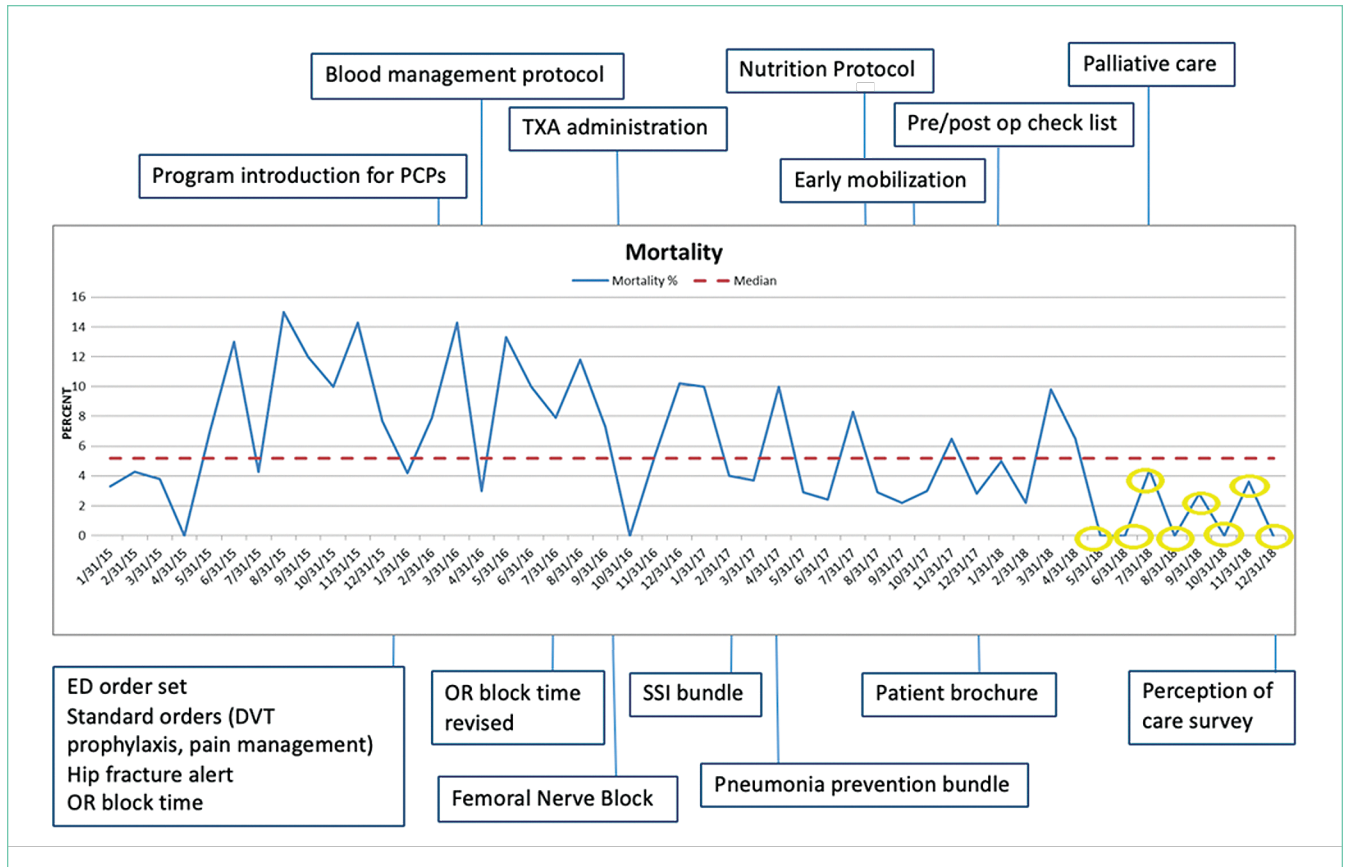


FIG. Timing of Implementation of Each Standardized Care Process Tracked Against 30-day Mortality Rate in the Fragility Hip Fracture Patient Population. Horizontal axis is time, reported in monthly intervals from January, 2015 through December 2018. Vertical axis is 30-day mortality reported as a percentage of patients admitted with fragility hip fracture who died within 30 days of discharge. Red dashed line represents median mortality in the population from January 1, 2015 to December 31, 2018. In a quality improvement run chart, six consecutive data points below the median demonstrate statistically significant reduction in the outcome measured. The 8 data points from May 2018 to December 2018 all fall below the median 30-day mortality, demonstrating statistically significant mortality reduction.

NOTE: Abbreviations: DVT, deep vein thrombosis; ED, emergency department; OR, operating room; PCP, primary care doctor; SSI, surgical site infection; TXA, tranexamic acid.

than 24 h but less than or equal to 36 h. We demonstrated a significant increase in the proportion of patients going to the OR in 24 h without an increase in patients waiting for 24 to 36 h for their surgery.

Transfusion rate reduction from 46.6% to 28.1% was achieved primarily by the implementation and strict enforcement of a policy to avoid transfusing *asymptomatic* patients with hemoglobin >7.0 g/dL. In addition, we recommended TXA using standard perioperative arthroplasty dosing of 1 g intravenously (IV) at the time of incision followed by 1 g IV 3 h later in the postanesthesia care unit. However, adherence to TXA recommendations was poor. A year-long audit (February 2017 to February 2018) demonstrated that only 29% of patients undergoing hip fracture surgery received the recommended TXA. After the conclusion of the study period of this review, we revised our TXA protocol to include an infusion at the time of admission and subsequent perioperative doses. The expanded TXA protocol (with clear exclusion criteria) has been “hard-wired” into our electronic perioperative order sets. We are tracking TXA compliance on a weekly basis. We anticipate that earlier TXA administration and improved compliance will further reduce transfusion rates.

We reduced the adverse effects of medications with two initiatives: First, dedicated hip fracture order sets with medications selected and dosed specifically for the geriatric population were launched at the onset of the IFHFP in 2016. Second, in coordination with our regional anesthesia team, patients who met criteria underwent a single-shot femoral nerve block upon diagnosis of the hip fracture. Patients reported up to 24 h of nonnarcotic pain relief with the femoral nerve block.

Prior to the introduction of the IFHFP, surgeons determined DVT prophylaxis based on their personal preference. Many of our surgeons were concerned that standardizing DVT prophylaxis to enoxaparin would increase the risk of surgical site bleeding, hematoma, infection, and reoperation. With data tracking and periodic reporting, we were able to reassure our surgeons: We demonstrated a reduction in the rate of patients unexpectedly requiring a return to the OR from 5.1% in 2015 to 0% in 2018.

We did not find a significant difference in mechanical complications due to surgical fixation during the index admission. Most mechanical complications do not present within the index admission and, therefore, would not be identified by this

metric. Furthermore, in this phase of the program, we did not seek to change or standardize intraoperative surgical processes outside of surgical site infection prevention measures. Surgical technical quality and variation among surgeons is an area of ongoing evaluation within our program. We have begun a surgical quality review process with an expert review of postoperative radiography, beginning with fixation of non-displaced femoral neck fractures, feedback to surgeons, and tracking of mechanical complications beyond the index admission. The surgical quality outcomes will be presented in a future manuscript.

Anticoagulation use is common in patients with hip fractures because of the high prevalence of comorbid conditions such as atrial fibrillation and venous thromboembolic disease. Direct oral anticoagulants (DOACs) are now commonly used in place of the vitamin K antagonist, warfarin. Our inability to efficiently reverse the DOACs compounded by surgeon unfamiliarity with these agents led to extreme caution in the timing of OR, with most patients delayed a full 48 h from the last dose of their prescribed DOAC. After recognizing the impact of anticoagulation on the timing of surgery, we convened a multidisciplinary group to determine rational guidelines for the timing of surgery in patients on chronic anticoagulation based on the bleeding risk of the planned operative procedure. These guidelines were instituted in December 2018, so their impact is not reflected in this review.

Our results showing a reduction in length of stay and mortality cannot be explained by any one intervention. We propose that the standardization of all processes and protocols, the establishment of clear expectations among all the medical and nursing personnel, and the shorter time spent waiting for surgery all contributed to the length of stay reduction. Likewise, the decrease in time to OR, reduction in time spent in the hospital, fewer transfusions, adverse effects of medication, and surgical complications requiring a return to the OR have all likely contributed to the significant reduction in mortality. The efforts of the orthopedic nursing team certainly contributed: The CMC nurses led the efforts to standardize surgical site infection bundle care, reduce indwelling bladder catheter use, and together with physical therapy, mobilize patients out of bed for meals postoperatively. The strong focus on teamwork, data tracking, feedback and accountability, and the desire for continued improvement may have been the strongest drivers in this program's success.

Our results showed a nonsignificant increase in 30-day readmission from 9.1% to 12.5%. One limitation of this study is that we did not track specific readmission diagnoses to better understand trends in diagnoses or indications for hospital readmission. Going forward, we are reviewing readmissions to better understand opportunities to improve our inpatient processes and transitions of care.

This an evolving project. We have expanded our use of TXA in an effort to further reduce transfusion rates. We have adjusted our protocols for patients admitted on DOACs and warfarin to allow more rapid surgical intervention. We have initiated a surgical quality review process in which surgical fixation is re-

viewed with timely feedback to the operating surgeon. We are working closely with the skilled nursing facilities to extend our rehabilitation and nursing care protocols beyond the acute care setting. We are measuring patient engagement with a brief discharge survey specific to the CMC IFHFP. We continue to seek feedback from our referring primary care physicians to improve communication at times of care transition.

One of the limitations of a quality improvement project such as this one is the inability to identify the effect of each individual intervention. We can conclude that the totality of the multidisciplinary project reduced mortality in our hip fracture population, but we cannot report the relative effect of each process change. Another center seeking to replicate this success cannot determine from this research how to prioritize their resources to achieve a similar outcome.

How we care for the fragility hip fracture patient after hospital discharge is critical and unaddressed in this current study. A limitation of our current program is the lack of consistent postdischarge bone health management—which we are working to address. Also related to postdischarge management, we have partnered with a network of preferred skilled nursing facilities to standardize the care and decrease the length of stay. These data will be published separately.

We understand that our experience at the CMC is unique and specific to our care environment. This is a single site study and may not be generalizable to other centers. Nonetheless, the principles of multidisciplinary care, evidence-based protocol development, technological integration of protocols through order sets, and data tracking with feedback and accountability are the essential elements of our success that can be generalized to other institutions.

CONCLUSIONS

The CMC at Yale School of Medicine and Yale-New Haven Hospital IFHFP provides a model for implementing well-documented evidence-based interventions to standardize the care of patients with fragility hip fractures. The IFHFP yielded reduced mortality, length of stay, blood transfusion utilization, adverse effects of medications, unexpected return to the OR, and time to the OR.

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