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RESEARCH ARTICLE

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Geriatric fracture program centering age-friendly care associated with lower length of stay and lower direct costs

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Abstract

Objective: To evaluate outcomes associated with an integrated inpatient and outpatient program aimed at optimizing the care of geriatric fracture patients in a mixed community and academic health system setting.

Data Sources and Study Setting: This study took place at a tertiary-care, 886-bed hospital system. The Geriatric Fracture Program (GFP) was designed in 2018 using the 4Ms Framework (What Matters, Medication, Mentation, and Mobility). Patients ≥65 years old with non-spine fractures managed by orthopedic faculty surgeons and participating hospitalist groups were included. A fracture liaison team educated patients regarding bone health and ensured ambulatory geriatrics follow-up. Outpatient geriatric visits focused on mobility, fall risk, bone health imaging, and medications.

Study Design: We compared GFP-enrolled patients ($n = 746$) to patients seen by non-GFP-participating physicians ($n = 852$) and used a generalized estimating equations approach and Poisson models to analyze associations between participation in the GFP program and four inpatient outcomes (time to surgery, length of stay, Vizient length of stay index, and total direct costs). We examined outcomes across all fractures and also stratified them by fracture type (hip vs. non-hip). We descriptively examined post-discharge care outcomes: fall, gait, and balance assessments; bone health imaging; and medications.

Data Collection/Extraction Methods: We collected data through chart reviews/electronic health record extracts from July 2018 to June 2021.

Principal Findings: GFP-enrolled patients with all fracture types had a significantly lower length of stay (marginal effect [ME]: −2.12, 95%CI: −2.61, −1.63), length of stay index (ME: −0.33, 95%CI: −0.42, −0.25), and total direct costs (ME: −$5316, 95%CI: −$6806, −$3826); the magnitude of the effects was greater for non-hip fractures. There was no significant difference in time to surgery. Of 746 GFP patients, 170 (23%) had a post-discharge visit with a participating geriatrician ≥6 months.

Conclusions: A systematic approach to improving care for older adults with fractures improved length of stay and total direct costs.

KEYWORDS
4Ms Framework, falls, geriatric, hip, orthopedic, osteoporosis, quality improvement

What is known on this topic

- While geriatric fracture management programs have been shown to improve inpatient outcomes, programs primarily are based in academic systems and focus only on inpatient care.
- It is less well studied whether such models could be successful in community health systems/mixed practice settings with faculty and private physicians.

What this study adds

- The Geriatric Fracture Program, implemented in a mixed practice health system, resulted in sustained improved inpatient outcomes, reduced costs of care, and was shown to be sustainable through stressors, such as the Covid-19 pandemic.

1 | INTRODUCTION

Osteoporosis is widely prevalent among older adults in the U.S., yet many older adults do not receive appropriate diagnosis, treatment, and follow-up, particularly after experiencing an osteoporotic fracture. In the United States, an estimated 10 million adults over the age of 50 have osteoporosis and 43 million more are at risk for the disease.[1] The prevalence of osteoporosis at either the femur neck, lumbar spine, or both is 12.6% among adults aged 50 and older and 17.7% among adults aged 65 and older.[2] The lifetime risk of an osteoporotic fracture is 40%–50% in women and 13%–33% in men.[3] Fractures in older adults are associated with severe adverse outcomes, including mortality, readmissions, institutionalization, chronic pain, and lower health-related quality of life.[4–6] Worldwide, hip fractures are associated with a high risk of mortality: 20%–30% of older adults with a hip fracture experience mortality within one year.[5]

While programs aimed at improving the quality of care for older adults experiencing fractures have been implemented at multiple academic medical centers and have been shown to improve inpatient outcomes such as length of stay, mortality, costs, and readmissions,[7,8] numerous barriers exist to their implementation, particularly at community health systems or mixed practice health systems which have both private and faculty physicians.[9] Barriers include lack of administrative support, lack of medical and surgical leadership, and operating time availability,[9] all of which may be more challenging in systems with multiple hospitalist groups and private practice physicians. Moreover, most programs have focused on outcomes in the inpatient setting. Outpatient follow-up has been less well studied. Despite the high risk for osteoporotic fractures, that is, fragility fractures, studies have found that the median rate of osteoporosis-related follow-up in patients who sustained a fragility fracture was just 11%, and that among older adults with a prior fracture, only 34% had a bone density scan and 16% were on bone-building medications (e.g., bisphosphonates, molecular-targeted medications such as denosumab and romosozumab).[10,11] Reasons for the low rates of follow-up and lack of appropriate care for osteoporotic fractures and osteoporosis treatment generally are systemic in nature. Barriers include lack of appropriate referrals from orthopedic specialty providers to geriatric specialists, lack of access to geriatricians, lack of training and knowledge among primary care physicians about how to best address osteoporosis, patient fears about the side effects of anti-resorptive medications or perceptions that they were already taking too many medications, patients' lack of knowledge about osteoporosis, and patient perception of the lack of severity of a diagnosis of osteoporosis.[12–16]

To address these barriers, the Department of Orthopedics and Geriatric Section at Cedars-Sinai Medical Center developed and subsequently implemented a comprehensive care program in 2018 designed to improve the care of geriatric fracture patients. One aim was to implement a program that optimized the care of older adult orthopedic trauma patients regardless of the attending physician. A second aim was to ensure that patients received high-quality care post-discharge, including appropriate imaging, assessments, and prescriptions. The approach to secondary fracture prevention has historically focused on osteoporosis management (e.g., fracture liaison services[17,18]) while typically lacking a combined clinical approach to fall prevention.[19] To address this gap, we implemented an innovative combined model of care for the assessment and prevention of falls and osteoporosis in the outpatient setting. The resulting program, the Geriatric Fracture Program (GFP), was developed to optimize the outcomes of older adult orthopedic patients in a complex, mixed practice hospital where patients are seen by private physicians, hospitalist groups, and academic faculty and residents. The GFP includes best practices of the 4Ms Framework, which details four evidence-based elements of high-quality care, including What Matters Most, Mentation, Medications, and Mobility, and was designed through the consensus of interprofessional champions and empirical evidence.[20]

By optimizing care for older adult fracture patients, we hypothesized patients treated in accordance with the GFP would have a shorter time to surgery, length of stay (LOS), and reduced total costs. Further, the GFP also includes post-discharge care, which includes a follow-up bone health and fall prevention visit with a geriatrician, hypothesized to result in improved secondary fracture prevention. This follow-up visit includes a fall risk assessment, gait and balance

assessments, bone health imaging, and prescription of bone health medications. Year-one outcomes evidencing early GFP successes in shortening LOS and reducing costs are published elsewhere.[21] The objective of this study was to describe a broader set of GFP-related outcomes over three years, including post-discharge outcomes related to secondary prevention of osteoporotic fractures.

2 | METHODS

2.1 | Setting

This study took place at Cedars-Sinai Medical Center, a non-profit, tertiary-care, 886-bed hospital system in Los Angeles County with 50,000 admissions per year and more than 4500 physicians and nurses. Cedars-Sinai employs a mixed practice physician model, composed of several groups of private hospitalists, independent community physicians, and a group of salaried faculty hospitalists. Cedars-Sinai cares for more patients over the age of 80 than any other tertiary health care system in the country. At least 50% of inpatient discharges at Cedars-Sinai are 65 years old or older and present in states of health ranging from robust to frail.

2.2 | Intervention

The GFP was designed to provide high-value, patient-centered fracture care for geriatric orthopedic trauma patients and to return them to a meaningful life in a timely manner (Table 1). To achieve this, GFP incorporates multidisciplinary education; evidence-based clinical protocols, including functional pain control; documentation tools; and geriatric-centered goals of care. Goals for the inpatient portion of the GFP include reducing time to surgery to ≤24 hours and LOS to ≤5 days; maintaining post-operative delirium prevalence of <20%; providing transitional care support; educating patients about bone health; and implementing comprehensive geriatric post-discharge assessment of fall risk and osteoporosis status. As the hospital does not have an inpatient geriatric service, the program utilizes a credentialed geriatric acute care nurse practitioner (NP) with orthopedic NP certification. An additional Geriatric NP was hired in the third year of the GFP to address the growing demand for program inclusion by the hospitalist groups. The second NP is credentialed as a Family NP and has multiple years of experience as an orthopedic staff nurse and as an NP in an outpatient geriatric practice. This model bridges communication across multiple inpatient and outpatient disciplines. In the outpatient setting, goals for the GFP include follow-up with a geriatrician within 6 months, assessment of gait and balance, discussion of bone health medications, discussion of bone health imaging, order for a bone density scan for older adults without a scan within two years, and a prescription for bone health medications when appropriate. A bone health coordinator, who holds a Master's in Public Health and has multiple years of experience in healthcare administration in an orthopedic clinic, works closely with the outpatient geriatrics team.

To best support GFP patients benefiting from structured discussions about their fracture care, recovery, and fracture prevention, in January of 2021, we implemented additional education and a warm handoff from the inpatient to post-discharge setting. A transitional care coordinator, a licensed vocational nurse, introduces themselves to the patients at the hospital and subsequently contacts them by phone regularly for three months after their discharge for follow-up, recovery assessment, and triage. The transitional care coordinator, who is fluent in several languages, also schedules a follow-up appointment with a geriatrician. Throughout the program, GFP geriatricians developed a structured note template to guide the visits based on the 4Ms.

TABLE 1 Design of the Geriatric Fracture Program incorporating the 4Ms Framework

4Ms	Description
What matters most	• Discuss patient goals in daily multidisciplinary care huddles • Educate patients about details of their hospital course and how we plan to meet their goals • Discuss goals post-discharge with patients
Mentation	• Attending physician and nurse training on delirium prevention, assessment, and mitigation • Delirium care checklists and electronic order sets available to clinicians • Hospital-wide delirium treatment protocol • Mental status discussed during daily multidisciplinary Geriatric Fracture Program (GFP) huddle and at nursing handoffs • Assess cognition during post-discharge visit
Medication	• Geriatric pain protocol developed by a multidisciplinary team • Patient medications reviewed for appropriateness, side effects, and interactions • Medication concerns, issues, or changes discussed during daily GFP multidisciplinary huddle • Review medications to identify fall risk medications during post-discharge visit • Refer to polypharmacy clinic when appropriate • Deprescribe potentially inappropriate medications
Mobility	• All patients expected to be out of bed to chair, especially for meals and visiting • Nurses and care partners are trained on patient mobility • Physical therapy sees patients on day 1 post-op or day after admission for non-operative patients • Educate patients on the need for mobility and what to expect as they recover from their injury • Conduct post-discharge fall risk assessment and gait and balance assessment

2.2.1 | The 4Ms Framework and GFP protocol

What matters most

Discussing "What Matters Most" with orthopedic trauma patients can be difficult because patients are often trying to process their emergent hospitalization. Although these conversations do not directly correlate to a particular quality metric, we have found that these conversations build trust with patients and support their engagement and full participation in their recovery while in the hospital. The GFP NP discusses patients' goals and preferences in the development of the patient's recovery plan. Elements of this discussion include patients' priorities, what brings them comfort during their difficult moments, and what they know about their current situation. Education is incorporated throughout their recovery, and the patient's priorities are documented in the progress notes and discussed during the daily GFP multidisciplinary huddles, which include the attending physicians, orthopedic physician assistants, nurses, case managers, and pharmacists. In the post-discharge visits, geriatricians discuss patients' priorities, goals, and preferences, including preferences for bone health medications, social support, and fall risk factors.

Mentation

Development of a delirium prevention program at Cedars-Sinai evolved from the GFP's focus on optimizing care for older adult patients and was piloted in the orthopedic unit. Prior to the pilot, delirium was assessed in only 3% of patients over 65 years of age in the hospital. The GFP NP developed a delirium protocol, nursing and physician training presentations, an electronic medical order set for delirium management, and patient education materials. Delirium assessment using the Confusion Assessment Method[22] was incorporated into the patient's head-to-toe assessments and performed every 12 hours by the patient's nurse. During the daily multidisciplinary huddle and medical assessments, the patient's mental status and potential interventions are discussed when appropriate.

Medications

Many older adults have significant polypharmacy. As a result, medication management is an integral part of an inpatient care plan. In addition to the Best Possible Medication History completed upon admission by pharmacists and pharmacist technicians, the GFP NP performs a detailed review of the patient's home medications as part of the inpatient admission assessment. This assessment includes using IBM Micromedex, a drug reference library, to perform an interaction review, and the American Geriatrics Society Beers Criteria[23] to assess for potentially inappropriate medications. Next, the patient's anticholinergic burden is calculated to evaluate possible contributions to the patient's fall, as well as evaluate common anticholinergic symptoms, including mental status change. The details from these assessments are discussed with the team during the daily huddle with the team pharmacist and attending physician to determine if changes, including deprescribing, are necessary. Additionally, the multidisciplinary team developed a pain management guideline for geriatric patients without current opioid use to improve functional pain management and reduce unwanted side effects. During the post-discharge visits, geriatricians assess fall risk medications and also determine past use and appropriateness of bisphosphonates and other bone health medications.

Mobility

All GFP patients are assessed for frailty, baseline mobility, activities of daily living,[24] and instrumental activities of daily life[25] by the attending physician and GFP NP. Physical and occupational therapy provide mobility and functional assessments while the patient is hospitalized and recommend structured or unstructured rehabilitation settings. All patients are educated on the importance of mobilizing to prevent complications and improve their recovery. Patients are encouraged to eat meals out of bed in a chair, and if possible, ambulate with assistance at least three times per day. The orthopedic unit uses a mobility plan ("Ready, Set, Mobilize!") to emphasize the importance of patient mobilization. In the post-discharge visit, geriatricians discuss fall history, assess the risk of future falls, and inquire about the patient's history of bone health imaging. Geriatricians also conduct assessments of gait and balance. If further bone health imaging or laboratory tests are warranted, the geriatrician orders the tests and scans and/or follows up with the patients' primary care provider to recommend these services.

2.3 | Enrollment criteria

Patients ≥65 years old with fractures, other than pathological or only to the spine, were included in the study. Our analytical sample ($n = 1598$) consisted of $n = 746$ patients who were managed by the Cedars-Sinai orthopedic faculty surgeons and participating hospitalist groups and received care in accordance with the GFP, and patients who were not because they were managed by physicians other than a participating GFP physician ($n = 852$). A small minority of patients received care through the GFP several times during the study period due to multiple fractures and related hospitalizations.

2.4 | Data collection

Inpatient data were collected daily from the electronic medical record between July 1, 2018 and June 30, 2021 by GFP providers and staff. Study data were collected and managed using REDCap (Research Electronic Data Capture) tools.[26] REDCap is a secure, HIPAA-compliant, web-based application designed to support data capture. The data source for the Vizient LOS index was the Vizient Data Warehouse. Vizient is a data analytics company that aggregates and groups U.S. hospital data and is contracted by the healthcare system. The data source for the average total direct costs was from the Business Intelligence Data Warehouse and is verified by financial teams in the hospital. For the post-discharge data, we created a data extract from the electronic health records database using a list of GFP-enrolled patients who had any outpatient stay with the five GFP-participating

geriatricians. We used the data extract to identify patients with follow-up visits for chart review. Two trained abstracters reviewed the charts of GFP-participating patients using an abstraction spreadsheet to track the post-discharge outcomes six months after the index hospitalization.

2.5 | Outcomes

2.5.1 | Inpatient

Our four primary outcomes were time to surgery, LOS, Vizient LOS index, and total direct costs. The average time to surgery was calculated by subtracting time (in hours) from admission to the emergency department from the time entering the operating room. The average LOS was calculated in days by counting the number of days from admission to the emergency department to discharge from the hospital. Vizient LOS index is an industry-standard measure for the LOS and is the sum of total observed days divided by the sum of the model's total expected days, where a LOS observed/expected index of 1.00 indicates the hospital is on par with the mean of the academic medical centers in the Vizient academic peer group. We also collected total direct costs.

Secondary outcomes included: 30-day readmissions, and 30-day, 90-day, and 1-year mortality post-discharge. We also obtained demographic data from the electronic health record, including age, sex, race, ethnicity, primary language (English vs. not English), and insurance payor. Finally, we calculated the Charlson Comorbidity Index, a measure shown to predict in-hospital mortality.[27]

2.5.2 | Post-discharge

We report whether patients completed a follow-up with a participating GFP geriatrician within 6 months. For patients with at least one post-discharge visit with a GFP geriatrician, we report fall risk assessment; assessment of gait and balance; discussion of bone health medications, including use of bone health medications prior to the follow-up visit; discussion of bone health imaging, including prior bone health imaging prior to the follow-up visit; order for a DEXA (dual-energy X-ray absorptiometry) scan or other bone health imaging after the follow-up visit; and prescription for new bone health medications after the follow-up visit were documented.

2.6 | Analyses

We compared GFP-enrolled and non-GFP-enrolled patients on the inpatient outcomes detailed above. For unadjusted bivariate analyses, we used chi-squared tests for categorical variables and t-tests for continuous variables. As our four primary outcomes were skewed, we used a generalized estimating equations (GEE) approach and Poisson models with Huber-White standard errors, that is, sandwich estimators.[28,29] We used Stata SE 14.0 for all analyses. We calculated marginal effects using the Stata *margins* command. GEE Poisson models for all fractures controlled for age, sex, race, ethnicity, primary language, Charlson Comorbidity Index, fracture type, GFP program year, and insurance payor. GEE Poisson models for hip and non-hip fractures controlled for age, sex, race, ethnicity, primary language, Charlson Comorbidity Index, insurance payor, and GFP program year. For our secondary outcomes, we used GEE logistic regression and controlled for age, sex, race, ethnicity, primary language, Charlson Comorbidity Index, fracture type, GFP program year, and insurance payor.

Post-discharge data were not accessible for all non-GFP patients, as some were cared for outside of the healthcare system; we report descriptive statistics on outcomes. The GFP was a quality improvement project and was deemed exempt from Institutional Review Board review.

3 | RESULTS

3.1 | Inpatient outcomes

GFP-enrolled patients and non-GFP-enrolled patients were similar across age, sex, race, and ethnicity, but non-GFP-enrolled patients were more likely to have a primary language other than English and also more likely to have hip fractures in comparison to GFP patients (Table 2). In our unadjusted analyses, LOS, Vizient LOS index score, and total direct costs were lower in GFP-enrolled patients compared to non-GFP-enrolled patients (Table 2).

In our adjusted analyses, LOS, Vizient LOS index score, and total direct costs were lower in GFP-enrolled patients compared to non-GFP-enrolled patients (Table 3). LOS and total direct costs were higher among Black, Hispanic, and male patients compared to White, Non-Hispanic, and female patients. We also found differences across the GFP program year, with a higher LOS, higher Vizient LOS index score, and total direct costs in years 2 and 3 compared to year 1 of the program.

We found that, on average, among patients with all fracture types, the LOS was 2.12 days lower for GFP-enrolled patients compared to non-GFP-enrolled patients, all else equal (95% CI: −2.61, −1.63) (Table 4). The marginal effects for the LOS were more substantial for non-hip fracture patients (marginal effects [ME]: −2.98, 95% CI: −4.13, −1.83) compared to hip fracture patients (ME: −1.19 [−1.77, −0.60]). Among patients with all fracture types, on average, the Vizient LOS index was 0.33 days lower for GFP-enrolled patients compared to non-GFP-enrolled patients, all else equal (95% CI: −0.42, −0.25), with a similar larger marginal effect for non-hip fractures compared to hip fractures. Total direct costs for patients with all fracture types were $5316 lower among GFP-enrolled patients compared to non-GFP-enrolled patients (95% CI: −6806, −3826), with a similar larger marginal effect among non-hip fractures.

We found no significant differences between GFP-enrolled and non-GFP-enrolled patients in 30-day readmissions, 1-year mortality, 90-day mortality, or 30-day mortality in our adjusted regression models (Table A1).

TABLE 2 Demographic characteristics of the Geriatric Fracture Program-enrolled and non-enrolled patients from 2018 to 2021

	Non-GFP	GFP	Total	*p*-value
N (%)	852 (53%)	746 (47%)	1598 (100%)	
Age [Mean (SD)]	81.8 (8.7)	81.5 (9.6)	81.6 (9.1)	0.58
Sex [*N* (%)]				
Female	602 (71)	546 (73)	1148 (72)	0.26
Race [*N* (%)]				
White	716 (84)	610 (82)	1326 (83)	0.13
Black/African American	47 (6)	61 (8)	108 (7)	
Asian, Native Hawaiian, Pacific Islander	42 (5)	42 (6)	84 (5)	
Other and Unknown[b]	47 (6)	33 (4)	80 (5)	
Ethnicity [*N* (%)]				
Non-Hispanic	783 (92)	695 (93)	1478 (92)	0.13
Hispanic	65 (8)	43 (6)	108 (7)	
Unknown	4 (1)	8 (1)	12 (1)	
Primary language [*N* (%)]				
English	594 (70)	652 (87)	1246 (78)	<0.001
Not english	258 (30)	94 (13)	352 (22)	
Insurance [*N* (%)]				
Medicare	711 (83)	553 (74)	1264 (79)	<0.001
Medicare advantage	13 (2)	86 (12)	99 (6)	
Medicaid	14 (2)	7 (1)	21 (1)	
Other (Workers' comp, Self-pay)	6 (1)	7 (1)	13 (1)	
Private	108 (13)	93 (12)	201 (13)	
Fracture type [*N* (%)]				
Non-hip fracture	415 (49)	402 (54)	817 (51)	
Hip fracture	437 (51)	344 (46)	781 (49)	0.04
Outcomes				
Time to surgery (hours) [Mean (SD)][a]	24.5 (13.7)	26.4 (52.6)		0.45
Length of stay (days) [Mean (SD)]	6.3 (5.7)	4.5 (3.4)		<0.001
Vizient length of stay index [Mean (SD)]	1.2 (1)	0.9 (0.6)		<0.001
Total direct cost (dollars) [Mean (SD)]	$19,351 (16,652)	$15,047 (14,423)		<0.001
30-day readmissions [*N* (%)]	85 (10)	60 (9)	153 (10)	0.56
1-year mortality [*N* (%)]	71 (8)	67 (9)	138 (9)	0.65
90-day mortality [*N* (%)]	44 (5)	34 (5)	78 (5)	0.57
30-day mortality [*N* (%)]	28 (3)	21 (3)	49 (3)	0.59

Abbreviation: GFP, Geriatric Fracture Program, SD, standard deviation.

[a]Among patients not exempt from time to surgery. Time to surgery appropriateness includes medically stable for surgery per medical team or no change in the plan of care by patient or physician.

[b]Other category includes multiple races or races not captured by electronic health records in the existing categories.

3.2 | Post-discharge outcomes

Table A2 shows aggregate data for outcomes among patients who had at least one follow-up visit with a GFP geriatrician 6 months after hospitalization for each of the three years since implementation of the GFP. Of the 746 patient hospitalizations, 170 (23%) had a follow-up appointment with a GFP geriatrician six months after the inpatient stay. Across the three years of the program, we found that 81% had a documented fall assessment, 61% had a documented gait and balance assessment, 75% had a discussion of bone health medications, and 78% had a discussion of bone health imaging. Of the patients who had at least one follow-up visit with a GFP geriatrician 6 months after hospitalization, 42% received an order for a DEXA scan, 22% completed the DEXA scan, and 31% were prescribed new bone health medications within 6 months.

TABLE 3 Enrollment in the Geriatric Fracture Program and association with time to surgery, length of stay, Vizient length of stay index, and total direct costs

	TTS[b]	LOS	Vizient LOS index	Total direct costs
Enrollment in GFP Program	−0.05 (−0.2, 0.1)	−0.4 (−0.49, −0.31)***	−0.32 (−0.4, −0.24)***	−0.31 (−0.39, −0.23)***
Race				
White	Reference	Reference	Reference	Reference
Black/African American	0.34 (−0.23, 0.92)	0.29 (0.12, 0.46)**	0.03 (−0.11, 0.17)	0.15 (0.02, 0.27)*
Asian/Pacific Islander	−0.03 (−0.27, 0.21)	−0.03 (−0.25, 0.2)	−0.01 (−0.2, 0.17)	−0.01 (−0.18, 0.17)
Other or Unknown[a]	0.12 (−0.07, 0.32)	−0.04 (−0.21, 0.13)	−0.07 (−0.21, 0.08)	0.07 (−0.14, 0.27)
Ethnicity				
Non-Hispanic	Reference	Reference	Reference	Reference
Hispanic	−0.04 (−0.27, 0.19)	0.28 (0.09, 0.47)**	0.2 (0, 0.39)	0.23 (0.06, 0.4)**
Unknown	0.38 (−0.09, 0.85)	0.09 (−0.3, 0.48)	0.1 (−0.32, 0.51)	0.26 (−0.15, 0.68)
Primary language				
English	Reference	Reference	Reference	Reference
Not English	0.04 (−0.08, 0.15)	0.05 (−0.07, 0.16)	−0.04 (−0.14, 0.05)	0 (−0.12, 0.12)
Sex				
Female	Reference	Reference	Reference	Reference
Male	−0.08 (−0.22, 0.07)	0.12 (0.02, 0.21)*	0.06 (−0.04, 0.15)	0.13 (0.04, 0.22)
Charlson Comorbidity index score	0 (−0.03, 0.03)	0.02 (0, 0.04)	−0.01 (−0.03, 0.01)	0.01 (0, 0.02)
Age	0 (0, 0.01)	0 (−0.01, 0.01)	0 (−0.01, 0)	−0.01 (−0.01, 0)***
GFP program year				
1	Reference	Reference	Reference	Reference
2	0.04 (−0.06, 0.13)	0.20 (0.09, 0.30)***	0.17 (0.08, 0.25)***	0.12 (0.04, 0.21)**
3	0.21 (−0.01, 0.44)	0.26 (0.14, 0.38)***	0.25 (0.13, 0.36)***	0.27 (0.16, 0.38)***
Hip fracture type				
Non-Hip	Reference	Reference	Reference	Reference
Hip	−0.25 (−0.42, −0.08)**	−0.01 (−0.1, 0.07)	−0.05 (−0.12, 0.02)	0.1 (0.02, 0.18)*
Insurance payor				
Medicare	Reference	Reference	Reference	Reference
Medicare advantage	0.35 (−0.27, 0.97)	−0.04 (−0.21, 0.13)	−0.24 (−0.35, −0.12)***	−0.07 (−0.18, 0.03)
Medicaid	−0.14 (−0.36, 0.08)	−0.08 (−0.39, 0.23)	−0.02 (−0.33, 0.29)	−0.11 (−0.35, 0.13)
Other	0.12 (−0.15, 0.39)	0.29 (−0.01, 0.59)	0.45 (0.08, 0.82)*	0.06 (−0.21, 0.34)
Private insurance	0.15 (−0.28, 0.58)	0.03 (−0.1, 0.16)	0.05 (−0.08, 0.18)	0.01 (−0.1, 0.12)
N	881	1598	1540	1598

Note: Poisson models for all fractures controlled for age, sex, race, ethnicity, primary language, Charlson Comorbidity Index, fracture type, insurance payor, and GFP program year. We used a generalized estimating equations (GEE) approach to account for multiple visits from a small number of patients in the sample. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Abbreviations: LOS, length of stay in days; LOS-I, vizient length of stay index; TTS: time to surgery.

[a]Other category includes multiple races or races not captured by electronic health records in the existing categories.

[b]Among patients not exempt from time to surgery. Time to surgery appropriateness includes medically stable for surgery per medical team or no change in plan of care by patient or physician.

TABLE 4 Marginal effects of enrollment in the Geriatric Fracture Program on time to surgery, length of stay, Vizient length of stay index, and total direct costs by fracture type

Marginal effects of enrollment in GFP	All fractures[a]	Hip fractures[b]	Non-hip fractures[b]
Time to surgery (hours)[c]	−1.34 (−5.07, 2.38)	−1.90 (−3.77, −0.03)	0.93 (−9.84, 11.69)
Length of stay (days)	−2.12 (−2.61, −1.63)***	−1.19 (−1.77, −0.60)***	−2.98 (−4.13, −1.83)***
Vizient length of stay index	−0.33 (−0.42, −0.25)***	−0.23 (−0.33, −0.12)***	−0.52 (−0.75, −0.29)***
Total direct costs (dollars)	−$5316 (−6806, −3826)***	−$2591 (−3965, −1218)***	−$4755 (−7033, −2478)***

Note: ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

[a]Generalized estimating equations (GEE) Poisson models for all fractures controlled for age, sex, race, ethnicity, primary language, Charlson Comorbidity Index, fracture type, insurance payor, and Geriatric Fracture Program (GFP) program year.

[b]Poisson models for hip and non-hip fractures controlled for age, sex, race, primary language, ethnicity, Charlson Comorbidity Index, insurance payor, and GFP program year.

[c]Among patients not exempt from time to surgery. Time to surgery appropriateness includes medically stable for surgery per medical team or no change in plan of care by patient or physician.

4 | DISCUSSION

The GFP was launched in 2018 to provide high-value, geriatric-centered care within an Age-Friendly Health System and exists in a mixed practice health system with multiple hospitalist groups and private physicians. The program aims to manage the patient's injury in the context of the patient as a whole and strives to return the patient to a meaningful life in a timely manner. Importantly, we found that the program is associated with improved inpatient outcomes. Compared to non-GFP patients, on average, GFP-enrolled patients had a shorter LOS, better performance as measured by the Vizient LOS index, and lower total direct costs. The key inpatient outcome measurements for GFP, including LOS, reduced costs, and follow-up bone health, were similar to previously published programs in other settings.[30–35]

Compared to White patients, we found that Black patients had longer lengths of stay and higher total direct costs, even after controlling for insurance payor, age, comorbidities, sex, and fracture type. We also found that compared to Non-Hispanic patients, Hispanic patients also had longer lengths of stay and higher total direct costs. Prior studies have found that race is associated with differences in radiographic evaluation and time to surgery in hip fractures,[36,37] however we found no differences in time to surgery by race or ethnicity in our sample, although we may have been limited in our ability to detect differences due to small sample size. These findings point to a need for further investigation into potential reasons for such disparities.

One of the strengths of the program is its generalizability. The hospital system does not have an inpatient geriatrics service, similar to the majority of community hospitals. As such, the GFP employs NPs, who are at the heart of the inpatient intervention. This cost-effective, high-quality approach could be replicated at other community hospitals. On the outpatient side, outpatient geriatricians are part of a private medical group, not an academic-based clinic. The creation of an effective inpatient-outpatient coordinated approach in such a setting could also be replicated across other community-based health systems.

One of the goals of the program was to ensure that any reduced LOS did not result in higher readmissions or higher mortality. We found no differences in readmission rates between GFP-enrolled and non-GFP-enrolled patients. Moreover, one of the innovations of the GFP is the care coordination between the inpatient and outpatient settings. Nationally, approximately 40% of women with a new fracture and no prior bone density test in the past two years or bone health pharmacotherapy in the past 12 months receive either bone density imaging or a prescription for an osteoporosis medication within 6 months of their fracture (a quality measure endorsed by the National Quality Forum since 2009).[38,39] Only about 25% receive pharmacotherapy after fragility fracture.[38] Among Medicare beneficiaries, about 35% of patients with a history of falls had a fall risk assessment completed and 60% had a plan of care for falls documented in 2016 based on HEDIS (Healthcare Effectiveness Data and Information Set) estimates.[38,40] Among patients who saw a GFP geriatrician post-discharge, we found preliminary evidence of better performance on outpatient outcomes compared to these national rates, although small sample sizes and the lack of a

comparison group limit our ability to make strong conclusions about the outpatient program.

Of note, we found that although clinicians ordered DEXA scans for 42% of patients during or after the follow-up visit throughout the program, only 22% of patients had a completed scan within six months. There could be numerous reasons for these findings, including patient fears of the diagnosis of osteoporosis, fears of infection from Covid-19 during the pandemic surges in 2020 and 2021 leading to avoidance of in-person imaging visits, a lack of perceived urgency from the patient perspective of the need for a DEXA scan, transportation challenges for the appointment, or the patient may have a primary care physician outside of the health system and the scan was completed but not in the health system's electronic health records. Future iterations of the GFP may include a better understanding why patients did not always complete bone health imaging.

We found that inpatient clinicians and outpatient geriatricians faced numerous challenges in providing care. Several years of the GFP overlapped with the Covid-19 pandemic. In the inpatient setting, burnout among nursing staff, staff turnover, and the use of floating nursing staff made it challenging to maintain the high standards of the program at all times.[41–43] In particular, we faced challenges with delirium-prevention protocols, as maintaining training was challenging during these times. Moreover, while improving management for patients with dementia has been identified as a health system priority as part of its Age-Friendly Health System initiatives, effective care pathways for screening and improving the quality of care for patients with dementia had not been implemented during the study period; these initiatives are ongoing.

In the outpatient setting, many visits were conducted virtually, particularly during 2020, which limited the ability of clinicians to conduct gait and balance and cognitive assessments. Moreover, during our chart review, we found that a sizable group of patients had multiple hospitalizations following the initial hospitalization, making it difficult for geriatricians and the bone health coordinator to follow-up with patients in the outpatient setting. Other challenges faced by geriatricians included managing numerous comorbidities, including dementia, which made prioritizing bone health care difficult when other more pressing symptoms were present. Although we did not systematically collect information about reasons why patients did not start on bisphosphonates and other bone health medications following a diagnosis of osteoporosis, through our chart review, we found documentation noting that many patients have significant fears of the side effects of these medications. Clinicians also documented that patients had concerns about the costs of the medications.

This study has several limitations. First, this is an evaluation of a quality improvement project and not a randomized controlled trial. As such, although we compared demographic characteristics between GFP-enrolled and non-GFP-enrolled patients, patients were not randomized into the program. It is possible that patients seen by GFP-participating hospitalists and other physicians are systematically different from patients of non-GFP-participating physicians. Second, we did not have access to claims data and so could not systematically examine post-discharge outcomes for patients who did not see a GFP-participating outpatient geriatrician. This limited our ability to compare post-discharge outcomes both between GFP-enrolled and non-GFP-enrolled patients and between GFP patients who did and did not have at least one post-discharge follow-up visit with a GFP-participating geriatrician. Third, while we collected some data on delirium assessments, the data was collected inconsistently and we selected not to report the data, which limited our ability to examine delirium-related outcomes in patients. As noted early, staff turnover, burnout, and an influx of new nursing staff made it challenging to consistently implement delirium training. Finally, as dementia is regularly underdiagnosed in both the inpatient and outpatient settings, we did not include dementia as a covariate in our models.[44] As the health system improves its screening of dementia in all settings, we hope to examine dementia-specific outcomes in future research.

Future iterations of the program are aimed at improving delirium assessment and documentation, care for patients with dementia-related needs, the percentage of patients enrolled in the GFP who have post-discharge follow-ups with geriatricians, and the proportion of patients who have a bone density scan completed. The majority of both GFP and non-GFP patients were discharged to inpatient rehabilitation facilities at rates greater than 30%. One of the goals of Medicare's Bundle Payments for Care Improvement is to reduce inefficient resource use. The health system is participating in an orthopedic bundle program as of January 2021 and one of the key focuses has been to reduce use of inpatient rehabilitation facilities for patients who do not meet the Medicare criteria for that higher level of care. The use of inpatient rehabilitation facilities among health system patients has been above the national average, highlighting an area for further improvement.

In conclusion, we found that the GFP program resulted in improved inpatient outcomes for older adults with non-spine fractures. Future research will focus on examining the effectiveness of the outpatient program.

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APPENDIX A

TABLE A1 Marginal effects of enrollment in the Geriatric Fracture Program on 30-day readmissions and 1-year, 90-day, and 30-day mortality

Marginal effects of enrollment in GFP	All fractures[a]
30-day readmissions	0 (−0.03, 0.03)
1-year mortality	0 (−0.02, 0.04)
90-day mortality	−0.01 (−0.03, 0.01)
30-day mortality	−0.01 (−0.03, 0.01)

Abbreviation: GFP, Geriatric Fracture Program.
[a]Generalized estimating equations (GEE) logistic models for all fractures controlled for age, sex, race, ethnicity, primary language, Charlson Comorbidity Index, fracture type, insurance payor, and GFP program year.

TABLE A2 Geriatric Fracture Program post-discharge outcomes among patients seen by a participating geriatrician within 6 months of hospital discharge by program year among $N = 746$ patients seen between 2018 and 2021

GFP post-discharge outcome	Year 1 $N = 31$ (20%) *n* (%)	Year 2 $N = 57$ (23%) *n* (%)	Year 3 $N = 82$ (23%) *n* (%)	Total $N = 170$ (23%) *n* (%)
Fall assessment within 6 months	29 (94)	42 (74)	67 (82)	138 (81)
Gait and balance assessment within 6 months[a]	21 (68)	26 (46)	57 (70)	104 (61)
Discussion of bone health medications within 6 months	19 (61)	46 (81)	63 (77)	128 (75)
Taking bone health medications prior to the index hospitalization	3 (10)	12 (21)	18 (22)	33 (19)
Discussion of bone health imaging within 6 months	21 (68)	48 (84)	64 (7)	133 (78)
Bone health imaging prior to the index hospitalization	14 (45)	38 (67)	46 (56)	98 (5)
Ordered bone health imaging within 6 months	11 (35)	19 (33)	41 (50)	71 (42)
Completed bone health scan within 6 months	7 (23)	10 (1)	21 (26)	38 (22)
Prescribed new bone health medications within 6 months[b]	5 (1)	13 (23)	35 (43)	53 (31)

Abbreviation: GFP, Geriatric Fracture Program.
[a]We found that gait and balance assessments were sometimes not conducted when visits were virtual or when the patient was in a wheelchair.
[b]This includes increasing the dose of an existing bone health medication.