

# Preventing Fragility Fractures: A 3-Month Critical Window of Opportunity

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## Abstract

**Introduction:** Low-energy falls are the leading cause of injury-related morbidity and mortality in the elderly. In the past, physicians focused on treating fractures resulting from falls rather than preventing them. The purpose of this study is to identify patients with a hospital encounter for fall prior to a fracture as an opportunity for pre-injury intervention when patients might be motivated to engage in falls prevention. **Materials & Methods:** A retrospective analysis of all emergency room and inpatient encounters in 2016 with an ICD10 diagnosis code including “fall” across a tri-state health system was performed. Subsequent encounters with diagnosis of fracture within 2 years were then identified. Data was collected for time to subsequent fracture, fracture type and location, and length of stay of initial encounter. **Results:** There were 12,382 encounters for falls among 10,589 patients. Of those patients, 1,040 (9.8%) sustained a subsequent fracture. Fractures were most commonly lower extremity fractures (661 fractures; 63.5%), including hip fractures (447 fractures; 45.87%). Median time from fall to fracture was 105 days (IQR 16-359 days). **Discussion:** Falls are an important, modifiable risk factor for fragility fracture. This study demonstrates that patients are presenting to the hospital with one of the main modifiable risk factors for fracture within a time window that allows for intervention. **Conclusions:** Presentation to the hospital for a fall is a vital opportunity to intervene and prevent subsequent fracture in a high-risk population.

## Keywords

elderly, falls, fragility fracture, prevention

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## Introduction

As the United States population ages, the overall cost of healthcare is dramatically increasing. Low energy falls such as falls from standing are the leading cause of injury-related morbidity and mortality in the elderly.<sup>1</sup> Additionally, the injuries sustained from these occurrences is disproportionate to the mechanism due to the prevalence of frailty among older adults<sup>2</sup> In 2014, 37.5% of falls required medical intervention or restricted activity for a day or greater, leading to a further stress on the healthcare economy.<sup>3</sup>

With a shifting focus in healthcare to preventing conditions rather than simply treating them, fragility fractures—fractures resulting from a low-energy fall—present an opportunity for prevention. The consequences on health and health-related quality of life is higher for fracture than for fall alone, but falls without fracture occur much more commonly<sup>4</sup> and present an opportunity to intervene to prevent future injury.

Most of the orthopedic literature has focused on secondary prevention after hip fracture; however, there have been multiple studies that have demonstrated the benefits of primary prevention programs in the elderly.<sup>1,5</sup> Interventions range from reduction of polypharmacy, cataract surgery, home modifications, and exercise programs to multifaceted, comprehensive programs addressing all potential sources of falls in older adults. The United States Preventive Services Task Force (USPSTF)

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recommendations state there is low likelihood of serious harms with available early interventions and that selected treatments provide moderate net benefit with moderate certainty.<sup>1</sup>

If patients are already entering the healthcare system with injuries related to known risk factors for fracture (i.e. fall[s]), why wait for the inevitable? Our team has previously shown a missed opportunity for implementation of these resources after use of acute care services prior to hip fracture in at risk patients at an urban, Level 1 trauma center.<sup>6</sup> The purpose of this study was to build off of our previous findings and to expand the analysis across facilities with diverse patient populations to determine if patterns in suburban and rural locations are similar to the findings from the academic medical center. We sought to characterize patients with a hospital encounter for fall prior to a fracture as an opportunity for intervention where patients, families, and the healthcare system might be motivated to engage in falls prevention. Additionally, better understanding of the time course from a fall to fracture could indicate whether current community-based interventions are appropriate.

## Materials and Methods

All inpatient and emergency room encounters from 2016 in the medical record of a tri-state health system were searched retrospectively for ICD10 diagnosis codes containing "fall." Encounters with the diagnosis code description containing key words "subsequent encounter" or "sequela" were excluded. Age was limited to those 55 years and older at the time of the event. A diagnosis of fracture was subsequently identified from encounters for these same patients within 2 years from the date of the fall. Patients who died prior to the 2-year follow-up period were excluded from analysis (n = 1,027). This study obtained IRB approval and a waiver of consent was granted.

The following information was also queried from the electronic medical record: demographic information (age, sex), medical history (history of falls and fractures from 2011-2015 as captured by encounter ICD10 diagnosis code and age-weighted Charlson Comorbidity Index (CCI) using encounter diagnosis codes recorded in the year prior to the fall), initial encounter information (emergency room or inpatient, length of stay, discharge disposition, outpatient follow-up for fall within 30 days), and subsequent fracture encounter information (subsequent fracture status, time to subsequent fracture, fracture type and location, and discharge disposition).

Descriptive statistics (mean and standard deviation for normally distributed variables, median and interquartile range for non-normally distributed variables and counts and percentages for categorical variables) were calculated for each variable collected and stratified by subsequent fracture status. T-tests, Wilcoxon rank sum tests, and chi-square tests were used for continuous normally distributed data, continuous non-normally distributed data, and categorical data, respectively, to determine bivariate associations with subsequent fracture status.

A multivariable log-binomial regression model was used to identify patient factors associated with subsequent fracture. Sex, previous fracture (yes/no), number of prior falls (0, 1, 2 or more)

and age-weighted CCI category (3 or less, 4-7, 8-11, 12+) were included in the model. Adjusted relative risks were computed.

All statistical tests were 2-tailed and P-values less than 0.05 were considered statistically significant. SAS software version 9.4 was used for all analyses (SAS Institute Inc., Cary, NC, USA).

## Results

There were 12,382 encounters for fall among 10,589 patients. Of those patients, 1,027 died prior to the 2 year follow up and were excluded from the analysis. Among the remaining patients, 1,040 (9.8%) sustained a subsequent fracture within 2 years. Table 1 presents patient demographic and encounter details of the initial fall encounter stratified by subsequent fracture status. Patients who sustained a subsequent fracture tended to be older at the initial fall encounter (median: 78 years, IQR: 67-86 versus median: 73 years, IQR: 63-82,  $p < 0.0001$ ) and more likely to be female (77.12% versus 65.6%,  $p < 0.0001$ ). There was no difference between the groups in whether they had a previous fall prior to 2016 (5.08% versus 5.87%,  $p 0.28$ ); however, patients with a subsequent fracture more often had a previous fracture (4.81% versus 1.82%,  $p < 0.0001$ ). The median time to fracture from the 2016 fall encounter was 105 days (IQR 15-359 days).

Table 2 presents the type of subsequent fracture. Hip fractures comprised the largest portion of fractures at 45.87% (477 fractures). Lower extremity fractures were present in 63.6% (661 fractures). A greater percentage of patients with subsequent fracture had lengths of stay greater than or equal to 1 day in their initial fall encounter than those without fracture (31.44% versus 23.48%,  $p < 0.0001$ ). Only 5.40% of patients had an outpatient follow-up visit during the 30 days following the 2016 fall encounter.

The results of the multivariable model are presented in Table 3. Female patients had 58% higher risk of subsequent fracture (RR: 1.58, CL: 1.37-1.82) compared to male patients. Patients with previous fracture had 88% higher risk of subsequent fracture (RR: 1.88, CL: 1.45-2.43). Number of prior falls was not associated with subsequent fracture. Increasing age-weighted CCI was associated with higher risk of subsequent fracture. Patients with an age-weighted CCI of 12 or more had an 89% higher risk of fracture compared to patients with an age-weighted CCI of 3 or less (RR: 1.89, CL: 1.31-2.74).

## Discussion

High utilization of healthcare services for fall and fall-related injury in the elderly has been well documented. This study demonstrated that 1 in 10 patients will return to the hospital after a fall with a fragility fracture within a 2-year window. Accounting for the rate of fracture in the hospital system, this was greater than 1 fracture per day (1.4 fractures/day). Of the subsequent fractures, approximately 60% were lower extremity fractures, which have been previously shown to lead to a decline in function and inability to continue living independently, putting additional burden on families, society, and the healthcare system.

**Table 1.** Demographics and Initial Fall Encounter Characteristics Stratified by Subsequent Fracture Status.

Name	All, N = 10,589	Patients with a fall, no subsequent fracture, N = 9,549	Patients with a fall, subsequent fracture, N = 1,040	P-value
Age (median, IQR)	74 (64-83)	73 (63-82)	78 (67-86)	<.0001
Female (%)	7069 (66.76%)	6267 (65.63%)	802 (77.12%)	<.0001
Any Prior Fall				
No	10043 (94.84%)	9064 (94.92%)	979 (94.13%)	0.2762
Yes	546 (5.16%)	485 (5.08%)	61 (5.87%)	
Previous fracture, yes (%)	224 (2.12%)	174 (1.82%)	50 (4.81%)	<.0001
Location type				
ED	8296 (78.35%)	7562 (79.19%)	734 (70.58%)	<.0001
Inpatient	2293 (21.65%)	1987 (20.81%)	306 (29.42%)	
Length of stay				
0	8020 (75.74%)	7307 (76.52%)	713 (68.56%)	<.0001
1-7	2219 (20.96%)	1925 (20.16%)	294 (28.27%)	
8+	350 (3.31%)	317 (3.32%)	33 (3.17%)	
Orders associated with initial fall encounter				
Get well	3651 (34.48%)	3182 (33.32%)	469 (45.10%)	<.0001
Physical therapy	1694 (16.00%)	1447 (15.15%)	247 (23.75%)	<.0001
External referral	61 (0.58%)	55 (0.58%)	6 (0.58%)	0.9969
Any outpatient visit with key word "fall," "falls," or "falling" in diagnosis description within 30 days of fall	572 (5.40%)	451 (4.72%)	121 (11.63%)	<.0001

**Table 2.** Encounter Details of First Subsequent Fracture Encounter (N = 1,040).

Type of fracture	Frequency	Percent
Hip	477	45.87%
Distal radius	199	19.13%
Pelvic	150	14.42%
Prox humerus	154	14.81%
Prox tibia	34	3.27%
Compression	75	7.21%

**Table 3.** Multivariable Model Predicting Subsequent Fracture (Log-Binomial Regression Model) N = 10,589 (1040 fractures, 9.82%).

Effect	Fracture rate	RR (95% CI)	P-value
Gender			
Male (N = 3520)	238/3520 (6.76%)	Ref	
Female (N = 7069)	802/7069 (11.35%)	1.58 (1.37-1.82)	<.0001
Previous Fracture			
No (N = 10365)	990/10365 (9.55%)	Ref	
Yes (N = 224)	50/224 (22.32%)	1.88 (1.45-2.43)	<.0001
Number of prior falls			
0 (N = 10043)	979/10043 (9.75%)	Ref	
1 (N = 448)	48/448 (10.71%)	0.85 (0.65-1.11)	0.2456
2 + (N = 98)	13/98 (13.27%)	0.92 (0.55-1.52)	0.7424
Age-weighted CCI category			
Less than or equal to 3 (N = 4290)	275/4290 (6.41%)	Ref	
4-7 (N = 5121)	602/5121 (11.76%)	1.47 (1.25-1.74)	<.0001
8-11 (N = 974)	135/974 (13.86%)	1.76 (1.42-2.18)	<.0001
12 + (N = 204)	28/204 (13.73%)	1.89 (1.31-2.74)	0.0006

A previous study from this group demonstrated that 45% of hip fracture patients at a single academic medical center presented to the emergency department or hospital in the year prior to their fracture and that 27.5% of these "preadmission" encounters were due to falls. For that cohort, the median time between preadmission and fracture was 217 days. In this study population, the median time between a fall encounter and fracture encounter was only 105 days. The window to intervene is perhaps not as great as previously expected, but still sufficient for intervention.

The National Council on Aging (NCOA) lists 14 evidence-based falls prevention programs that can be delivered in community settings for older adults.<sup>7</sup> These programs have demonstrated efficacy and effectiveness for preventing falls and improving outcomes among older adults through randomized controlled trials, and are being disseminated widely through the aging network with support from the Administration for Community Living within the United States Department of Health and Human Services. These fall and secondary fracture prevention programs and exercise-based interventions are typically 6-8 weeks in duration and are offered in the home or in locations accessible widely to older adults, including senior centers, parks and recreation departments, and YMCAs.<sup>8-14</sup> Our findings demonstrate that there is enough time to implement these strategies in the community setting between the time of fall and of subsequent fracture in the majority of cases.

Addressing modifiable risk factors for fragility fracture is key in injury prevention. Intrinsic modifiable risk factors include smoking, alcohol intake, glucocorticoid therapy, vitamin D deficiency, low calcium intake, low body mass index, poor vision, and lack of physical activity.<sup>15</sup> Extrinsic factors in the environment also put patients at risk, such as slippery

surfaces and other trip hazards, which are very common in the homes of older adults.<sup>16,17</sup> Falls are an important, modifiable risk factor for fragility fracture. This study demonstrates that patients are presenting to the hospital with one of the main modifiable risk factors for fracture within a time window that allows for intervention. Additionally, some patients were noted to have a previous fracture and continue to have falls, placing them into an even higher risk category. Moreover, only 5 percent of patients are seen in an outpatient setting within a month after a hospital encounter requiring acute care services or an inpatient admission. Though it seems logical that orthopedic surgeons would be involved in fragility fracture prevention programs, they are rarely consulted for or involved in the care of patients who have a fall without sustaining a musculoskeletal injury. This reinforces the need for a multidisciplinary approach to address these issues and to ensure that patients receive the services that might prevent subsequent injury. The multivariable model might help provide direction for determining the patients with the greatest opportunity for benefit. Fall patients who are women, who have had a previous fracture, and who have a higher CCI could be targeted for more urgent and intensive interventions.

There were several limitations for this study. First, data was collected using a query of the electronic medical record. The initial fall encounter, subsequent fracture, prior fall history, subsequent outpatient visit relating to the fall, and comorbidities relating to the Charlson Comorbidity Index were determined by encounter diagnosis code as entered in the EMR. Therefore, data quality is subject to coding error, coding bias, or missed information if a patient seeks care outside this tri-state health system.<sup>18-21</sup> If patients presented to another institution outside of the system for care of their subsequent fracture, the absolute rate of fragility fracture after fall would be underestimated, indicating an even greater need to intervene than we are able to document. However, we have a large catchment area and our data includes over 23 hospitals in our region.

Second, this study was a retrospective cohort design that identified risk factors associated with fracture. Therefore, this study cannot establish cause and is also subject to confounding. Confounding was minimized by applying a multivariable model; however, residual confounding could still occur. Additionally, it is possible that a factor associated with fracture was not included in the multivariable model. For example, whether or not the patients were being treated for osteoporosis was not discernable and therefore could be included in the model.

Finally, this study captured data from a 2-year window after the fall encounter. If a fracture occurred later, it was not captured. The decision to limit the data query to 2 years was to focus on the opportunity for timely intervention to prevent fractures after an initial presentation for fall.

## Conclusions

Falls are a significant source of morbidity and mortality in the older adult population. This study found that presentation to the hospital for a fall is a vital opportunity to engage in secondary

prevention to prevent subsequent fracture in a high-risk population.

One in 10 patients who presented with a fall returned with a subsequent fracture within 2 years. In our healthcare system, on average, more than 1 patient (1.4) a day returns for a fall resulting in a new fracture. Sixty percent of patients with a subsequent fracture sustained a lower extremity fracture. Nearly half of all fractures were hip fractures, which have a high morbidity and mortality relative to other fracture types. Therefore, intervention efforts across a large healthcare system could impact a large population. Finally, the median time to fracture was 105 days, presenting a 3-month time window for intervention. Current community-based fall interventions could likely be implemented during this time period. This highlights an opportunity for healthcare systems to partner with existing public health and community health resources to identify at-risk patients and connect them to evidence-based falls prevention programs.

## Authors' Note

Data are available upon reasonable request from the corresponding author. The study was approved by our local hospital IRB. The study was conducted in accordance with the principles of the Declaration of Helsinki. Consent was obtained by participants in the study. Atrium Health IRB—05-11-08E “Implementation of a Fragility Fracture Program to Carolinas Medical Center.”

## Declaration of Conflicting Interests

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