Original Investigation

Survival and Functional Outcomes After Hip Fracture Among Nursing Home Residents

Mark D. Neuman, MD, MSc; Jeffrey H. Silber, MD, PhD; Jay S. Magaziner, PhD; Molly A. Passarella, MS; Samir Mehta, MD; Rachel M. Werner, MD, PhD

IMPORTANCE Little is known regarding outcomes after hip fracture among long-term nursing home residents.

OBJECTIVE To describe patterns and predictors of mortality and functional decline in activities of daily living (ADLs) among nursing home residents after hip fracture.

DESIGN, SETTING, AND PARTICIPANTS Retrospective cohort study of 60 111 Medicare beneficiaries residing in nursing homes who were hospitalized with hip fractures between July 1, 2005, and June 30, 2009.

MAIN OUTCOMES AND MEASURES Data sources included Medicare claims and the Nursing Home Minimum Data Set. Main outcomes included death from any cause at 180 days after fracture and a composite outcome of death or new total dependence in locomotion at the latest available assessment within 180 days. Additional analyses described within-residents changes in function in 7 ADLs before and after fracture.

RESULTS Of 60 111 patients, 21 766 (36.2%) died by 180 days after fracture; among patients not totally dependent in locomotion at baseline, 53.5% died or developed new total dependence within 180 days. Within individual patients, function declined substantially after fracture across all ADL domains assessed. In adjusted analyses, the greatest decreases in survival after fracture occurred with age older than 90 years (vs ≤75 years: hazard ratio [HR], 2.17; 95% CI, 2.09-2.26 [$P < .001$]), nonoperative fracture management (vs internal fixation: HR for death, 2.08; 95% CI, 2.01-2.15 [$P < .001$]), and advanced comorbidity (Charlson score of ≥5 vs 0: HR, 1.66; 95% CI, 1.58-1.73 [$P < .001$]). The combined risk of death or new total dependence in locomotion within 180 days was greatest among patients with very severe cognitive impairment (vs intact cognition: relative risk [RR], 1.66; 95% CI, 1.56-1.77 [$P < .001$]), patients receiving nonoperative management (vs internal fixation: RR, 1.48; 95% CI, 1.45-1.51 [$P < .001$]), and patients older than 90 years (vs ≤75 years: RR, 1.42; 95% CI, 1.37-1.46 [$P < .001$]).

CONCLUSIONS AND RELEVANCE Survival and functional outcomes are poor after hip fracture among nursing home residents, particularly for patients receiving nonoperative management, the oldest old, and patients with multiple comorbidities and advanced cognitive impairment. Care planning should incorporate appropriate prognostic information related to outcomes in this population.

JAMA Intern Med. 2014;174(8):1273-1280. doi:10.1001/jamainternmed.2014.2362
Published online June 23, 2014.

Invited Commentary page 1281

Supplemental content at jamainternalmedicine.com

Author Affiliations: Author affiliations are listed at the end of this article.

Corresponding Author: Mark D. Neuman, MD, MSc, Department of Anesthesiology and Critical Care, Perelman School of Medicine at the University of Pennsylvania, 423 Guardian Dr, 1119A Blockley Hall, Philadelphia, PA 19104 (neumanm @mail.med.upenn.edu).

Hip fractures (HFs) occur more than 300 000 times each year among older US adults,[1,2] resulting in substantial mortality[3,4] and loss of functional independence.[5,6] Residents of long-term nursing homes are twice as likely as community-dwelling individuals to sustain a HF,[7-9] and outcomes after fracture are worse among nursing home residents than among community dwellers.[10-12] Nonetheless, past cohort studies of HF have commonly excluded nursing home residents,[4,5,13-15] and studies that have focused on nursing home residents with HFs have been limited by small sample sizes,[12,16,17] single-center designs,[18-20] and lack of data on functional outcomes.[17,18] As a result, little is currently known about patterns and predictors of mortality and functional decline among nursing home residents with HFs.

We undertook a retrospective cohort study to examine outcomes among all fee-for-service Medicare beneficiaries who were hospitalized with an acute HF between July 1, 2005, and June 30, 2009, and who were living in a nursing home prior to fracture. Our study had 3 goals: first, we aimed to characterize patterns of survival and new total dependence in locomotion among nursing home residents at 6 months and a year after HF; second, we sought to describe within-residents changes in functional dependence in 7 activities of daily living (ADLs) before and after fracture; finally, we aimed to identify risk factors associated with survival after HF, along with a composite outcome of death or new total dependence in locomotion within 180 days after fracture.

Methods

Data Sources and Study Sample

This study was approved by the institutional review boards of the Perelman School of Medicine and The Children's Hospital of Philadelphia. Our data set merged the following administrative and clinical data sources: (1) the 2005-2009 Long-Term Care Minimum Data Set (MDS), which contains standardized, validated clinical assessments completed by nurses for all residents in Medicare- or Medicaid-certified US nursing homes at the time of admission and at specified intervals thereafter[21-24]; (2) the 2005-2009 100% Medicare Provider Analysis and Review (MedPAR) files, which include claims for inpatient hospital care for all fee-for-service Medicare beneficiaries; and (3) the 2005-2009 Medicare Beneficiary Summary File, which records health maintenance organization (HMO) enrollment and vital status information. Beneficiaries were linked across files using an encrypted unique identifier.

To identify Medicare beneficiaries who were hospitalized with an acute HF and were residents in a long-term nursing home prior to hospitalization, we first identified all beneficiaries who had a hospital discharge record with a principal or secondary discharge diagnosis code indicating an acute femoral neck, intertrochanteric, or subtrochanteric fracture (*International Classification of Diseases, Ninth Revision, Clinical Modification* [*ICD-9-CM*] diagnosis codes 820.00-09, 820.01-19, 820.21-2, 820.31-2, and 820.8-9) between July 1, 2005, and June 30, 2009. To ensure that we included only acute admissions for HF, rather than readmissions, we considered the first recorded HF admission to be the index, and we excluded from our sample any patient hospitalized for HF between July 1, 2005, and December 31, 2005, who had been hospitalized for HF in the preceding 180 days.

We next identified patients who were residents in long-term nursing homes prior to fracture. As all Medicare- and Medicaid-certified nursing homes are required to complete MDS assessments of residents at admission and at intervals no greater than 92 days thereafter, we followed prior investigators in using the presence of 2 MDS assessments within an appropriate interval as an indicator of nursing home residence.[25-27] Specifically, we selected all individuals with 2 or more routine quarterly assessments in the MDS or an MDS admission assessment followed by a quarterly assessment in the 184 days before the index hospitalization. We considered MDS assessments conducted for changes in clinical status or to correct errors in earlier assessments to be equivalent to quarterly assessments.

Independent Variables: Baseline Characteristics and Acute Fracture Management

We collected data from MedPAR files on patient age, sex, and race, which we coded as black, white, and other.[28] As in previous work, we used *ICD-9-CM* diagnosis codes to create indicator variables for the anatomic location of the fracture (femoral neck, intertrochanteric, subtrochanteric, or multiple locations).[29] We used *ICD-9-CM* procedure codes (see eTable 1 in the Supplement) to identify receipt of surgical HF treatment via total hip arthroplasty, hemiarthroplasty, or internal fixation during the index admission. We considered patients without an *ICD-9-CM* code for any of the aforementioned treatments to have received nonoperative management. We used validated algorithms to identify 16 Charlson comorbidities[30] based on *ICD-9-CM* diagnosis codes for all hospitalizations in the 180 days prior to the index admission and information on chronic medical conditions recorded in the last MDS assessment prior to admission.[30,31]

We collected data from the MDS on self-performance in ADLs using each individual's last MDS quarterly assessment prior to the index admission. Following past investigations that have used MDS data to measure changes over time in ADL function,[25-27,32] we obtained information regarding baseline self-performance in 7 ADLs: (1) locomotion on the nursing home unit, (2) dressing, (3) personal hygiene, (4) using the toilet, (5) transferring between surfaces, (6) getting in and out of bed, and (7) eating. Detailed descriptions of these ADL domains appear in eTable 2 in the Supplement.

For each ADL domain, MDS assessors graded resident self-performance as observed across all nursing shifts over a 7-day period. Grading used a 5-point scale with the following categories: independent, supervision, limited assistance, extensive assistance, and total dependence. Within the MDS, independent in a given ADL indicated the ability to perform that activity without help or oversight or requiring help or oversight only 1 or 2 times over 7 days; total dependence indicated the need for full staff performance of that activity for all 7 days. For this analysis, patients for whom a particular ADL did not occur over 7 days were classified as being totally dependent in that domain. A detailed description of the MDS ADL self-performance grading scale appears in eTable 3 in the Supplement.

To obtain a measure of baseline cognitive status, we used the MDS Cognitive Performance Scale (CPS).[33] The CPS is a validated measure that grades cognition on a 7-point scale ranging from "intact" to "very severe impairment" based on MDS items describing cognition over a 7-day period. Increasing CPS values correlate highly with decreasing scores on the Folstein Mini-Mental Status Examination.[33,34] As with prefracture ADL assessments, baseline CPS scores were obtained from the last available MDS assessment prior to the index admission.

Outcome Variables

Our primary outcome was death from any cause within 180 days of hospital admission. In addition, we examined postfracture self-performance for each of the 7 ADLs as recorded in the last available MDS assessment within 180 days after the index admission. Following past investigations of survival and locomotion outcomes after HF,[16,35] we also created a composite outcome of death by 180 days or new total dependence in locomotion at the last available assessment within 180 days among all patients who were not totally dependent in locomotion at baseline. Among individuals for whom we had at least 365 days of follow-up data (ie, those hospitalized between July 1, 2005, and December 31, 2008), we also examined mortality at 365 days and a composite outcome of death by 365 days or new total dependence in locomotion at the latest available assessment within 365 days.

Statistical Analyses

Initial analyses used descriptive statistics and Kaplan-Meier survival curves to characterize baseline features and outcomes among the full study sample and separately among men and women. To assess within-residents changes in ADL function before and at 180 days after fracture, we examined the distribution of postfracture MDS self-performance scores within each ADL domain among patients with the same level of baseline self-performance in that ADL. To account for deaths, these analyses added a sixth outcome category, corresponding to death within 180 days, to the 5-level MDS self-performance scale.[36] Patients who survived to 180 days after hospital admission but had no recorded postfracture MDS assessments (362 patients [0.6% of the study sample]) were included in our calculations for 180-day mortality but excluded from calculations related to 180-day functional outcomes; we took an analogous approach in analyzing 365-day outcomes.

We developed a multivariate Cox proportional hazards model to measure the adjusted association of baseline patient factors and acute fracture management with postfracture survival, considering the survival time to be right censored for all patients who were alive as of December 31, 2009. As a supplementary analysis, we also developed a regression model to predict a binary outcome of death at 180 days; this model used multivariate Poisson regression with robust variance estimates[37-39] to measure the adjusted relative risks (RRs) of mortality associated with specific patient factors and fracture management approaches. Finally, to measure the adjusted association of baseline patient factors and acute fracture management with the composite outcome (death or new total dependence in locomotion within 180 days), we estimated adjusted RRs using a multivariate Poisson regression model with robust variance estimates.

We chose variables for inclusion in our regression models based on clinical judgment and literature review. They included age, sex, race, Charlson comorbidity index score,[30] fracture location, fracture management approach (internal fixation, hemiarthroplasty, total hip arthroplasty, or nonoperative management), baseline cognitive performance, baseline locomotion self-performance, and the number out of 6 nonlocomotion ADLs with independent self-performance at baseline. While the survival model and the 180-day mortality model each included all patients in our study sample, the model for our composite outcome excluded those individuals who were totally dependent in locomotion at baseline. As longitudinal studies of health that exclude decedents may produce misleading results,[36,40] we did not carry out regression analyses restricted to patients who survived to 180 days after HF. Analyses used SAS 9.3 (SAS institute) statistical software. $P < .05$ was considered statistically significant.

Results

Of 724 699 fee-for-service Medicare beneficiaries hospitalized with a HF over the study period, 60 111 (8.3%) were nursing home residents. Among these individuals, the median time between the last prefracture MDS assessment and the index admission was 39 days (interquartile range [IQR], 18-63 days). Among patients who survived to 180 days after fracture, the median number of days between the index admission and the last available MDS assessment within 180 days was 128 days (IQR, 103-166 days); within this group, the timing of the last available MDS assessment ranged from 3 days to 180 days after admission.

Long-term nursing home patients with HF had a high degree of baseline comorbidity, ADL dependence, and cognitive impairment (**Table 1**). Within the overall sample, 26.6% had a Charlson score of 4 or greater. At the last available MDS assessment prior to admission, 31.0% of the sample was independent in locomotion, but only 5.8% of the sample were independent in 6 of 6 nonlocomotion ADLs. At baseline, 9.3% were cognitively intact. During the index hospitalization, 11.8% of patients had no evidence of surgical HF treatment. Baseline characteristics differed between men and women in our sample; while men more often had high degrees of comorbidity, women demonstrated a higher degree of dependence in locomotion (see eTable 4 in the Supplement).

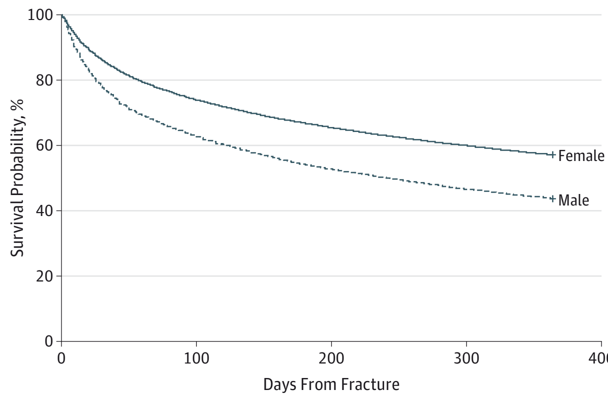
Of 60 111 patients in our full sample, 21 766 (36.2%) died by 180 days after fracture (**Figure 1** and **Table 2**). Median survival time after fracture was 377 days (IQR, 70-1002 days). Of the 52 734 patients who were not totally dependent in locomotion at baseline, 28 225 (53.5%) either died or were newly dependent in locomotion within 180 days; among patients who survived to 180 days, new total dependence in locomotion occurred in 9438 of 33 947 (27.8%).

Table 1. Baseline Characteristics and Acute Fracture Management in 60 111 Long-term US Nursing Home Residents Hospitalized With Hip Fractures Between July 1, 2005, and June 30, 2009

Characteristic/Management	Residents, No. (%)
Sex	
Female	45 345 (75.4)
Male	14 766 (24.6)
Age, y	
≤75	6662 (11.1)
76-80	8408 (14.0)
81-85	14 343 (23.9)
86-90	15 930 (26.5)
≥91	14 768 (24.6)
Race	
White	55 241 (91.9)
Black	3335 (5.5)
Other	1535 (2.6)
Charlson score	
0	4967 (8.3)
1	15 228 (25.3)
2	13 918 (23.2)
3	10 027 (16.7)
4	6551 (10.9)
≥5	9420 (15.7)
Baseline cognitive performance	
Intact	5586 (9.3)
Borderline intact	5600 (9.3)
Mild impairment	10 120 (16.8)
Moderate impairment	25 296 (42.1)
Moderate-severe impairment	6340 (10.5)
Severe impairment	5889 (9.8)
Very severe impairment	1280 (2.1)
Baseline dependence in locomotion	
Independent	18 638 (31.0)
Requires supervision	12 022 (20.0)
Requires limited assistance	12 497 (20.8)
Requires extensive assistance	9884 (16.4)
Total dependence	7070 (11.8)
No. out of 6 nonlocomotion ADLs with functional independence	
6	3503 (5.8)
4-5	5743 (9.6)
2-3	11 263 (18.7)
0-1	39 602 (65.9)
Fracture location	
Femoral neck	28 380 (47.2)
Intertrochanteric	25 535 (42.5)
Subtrochanteric	2088 (3.5)
Multiple locations	4108 (6.8)
Acute fracture management	
Hemiarthroplasty	18 760 (31.2)
Internal fixation	33 273 (55.4)
Total hip arthroplasty	1009 (1.7)
Nonoperative management	7069 (11.8)

Abbreviation: ADLs, activities of daily living (activities assessed include bed mobility, transferring, dressing, personal hygiene, eating, and toileting).

Figure 1. Survival at up to 365 Days Among 60 111 US Long-term Care Residents Hospitalized With Hip Fracture Between July 1, 2005, and June 30, 2009



Male patients demonstrate a lower probability of survival than women at all time points after fracture ($P < .001$ by log-rank test).

Among the 52 914 patients with at least 1 year of available follow-up data, 24 883 (47.0%) died by 365 days. Among the 46 842 of these patients who were not totally dependent in locomotion at baseline, 28 114 (60.5%) either died or experienced new total dependence in locomotion within 365 days. Among the 24 984 patients without total dependence in locomotion at baseline who had at least 365 days of follow-up data and who survived 365 days after fracture, 6618 (26.5%) were totally dependent in locomotion at 365 days.

Outcomes differed according to sex; compared with women, death by 180 days and the 180-day composite outcome each occurred more frequently among men. Dependence in locomotion also occurred frequently among patients who died within 180 days of fracture; among the 16 153 decedents who had at least 1 postfracture ADL measurement, 90% were either totally dependent or required extensive assistance in locomotion at the last available assessment prior to death.

Within individual residents, differences in the degree of independence in locomotion before and after fracture varied according to baseline locomotion status (Figure 1). Among patients who were fully independent in locomotion at baseline, 21.0% both survived to 180 days and were independent in locomotion at their last available assessment within 180 days. Among patients who required supervision in locomotion at baseline and among those who required limited assistance for locomotion at baseline, 16.2% and 22.1%, respectively, both survived to 180 days and attained or exceeded their prefracture level of independence in locomotion by the last available assessment within 180 days (**Figure 2**). Marked within-residents changes in ADL self-performance also occurred in transferring between surfaces, mobility in bed, dressing, personal hygiene, and toileting; smaller changes occurred in ADL self-performance related to eating (see eFigure in the Supplement).

In our proportional hazards model, male sex, increasing age, white race, and high levels of comorbidity, cognitive impairment, locomotion dependence, and dependence in nonlocomotion ADLs were all significantly associated with de-

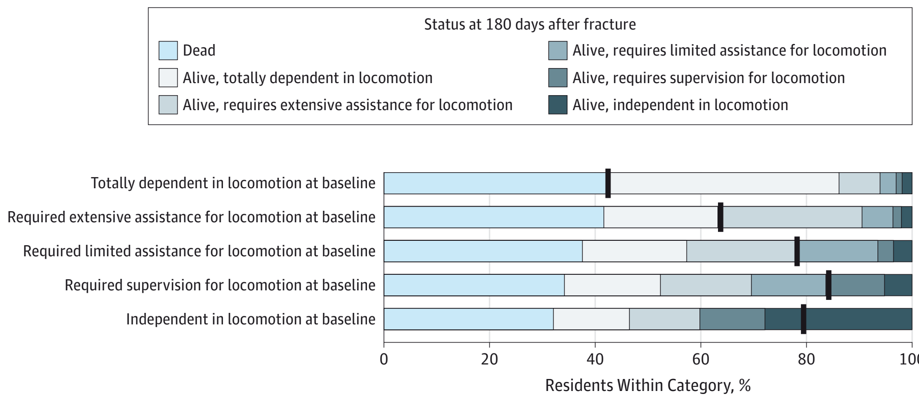
Table 2. Study Outcomes

Outcome	Residents, No./Total (%) All	Female	Male	*P* Value, Male vs Female
Death at 180 d[a]	21 766/60 111 (36.2)	15 009/45 345 (33.1)	6757/14 766 (45.8)	<.001
Death or new total disability in locomotion at 180 d[b]	28 225/52 734 (53.5)	20 517/39 508 (51.9)	7708/13 226 (58.3)	<.001

[a] Sample includes all patients in starting cohort.

[b] Sample includes all patients without total dependence in locomotion at baseline and all patients who either died by 180 days or who survived to 180 days and had a valid Minimum Data Set assessment in the first 180 d following admission.

Figure 2. Survival to 180 Days and Within-Residents Changes in Locomotion Self-performance Among 59 749 Nursing Home Residents Hospitalized With Hip Fractures Between July 1, 2005, and June 30, 2009



For individuals within a given category of baseline locomotion self-performance, the corresponding horizontal bar shows the fraction of patients who died within 180 days, along with the distribution of postfracture locomotion scores at the last available assessment within 180 days among survivors. The bold vertical line intersecting each bar demarcates the fraction of individuals within a baseline locomotion category who both survived to 180 days and regained or exceeded their baseline level of locomotion self-performance at the latest available assessment within 180 days after fracture.

creases in adjusted postfracture survival. Decreased survival was also seen among patients with nonfemoral neck fractures, patients undergoing hemiarthroplasty or total hip arthroplasty vs internal fixation, and patients who received nonoperative management (**Table 3**). The factors most strongly associated with decreased survival after fracture were age older than 90 years (vs ≤75 years: hazard ratio [HR], 2.17; 95% CI, 2.09-2.26 [*P* < .001]), nonoperative fracture management (vs internal fixation: HR, 2.08; 95% CI, 2.01-2.15 [*P* < .001]), and a Charlson score of 5 or greater (vs 0: HR, 1.66; 95% CI, 1.58-1.73 [*P* < .001]). We obtained qualitatively similar results from a multivariate Poisson regression model that used the same set of independent variables to predict a binary outcome of death at 180 days (see eTable 5 in the Supplement).

Most factors associated with decreased adjusted survival were also associated with an increased adjusted risk of our composite outcome of death or new total dependence in locomotion within 180 days, although black patients were at slightly elevated risk of experiencing this outcome compared with white patients (RR, 1.05; 95% CI, 1.02-1.09 [*P* = .002]). In our Poisson regression model, the factors most strongly associated with the composite adverse outcome were very severe cognitive impairment (vs intact cognition: RR, 1.66; 95% CI, 1.56-1.77 [*P* < .001]), nonoperative fracture management (vs internal fixation: RR, 1.48; 95% CI, 1.45-1.51 [*P* < .001]), and age over 90 years (vs ≤75 years: RR, 1.42; 95% CI, 1.37-1.46 [*P* < .001]).

Discussion

In this study of 60 111 US long-term nursing home residents, HFs were associated with substantial mortality and increases in ADL dependence. By 180 days after fracture, more than 1 in 3 patients had died, including nearly 1 of every 2 men. Among those individuals who had some degree of functional independence in locomotion at baseline, 1 of 2 had either died or developed new total dependence in locomotion within 180 days after fracture.

Hip fractures were associated with profound increases in dependence in multiple ADLs. Among patients who were fully independent in locomotion at baseline or required supervision or limited assistance, approximately 1 in 5 survived to regain their prefracture level of independence in locomotion at 180 days after fracture; similar patterns were observed for other ADLs, including transferring, mobility in bed, personal hygiene, and toileting.

Finally, we identified several risk factors for adverse outcomes after HF among nursing home residents. We classified

Table 3. Predictors of Adverse Outcomes After Hip Fracture Among Nursing Home Residents

Predictor	Adjusted HR (95% CI) for Survival After Admission for Hip Fracture (95% CI)[a]	*P* Value	Adjusted RR (95% CI) for Death or New Total Disability in Locomotion at 180 Days After Hip Fracture[b]	*P* Value
Sex				
Female	1 [Reference]		1 [Reference]	
Male	1.54 (1.51-1.58)	<.001	1.14 (1.12-1.16)	<.001
Age, y				
≤75	1 [Reference]		1 [Reference]	
76-80	1.20 (1.15-1.25)	<.001	1.08 (1.05-1.13)	<.001
81-85	1.40 (1.34-1.45)	<.001	1.18 (1.14-1.22)	<.001
86-90	1.65 (1.59-1.72)	<.001	1.26 (1.22-1.30)	<.001
≥91	2.17 (2.09-2.26)	<.001	1.42 (1.37-1.46)	<.001
Race				
White	1 [Reference]		1 [Reference]	
Black	0.77 (0.73-0.80)	<.001	1.05 (1.02-1.09)	.002
Other	0.74 (0.70-0.79)	<.001	0.94 (0.90-0.99)	.03
Charlson score				
0	1 [Reference]		1 [Reference]	
1	1.10 (1.05-1.15)	<.001	1.05 (1.02-1.09)	.005
2	1.22 (1.17-1.28)	<.001	1.06 (1.03-1.10)	<.001
3	1.35 (1.29-1.41)	<.001	1.11 (1.07-1.15)	<.001
4	1.44 (1.37-1.51)	<.001	1.13 (1.09-1.18)	<.001
≥5	1.66 (1.58-1.73)	<.001	1.20 (1.16-1.25)	<.001
Baseline cognitive performance				
Intact	1 [Reference]		1 [Reference]	
Borderline intact	1.01 (0.96-1.06)	.65	1.01 (0.97-1.05)	.63
Mild impairment	1.09 (1.05-1.14)	<.001	1.07 (1.04-1.11)	<.001
Moderate impairment	1.14 (1.10-1.19)	<.001	1.18 (1.14-1.22)	<.001
Moderate-severe impairment	1.22 (1.17-1.28)	<.001	1.34 (1.29-1.40)	<.001
Severe impairment	1.29 (1.23-1.35)	<.001	1.42 (1.37-1.47)	<.001
Very severe impairment	1.16 (1.07-1.25)	<.001	1.66 (1.56-1.77)	<.001
Baseline dependence in locomotion				
Independent	1 [Reference]		1 [Reference]	
Requires supervision	1.02 (0.99-1.05)	.25	1.02 (1.00-1.05)	.051
Requires limited assistance	1.08 (1.04-1.11)	<.001	1.09 (1.06-1.11)	<.001
Requires extensive assistance	1.16 (1.12-1.20)	<.001	1.16 (1.13-1.19)	<.001
Total dependence	1.12 (1.08-1.17)	<.001	NA	
No. out of 6 nonlocomotion ADLs with functional independence at baseline[c]				
6	1 [Reference]		1 [Reference]	
4-5	1.13 (1.07-1.19)	<.001	1.17 (1.11-1.23)	<.001
2-3	1.23 (1.17-1.30)	<.001	1.30 (1.24-1.37)	<.001
0-1	1.27 (1.20-1.33)	<.001	1.30 (1.24-1.37)	<.001
Fracture location				
Femoral neck	1 [Reference]		1 [Reference]	
Intertrochanteric	1.10 (1.07-1.13)	<.001	1.10 (1.07-1.12)	<.001
Subtrochanteric	1.09 (1.02-1.15)	.006	1.18 (1.12-1.23)	<.001
Multiple locations	1.13 (1.08-1.18)	<.001	1.13 (1.10-1.17)	<.001
Acute fracture management				
Internal fixation	1 [Reference]		1 [Reference]	
Total hip arthroplasty	1.15 (1.06-1.25)	<.001	1.10 (1.03-1.18)	.003
Hemiarthroplasty	1.10 (1.07-1.14)	<.001	1.12 (1.10-1.15)	<.001
Nonoperative management	2.08 (2.01-2.15)	<.001	1.48 (1.45-1.51)	<.001

Abbreviations: ADLs, activities of daily living; HR, hazard ratio; NA, not applicable; RR, relative risk.

[a] Sample includes all patients in starting cohort (N = 60 111).

[b] Sample includes all patients without total dependence in locomotion at baseline and all patients who either died by 180 days or who survived to 180 days and had a valid Minimum Data Set assessment in the first 180 days following admission (n = 52 734).

[c] Activities assessed include bed mobility, transferring, dressing, personal hygiene, eating, and toileting.

11.8% of patients in our sample as having received nonoperative management, a rate approximately twice that seen in the overall Medicare population.[41] Within our cohort, nonoperative care was associated with marked decreases in survival after HF and a substantially greater adjusted risk of death or new total dependence in locomotion within 180 days compared with internal fixation. While this finding may be due in part to the sickest patients electing to undergo nonoperative management, it would also be consistent with a substantial negative effect of nonoperative care on outcomes. Beyond nonoperative fracture management, male sex, increasing age, white race, high levels of comorbidity, advanced cognitive impairment, nonfemoral neck fracture location, and increasing baseline ADL dependence were all associated with decreased survival after HF. Most of these same factors were also associated with a significantly elevated risk of the composite outcome of death or new total dependence in locomotion within 180 days, although we did observe black patients to be at a slightly higher risk of experiencing the composite outcome compared with white patients. Overall, the presence of very severe cognitive impairment at baseline was associated with the greatest increase in the risk of this outcome.

Poor outcomes among long-term nursing home residents with HF have previously been noted in small cohort studies[12,16,17] and single-center investigations.[18-20] For example, in a study of 195 long-term care residents from a single US institution who experienced a HF between 1999 and 2006, Berry and colleagues[18] noted an overall mortality rate of 40% at 1 year. Similarly, among 60 ambulatory nursing home patients with HF in Canada in 2008 and 2009, Beaupre and colleagues[16] noted a 45% mortality rate and a combined rate of death or new inability to ambulate of 63% at 1 year. Among 38 patients with end-stage dementia and HF, the majority of whom were long-term nursing home residents, Morrison and Siu[20] reported a 6-month mortality of 55%.

Our study confirms and extends these prior findings. To our knowledge, ours is the largest and most comprehensive study to date of outcomes following HF among nursing home residents. By taking advantage of a large, national data set, this study provides a reliable and highly generalizable description of the experiences of nursing home residents who experience HFs. Furthermore, it provides important insight into the heterogeneous nature of HF as a clinical syndrome. While past investigators have identified selected risk factors for adverse outcomes after HF in general,[10,11] our findings offer new evidence regarding specific baseline risk factors for adverse outcomes at 180 days among nursing home residents who experience HFs.

Our study has limitations. Because MedPAR files do not contain records on HMO patients, we were unable to identify HMO patients with HF. While our study data set contained detailed clinical information on the patients in our sample, we cannot rule out unobserved differences in severity of illness that may have partially explained differences in outcomes we observe across groups of patients, such as those receiving operative vs nonoperative care. Because we did not examine the effect of postacute care services on outcomes, we cannot comment here on the impact of variations in the quality of postfracture nursing home care on survival or functional recovery. Furthermore, because additional recovery may have occurred beyond the date of each patient's latest available MDS assessment, our analyses may underestimate the true extent of functional recovery at 180 days. Finally, as our composite outcome incorporates information on both survival and postfracture locomotion, it should not be interpreted as a measure of the relative likelihood of new dependence in locomotion after fracture per se; rather, it is a more general indicator of the likelihood of an adverse health outcome, defined here as death or the development of new total dependence within 180 days after fracture.

Conclusions

Despite these limitations, our findings have important implications for clinical practice and health care delivery. Residents of long-term nursing facilities represent a uniquely vulnerable subset of all patients with HF, and approaches to clinical care for these individuals should consider the high probability of death and functional disability after fracture in this group. In particular, the extreme rates of mortality and functional disability documented herein suggest that counseling regarding prognosis for survival and recovery, explicit discussions of goals of care, and aggressive efforts to control pain and other distressing symptoms represent essential components of management for nursing home residents with HF. At the same time, our observation of substantially worse risk-adjusted outcomes among patients receiving nonoperative management suggests that indicated operative fracture treatment may be reasonable even in the presence of advanced comorbidity, cognitive impairment, or baseline functional dependence if it is consistent with patients' overall goals of care. More generally, our findings emphasize the importance of continued efforts to prevent HFs among nursing home residents, and they stress the need for further research on the potential for quality improvement initiatives, potentially including specialized inpatient geriatric fracture programs, to improve outcomes among nursing home residents who sustain HFs.

ARTICLE INFORMATION

Accepted for Publication: March 25, 2014.

Published Online: June 23, 2014. doi:10.1001/jamainternmed.2014.2362.

Author Affiliations: Department of Anesthesiology and Critical Care, Perelman School of Medicine at the University of Pennsylvania, Philadelphia (Neuman, Silber); Leonard Davis Institute for Health Economics, the University of Pennsylvania, Philadelphia (Neuman, Silber, Werner); Center for Outcomes Research, Children's Hospital of Philadelphia, Philadelphia (Silber, Passarella); Department of Pediatrics, Perelman School of Medicine at the University of Pennsylvania, Philadelphia (Silber); Health Care Management Department, the Wharton School, the University of Pennsylvania, Philadelphia (Silber); Department of Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore (Magaziner); Department of Orthopedic Surgery, Perelman School of Medicine at the University of Pennsylvania, Philadelphia (Mehta); Division of General Internal Medicine, Department of Internal Medicine, Perelman School of Medicine at the University of Pennsylvania, Philadelphia (Werner).

Author Contributions: Dr Neuman had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Neuman, Silber, Mehta, Werner.
Acquisition, analysis, or interpretation of data: Neuman, Silber, Magaziner, Passarella, Werner.
Drafting of the manuscript: Neuman, Passarella.
Critical revision of the manuscript for important intellectual content: Neuman, Silber, Magaziner, Mehta, Werner.
Statistical analysis: Neuman, Silber, Passarella, Werner.
Obtained funding: Neuman.
Administrative, technical, or material support: Neuman, Mehta.
Study supervision: Neuman, Magaziner, Mehta, Werner.

Conflict of Interest Disclosure: During the past 3 years, Dr Magaziner has consulted or served on advisory boards for the American Orthopaedic Association, Amgen, Ammonett, Eli Lilly, Glaxo SmithKline, Organext, and Regeneron, and received research funds through contract with the University of Maryland from Eli Lilly. No other disclosures are reported

Funding/Support: Dr Neuman received funding from the National Institute on Aging (grant K08AG043548-02).

Role of the Sponsor: The National Institute on Aging had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

REFERENCES

1. Hall MJ, DeFrances CJ, Williams SN, Golosinskiy A, Schwartzman A. National Hospital Discharge Survey: 2007 summary. *Natl Health Stat Report*. 2010;(29):1-20, 24.

2. Blackman DK, Kamimoto LA, Smith SM. Overview: surveillance for selected public health indicators affecting older adults—United States. *MMWR CDC Surveill Summ*. 1999;48(8):1-6.

3. Brauer CA, Coca-Perraillon M, Cutler DM, Rosen AB. Incidence and mortality of hip fractures in the United States. *JAMA*. 2009;302(14):1573-1579.

4. Magaziner J, Lydick E, Hawkes W, et al. Excess mortality attributable to hip fracture in white women aged 70 years and older. *Am J Public Health*. 1997;87(10):1630-1636.

5. Magaziner J, Simonsick EM, Kashner TM, Hebel JR, Kenzora JE. Predictors of functional recovery one year following hospital discharge for hip fracture: a prospective study. *J Gerontol*. 1990;45(3):M101-M107.

6. Magaziner J, Hawkes W, Hebel JR, et al. Recovery from hip fracture in eight areas of function. *J Gerontol A Biol Sci Med Sci*. 2000;55(9):M498-M507.

7. Norton R, Campbell AJ, Reid IR, et al. Residential status and risk of hip fracture. *Age Ageing*. 1999;28(2):135-139.

8. Butler M, Norton R, Lee-Joe T, Cheng A, Campbell AJ. The risks of hip fracture in older people from private homes and institutions. *Age Ageing*. 1996;25(5):381-385.

9. Brennan nee Saunders J, Johansen A, Butler J, et al. Place of residence and risk of fracture in older people. *Osteoporos Int*. 2003;14(6):515-519.

10. Eastwood EA, Magaziner J, Wang J, et al. Patients with hip fracture: subgroups and their outcomes. *J Am Geriatr Soc*. 2002;50(7):1240-1249.

11. Penrod JD, Litke A, Hawkes WG, et al. Heterogeneity in hip fracture patients. *J Am Geriatr Soc*. 2007;55(3):407-413.

12. Beaupre LA, Cinats JG, Jones CA, et al. Does functional recovery in elderly hip fracture patients differ between patients admitted from long-term care and the community? *J Gerontol A Biol Sci Med Sci*. 2007;62(10):1127-1133.

13. Taylor BC, Schreiner PJ, Stone KL, et al. Long-term prediction of incident hip fracture risk in elderly white women: study of osteoporotic fractures. *J Am Geriatr Soc*. 2004;52(9):1479-1486.

14. Richmond J, Aharonoff GB, Zuckerman JD, Koval KJ. Mortality risk after hip fracture. *J Orthop Trauma*. 2003;17(1):53-56.

15. Marottoli RA, Berkman LF, Leo-Summers L, Cooney LM Jr. Predictors of mortality and institutionalization after hip fracture: the New Haven EPESE cohort. *Am J Public Health*. 1994;84(11):1807-1812.

16. Beaupre LA, Jones CA, Johnston DW, Wilson DM, Majumdar SR. Recovery of function following a hip fracture in geriatric ambulatory persons living in nursing homes: prospective cohort study. *J Am Geriatr Soc*. 2012;60(7):1268-1273.

17. Cameron ID, Chen JS, March LM, et al. Hip fracture causes excess mortality owing to cardiovascular and infectious disease in institutionalized older people: a prospective 5-year study. *J Bone Miner Res*. 2010;25(4):866-872.

18. Berry SD, Samelson EJ, Bordes M, Broe K, Kiel DP. Survival of aged nursing home residents with hip fracture. *J Gerontol A Biol Sci Med Sci*. 2009;64(7):771-777.

19. Crotty M, Miller M, Whitehead C, Krishnan J, Hearn T. Hip fracture treatments—what happens to patients from residential care? *J Qual Clin Pract*. 2000;20(4):167-170.

20. Morrison RS, Siu AL. Survival in end-stage dementia following acute illness. *JAMA*. 2000;284(1):47-52.

21. Brown DL, ed. *Center for Medicare and Medicaid Services Revised Long-Term Care Resident Assessment Instrument User's Manual, Version 2.0.* West Des Moines, IA: Briggs Corporation; 2003.

22. Hawes C, Morris JN, Phillips CD, Mor V, Fries BE, Nonemaker S. Reliability estimates for the Minimum Data Set for nursing home resident assessment and care screening (MDS). *Gerontologist*. 1995;35(2):172-178.

23. Casten R, Lawton MP, Parmelee PA, Kleban MH. Psychometric characteristics of the minimum data set I: confirmatory factor analysis. *J Am Geriatr Soc*. 1998;46(6):726-735.

24. Lawton MP, Casten R, Parmelee PA, Van Haitsma K, Corn J, Kleban MH. Psychometric characteristics of the minimum data set II: validity. *J Am Geriatr Soc*. 1998;46(6):736-744.

25. Finlayson E, Wang L, Landefeld CS, Dudley RA. Major abdominal surgery in nursing home residents: a national study. *Ann Surg*. 2011;254(6):921-926.

26. Finlayson E, Zhao S, Boscardin WJ, Fries BE, Landefeld CS, Dudley RA. Functional status after colon cancer surgery in elderly nursing home residents. *J Am Geriatr Soc*. 2012;60(5):967-973.

27. Kurella Tamura M, Covinsky KE, Chertow GM, Yaffe K, Landefeld CS, McCulloch CE. Functional status of elderly adults before and after initiation of dialysis. *N Engl J Med*. 2009;361(16):1539-1547.

28. Arday SL, Arday DR, Monroe S, Zhang J. HCFA's racial and ethnic data: current accuracy and recent improvements. *Health Care Financ Rev*. 2000;21(4):107-116.

29. Neuman MD, Silber JH, Elkassabany NM, Ludwig JM, Fleisher LA. Comparative effectiveness of regional versus general anesthesia for hip fracture surgery in adults. *Anesthesiology*. 2012;117(1):72-92.

30. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373-383.

31. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care*. 2005;43(11):1130-1139.

32. Morris JN, Fries BE, Morris SA. Scaling ADLs within the MDS. *J Gerontol A Biol Sci Med Sci*. 1999;54(11):M546-M553.

33. Morris JN, Fries BE, Mehr DR, et al. MDS Cognitive Performance Scale. *J Gerontol*. 1994;49(4):M174-M182.

34. Hartmaier SL, Sloane PD, Guess HA, Koch GG, Mitchell CM, Phillips CD. Validation of the Minimum Data Set Cognitive Performance Scale. *J Gerontol A Biol Sci Med Sci*. 1995;50(2):M128-M133.

35. Hannan EL, Magaziner J, Wang JJ, et al. Mortality and locomotion 6 months after hospitalization for hip fracture. *JAMA*. 2001;285(21):2736-2742.

36. Diehr P, Johnson LL, Patrick DL, Psaty B. Methods for incorporating death into health-related variables in longitudinal studies. *J Clin Epidemiol*. 2005;58(11):1115-1124.

37. McNutt LA, Wu C, Xue X, Hafner JP. Estimating the relative risk in cohort studies and clinical trials of common outcomes. *Am J Epidemiol*. 2003;157(10):940-943.

38. Greenland S. Model-based estimation of relative risks and other epidemiologic measures in studies of common outcomes and in case-control studies. *Am J Epidemiol*. 2004;160(4):301-305.

39. Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol*. 2004;159(7):702-706.

40. Rothman K, Greenland S, Lash T, eds. *Modern Epidemiology.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2008.

41. Neuman MD, Fleisher LA, Even-Shoshan O, Mi L, Silber JH. Nonoperative care for hip fracture in the elderly. *Med Care*. 2010;48(4):314-320.