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Thirty-Day, All-cause Readmissions for Elderly Patients Who Have an Injury-related Inpatient Stay

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Background: Policymakers are exploring ways to reduce readmission rates. Much attention has been given to readmissions for conditions such as heart failure, acute myocardial infarction, and pneumonia, but little attention has been given to readmissions of patients with injury-related index admissions.

Methods: This analysis is a retrospective cohort study of elderly persons who are admitted to a community hospital for a principal diagnosis of injury. We use 2006 Healthcare Cost and Utilization Project State Inpatient Databases and State Emergency Department Databases from 11 States. With logistic regression we identify factors associated with a 30-day, all-cause inpatient readmission. Factors include: patient characteristics, injury characteristics, clinical experiences during the hospital stay, and hospital characteristics.

Results: About 1 in 7 elderly patients with an injury-related admission were readmitted in 30 days (13.7%). We found that severe injuries had higher predicted readmission rates. Patients receiving transfusions, experiencing a Patient Safety Indicator event, and with infections had higher readmission rates. Patients discharged to nursing homes or home health care had higher readmission rates compared with patients discharged to the community.

Conclusions: This study expands evidence for the influence of injury characteristics on readmission rates. It also provides evidence about hospital experiences that affect readmissions. These findings suggest that a focus on preventing complications during the hospital stay may help reduce hospital-specific readmissions for patients with injury-related conditions. It also suggests that a strategy to reduce readmission rates should not only focus on hospitals but also nursing homes and home health care.

Key Words: hospital readmission, injury, readmission rate

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About 20% of fee-for-service Medicare beneficiaries discharged from an inpatient stay are readmitted in 30 days.^{1,2} Hospital readmission rates vary greatly even after adjusting for hospital case mix differences.² Research suggests that hospital-based and community-based initiatives can prevent some readmissions by improving communication between providers and beneficiaries, improving coordination of care among providers after discharge, and improving the quality of care during the initial hospitalization.^{3–5}

Policymakers are exploring ways to reduce readmission rates. The Medicare Payment Advisory Commission recommended using publicly reported, hospital-specific readmission rates for specific conditions as a basis for payment and penalizing hospitals with high rates.² The Centers for Medicaid and Medicare Services (CMS) with Quality Improvement Organizations has begun implementing a Care Transitions Program working with 14 communities to prevent unnecessary readmissions.⁶ CMS also reports readmission rates on its Hospital Compare Web site for heart failure (HF), acute myocardial infarction, and pneumonia. The Patient Protection and Affordable Care Act authorizes CMS to penalize hospitals with above-expected readmission rates for these conditions in 2012.⁷

The policy interest in preventing readmissions focuses on readmissions for highly prevalent medical and surgical conditions.² Little attention has been given to readmissions of patients with injury-related admissions. Although injuries represent only about 5% of all admissions, for the elderly they account for 37% of admissions⁸ and one tenth of emergency department (ED) visits.⁹ In addition, these patients are likely to be discharged to skilled nursing facilities and receive home health care (HHC) services, which are also associated with high admission rates.^{10,11} Cost is higher for more severe injuries, like hip fractures. They carry a high mortality risk and recovery can be slow with functional deficits persisting a year after injury.^{12–16}

Research on injury-related readmissions is sparse. The main focus has been on hip fractures and has been limited to understanding health risk factors.^{16–18} In a cohort study of veterans admitted to Veterans Administration (VA) or non-VA hospitals after hip fracture, 18% had an all-cause readmission within 30 days. Older age, male sex, longer length of stay (LOS), and a large number of comorbidities, such as fluid and electrolyte disorders, renal failure, cardiac arrhythmias, chronic pulmonary disease, and HF, had higher 30-day readmission rates.¹⁸ The most common reasons for readmissions were infections and cardiac diseases.^{16,19}

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The goal of this research is to broaden the injury and readmission literatures to consider all types of injuries, rather than just hip fractures, and to explore the factors that are associated with readmissions, such as the role of long-term care, the experience of patients in the initial hospital visit, and the characteristics of that hospital. These results will help identify important provider-related factors that influence readmission rates. Relative risk (RR) rates are estimated after controlling for patient demographic and socioeconomic characteristics, comorbidities, and State effects.

METHODS

Data and Design

This study is a retrospective cohort study of elderly persons from select States admitted to community non-rehabilitation, acute care hospitals for injury-related admissions in 2006. Data are from 11 States that provided encrypted patient identifiers to the 2006 Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID)²⁰ and State Emergency Department Databases (SEDD).²¹ The SID and SEDD contain nearly the universe of records from hospitalizations and ED visits from participating States. States include Arizona, California, Florida, Hawaii, Missouri, Nebraska, New Hampshire, New York, South Carolina, Tennessee, and Utah. We combined SID and SEDD records for individuals aged 65 and over and identified persons with an inpatient stay and a principal diagnosis of injury. Using a unique patient identifier, we identified all-cause readmissions that occurred within 30 days after discharge from the index hospitalization. An all-cause 30-day interval was chosen because it is short enough that the readmission may be affected by the care provided in the index visit. This metric is also commonly used in readmission research. For patients with an index admission in December, we used 2007 data when necessary to complete the follow-up. If any revisit within 30 days resulted in an inpatient stay, it was classified as readmission. If the revisit resulted in an ED visit and was not followed within the 30-day period by an inpatient stay, it was classified as a treat-and-release ED revisit. Patients transferred from one hospital to another hospital were identified as transfers and not readmissions per se, although we did capture readmissions that occurred subsequently. Discharges to nursing homes (NHs) that had a same day new inpatient stay, and any discharges with a diagnosis-related group (DRG) of 462 (rehabilitation) were not counted as readmissions. The time to readmission is the number of days from the index hospital discharge to next inpatient admission. For patients with transfers, days were counted from the discharge date of the final inpatient setting.

Sample

Injury-related index hospital stays were identified as any ICD-9 diagnosis code in the range of 800.0–909.2, 909.4, 909.9, 910.0–994.9, and 995.8–995.85. This definition is consistent with the State and Territorial Injury Prevention Directors Association's Consensus Recommendations for Using Hospital Discharge Data for Injury Surveillance.²²

There were 224,193 patients who had an injury-related index hospital stay during 2006 in the 11 States. We excluded 15,699 patients who died during the index stay, and 301 with missing information. The final sample is 208,193 patients with a principal diagnosis of injury.

Model

We used logistic regression to identify factors associated with 30-day, all-cause inpatient readmission, including: patient characteristics, injury characteristics, clinical experiences during the hospital stay, and hospital characteristics. The model includes State fixed effects. All SEs are robust and account for clustering of patients in the hospital; 95% confidence bands for RRs and margins are calculated using the delta method. We calculate RRs and marginal effects (absolute risk changes) based on the model results. Persons who died during the 30-day period after the index admission were censored. We also estimate a model for the probability of any revisit (treat-and-release ED visit or inpatient admission) to determine whether risk factors vary between the 2 analyses. All analyses were conducted using logit in Stata version 12.0 MP (StataCorp, College Station, TX).

Dependent Variable

In the main analyses, the dependent variable is a 0/1 binary variable that identifies whether an all-cause inpatient readmission occurred within 30 days of discharge from the index admission. In the second analyses the dependent variable is defined as any 30-day revisit (inpatient or ED treat-and-release).

We grouped readmission DRGs as follows: surgery for upper and lower extremities, pneumonia, HF, septicemia, urinary tract infection (UTI), gastrointestinal (GI) problems, GI bleeding, nutrition-related or metabolic issues, intracranial bleeding or cerebral infarction, arrhythmias, and others.

Independent Variables

Injury

Injuries were classified based on body region and nature of injury using the Barell Injury Diagnosis Matrix.²³ We primarily relied on the body region, but for high-frequency groups, we distinguished between body region with and without fracture and between hip and other lower extremities.

Severity of injury was measured using the New Injury Severity Score (NISS) generated by the ICDPIC program.²⁴ The NISS is computed as the sum of squares of the 3 most severe abbreviated injury scale injuries. NISS may vary from 1 (minimal severity) to 75 (maximum severity).²⁵ We created a dummy variable for injuries that cannot be scored using the NISS (NISS=0 or 99). In addition, we included a dummy variable for injuries related to a fall, based on the AHRQ Clinical Classification Software external injury code 2603.²⁶ We included dummy variables for select body region locations—spinal cord injuries (SCI), traumatic brain injuries (TBI), and vertebral column injuries (VCI).

Hospital Experience

Major surgery was identified by using HCUP Procedure Classes that categorize procedure codes, based on ICD-9-CM, into the following categories: minor diagnostic, minor

therapeutic, major diagnostic, and major therapeutic.²⁷ Patients that had major diagnostic or major therapeutic procedures were classified as having had major surgery. A dichotomous variable was created to identify patients who received a transfusion during the stay based on the Clinical Classification Software procedure code 222. Recent literature has identified large variation in the proportion of patients who receive transfusions and have found positive associations with complications, infections, mortality risk, and longer LOS.^{28–30}

LOS was determined by subtracting the discharge date from the admission date. For hospitalizations that began in the ED, time in the ED was not included. We then computed a DRG-adjusted expected LOS variable³¹ by subtracting the expected LOS from the actual LOS. The expected LOS was the arithmetic mean LOS for the DRG assigned to each admission.

We identified whether patients had any of the 16 Patient Safety Indicator (PSI) events, excluding the neonate and obstetric indicators, using the PSI module of the AHRQ Quality Indicator software version 3.2.³² We identified patient disposition at discharge as routine, NH, HHC, or other.

Hospital Characteristics

Hospital characteristics included the geographic location (Metropolitan Statistical Area, non-Metropolitan Statistical Area), bed size, ownership (nonprofit, for profit, and public), and teaching status. Bed size included 3 categories based on the HCUP definition: small, medium, and large. These categorizations are specific to location and teaching status.³³ We also identified if a hospital was a trauma center based on information from the Trauma Information Exchange Program database, a national inventory of trauma centers in the United States, collected by the American Trauma Society and the Johns Hopkins Center for Injury Research and Policy.³⁴

Patient Characteristics

Patient characteristics included age, sex, comorbidities, median household income of patients' ZIP code, and rural/urban location. Patient comorbidities included chronic pulmonary disease, diabetes, infection, blood disease, arthritis, depression, dementia, obesity, cancer, anxiety, substance abuse, renal failure, circulatory system disease, fluid and electrolyte disorder, paralysis and neurological disorder, and psychoses (Supplemental Digital Content 1, <http://links.lww.com/MLR/A312> for definitions of comorbidities).

Median household income quartile of the patient's ZIP code of residence was used as an indicator of the socioeconomic status of the patient. In 2006, the lowest income quartile was income under \$38,000 whereas the highest income quartile was defined as \$62,000 or above.

We categorized the patient's residence using a 4 level modification of the National Center for Health Statistics 2006 Urban-Rural Classification Scheme for Counties.³⁵

We controlled for State effects to remove differences because of factors such as practice pattern variation and policies.

TABLE 1. Selected Patient and Hospital Characteristics of Elderly Patients With an Injury-Related Hospital Stay (N = 208,193)

	N	Percentage
With a 30-day inpatient readmission	28,507	13.7 (SE = 0.7)
Patient characteristics		
Female	145,635	70.0
Age		
65–74	50,774	24.4
75–84	84,764	40.7
85+	72,655	34.9
Injury characteristics		
Fall	157,144	75.5
Fracture	153,611	73.8
New injury severity score*		
1–8	82,500	39.6
9–15	95,635	45.9
16–75	18,207	8.8
Injuries not scored	11,851	5.6
Hospital experience		
Type of initial admission		
Direct inpatient admission	24,944	12.0
First seen in ED	174,450	83.8
Transferred from other facility	8799	4.2
Transfusion	38,855	18.7
Major surgery	115,574	55.5
Infection	40,211	19.3
Any patient safety indicator	2915	1.4
DRG-adjusted length of stay		
Within 1 d	63,091	30.3
1–7 d less	82,101	39.4
> 7 d less	1538	0.7
1–7 d more	49,127	23.6
> 7 more	12,336	5.9
Discharge disposition		
Home or community	47,527	22.8
Nursing home	133,045	63.9
Home health care	25,264	12.1
Other	2357	1.1
Hospital characteristics		
Nonteaching	125,691	60.4
Rural	19,403	9.3
Trauma center	67,907	32.6
Ownership		
For profit	36,795	17.7
Nonprofit	143,828	69.1
Government owned	27,570	13.2
Bed size		
Small	20,546	9.9
Medium	54,087	26.0
Large	133,560	64.2

*On the basis of patient's 3 most severe injuries, regardless of the body region in which the injuries occur.

RESULTS

Elderly patients with an injury-related index hospital admission were disproportionately female (70% vs. 57% for general population ≥ 65 y), and more likely to be "old-old" (75% were ≥ 75 y vs. 49% for the general population ≥ 65 y).³⁶ Forty-six percent had a moderately severe injury (NISS = 9–15) and 9% had a severe injury (NISS ≥ 16). About three fourths (76%) of all injuries were related to a fall (Table 1).

The vast majority of patients (84%) were initially seen in the ED and 12% were admitted directly to an inpatient unit.

Although 23% of the injured elderly patients were discharged to the community, almost two thirds (64%) went to a NH and 12% received HHC services after discharge from the hospital. Elderly patients with injury-related hospital stays were mostly admitted to nonprofit (69%), large (64%), or nonteaching (60%) hospitals. A third (33%) of the injured patients was admitted to hospitals designated as trauma centers. One percent of patients experienced a PSI. During the hospital stay, 19% received a transfusion and 56% had major surgery of which 66% were surgeries of the hip or knee, 11% of the lower extremity, 4% of the shoulder, 3% of other muscular-skeletal system, 2% were for limb reattachments, and 2% for craniotomies. Of the 44% that did not have surgeries (based on medical-related DRGs), 31% received treatments for trauma; 17% for hip, femur, or pelvis; 16% for fractures, sprains, or dislocation of the hand or foot; 11% for back problems; 10% for poisoning; and 3% for concussions.

The vast majority of injured patients had a diagnosis of fracture (74%). More than one third of the injuries (37%) were for hip fractures, followed by lower body fractures (10.2%), and upper extremity fractures (8.7%). About 1 in 7 elderly patients with an injury-related index hospital admission was readmitted in 30 days (13.7%), of which 36% occurred within 7 days, 61% within 14 days, and 81% within 21 days. An additional 5% had a treat-and-release ED revisit within 30 days. The highest readmission rates occurred for those with SPI (18.3%), followed by TBI (15.9%) and VCI (15.4%) (Table 2).

Table 3 presents the 10 most common reasons for readmissions. The most common reason was surgery of the upper or lower extremities (7.4%), followed by pneumonia (7.2%), HF (4.5%), septicemia (3.8%), UTI (3.6%), GI problems (3.2%), GI bleeding (2.9%), nutritional-related or metabolic issues (2.9%), intracranial bleeding or cerebral infarction (2.1%), and arrhythmia (2.0%).

Results of the logit model are presented in Table 4. The second column presents the coefficients from the estimated model and 95% confidence bands. The third column presents the RRs, and the last column presents the absolute risks (ie, marginal effects). Patient demographic, socioeconomic,

TABLE 3. Most Frequent Reasons for a 30-Day Inpatient Readmission (N = 28,507)

Reasons Readmission	N	Percentage
Pneumonia	2057	7.2
Heart failure	1271	4.5
Septicemia	1070	3.8
UTI	1024	3.6
GI problem	898	3.2
GI bleeding	830	2.9
Nutritional-related or metabolic issue	827	2.9
Intracranial bleeding or cerebral infarction	589	2.1
Arrhythmia	563	2.0
Other	17,278	60.4

Index conditions are in order of decreasing total number of readmission within 30 days after discharge. Diagnosis-related group numbers for the conditions listed are as follows: Major surgery in the upper and lower extremities: 210, 211, 218, 219, 220, 223, 224, 228, 229, 544, 545, 485; Pneumonia: 79, 80, 89, 90; Heart failure: 127; Septicemia: 416; Urinary tract infection (UTI): 320, 321, 322; Gastrointestinal (GI) problems: 182, 183, 184; GI bleeding: 174, 175; Nutritional-related or metabolic issue: 296, 29; Intracranial bleeding or cerebral infarction: 14; Arrhythmia: 138, 139.

comorbidities, and State effects were also included in the estimated model, but coefficients and risks for these variables are not shown in the table to save space. PSI and infections which may occur in the hospital are shown in the table. The full table is available from the corresponding author.

Injury characteristics were associated with readmission risk. Having a moderate (NISS=9–15) or severe (NISS ≥ 16) injury increased risk compared with a low severity score (RR = 1.04 and 1.16, respectively). Location of injury also affected the risk: SCI (RR = 1.25), TBI (RR = 1.12), and VCI (RR = 1.26).

Hospital experience was associated with the patient's risk of readmission. Patients transferred from another hospital and those who entered through the ED had higher risks (RR = 1.21 and 1.11, respectively) than those directly admitted to the hospital. Patients with a major surgery had a lower risk (RR = 0.91), but a transfusion was associated with higher risk (RR = 1.11). Having a DRG-adjusted LOS >1 day was associated with an increased readmission risk. Patients with more than 1–7 days longer stay had higher risk (RR = 1.17), and patients with more than 7 days longer stay had even higher risk (RR = 1.42), compared with patients with LOS within 1 day of the expected LOS. Any PSI event (RR = 1.20) and infection (RR = 1.08) also increased the risk. Discharge location was also associated with readmission rates. Those discharged to long-term care facilities or discharged with HHC services had higher risks (RR = 1.17 and 1.09, respectively) than those with a routine discharge to the community.

Select index hospital characteristics were also associated with readmission risk. Those admitted to a nonprofit hospital (RR = 0.94) and those admitted to a hospital with a trauma center designation (RR = 0.95) had lower risks. Teaching status, size, and rural location of the hospital were not significant.

Patient characteristics were also associated with the readmission risk: higher for those aged 75–84 (RR = 1.11) and aged ≥ 85 (RR = 1.19) than persons aged 65–74, higher for males (RR = 1.18), and higher for certain comorbidities. The largest comorbidity effects were for renal failure (RR = 1.41) followed by chronic pulmonary disease (RR = 1.28), and cancer (RR = 1.21). Patients living in noncore

TABLE 2. Types of Injury at Index Admission

	Percentage	Percent With a 30-Day Inpatient Readmission
Hip: fracture	37.0	14.3
Hip: nonfracture	1.4	13.3
Other lower extremity: fracture	10.2	12.4
Other lower extremity: nonfracture	2.5	13.9
Upper extremity: fracture	8.7	11.5
Upper extremity: nonfracture	1.9	9.2
Torso: fracture	8.3	12.0
Torso: nonfracture	3.6	13.9
Vertebral column injury	8.0	15.4
Traumatic brain injury	8.7	15.9
Head and neck	3.6	11.9
Spinal cord injury	0.4	18.3
Other	5.9	14.1
Total N (%)	208,193 (100)	28,507 (13.7)

TABLE 4. Logistic Regression Results on Selected Patient and Hospital Characteristics of Elderly Patients With an Injury-related Hospital Stay (N = 208,193)

Dependent Variable: 30-Day Inpatient Readmission (Yes/No)	Coefficient (95% CI)	Relative Risk (95% CI)	Absolute Risk (95% CI)
Age			
65–74	—	—	—
75–84	0.127*** (0.090, 0.164)	1.11 (1.08, 1.150)	0.014 (0.010, 0.018)
85+	0.209*** (0.169, 0.250)	1.19 (1.15, 1.24)	0.024 (0.019, 0.028)
Female	–0.242*** (–0.272, –0.211)	0.82 (0.797, 0.84)	–0.029 (–0.033, –0.025)
Fall	0.047 (–0.005, 0.099)	1.04 (0.99, 1.09)	0.005 (4.53E–4, 0.011)
New injury severity score [†]			
Low (1–8)	—	—	—
Medium (9–15)	0.049** (0.013, 0.084)	1.04 (1.01, 1.07)	0.006 (0.002, 0.010)
Severe (16–75)	0.175*** (0.115, 0.234)	1.16 (1.10, 1.22)	0.021 (0.013, 0.028)
Injuries not scored	0.158*** (0.087, 0.230)	1.14 (1.07, 1.21)	0.019 (0.010, 0.027)
Spinal cord injury	0.272** (0.086, 0.458)	1.25 (1.06, 1.44)	0.034 (0.009, 0.060)
Traumatic brain injury	0.130*** (0.073, 0.187)	1.12 (1.06, 1.17)	0.016 (0.008, 0.023)
Vertebral column injury	0.278*** (0.227, 0.328)	1.26 (1.21, 1.31)	0.034 (0.028, 0.042)
Type of initial admission			
Direct inpatient admission	—	—	—
First seen in ED	0.122*** (0.074, 0.170)	1.109 (1.06, 1.16)	0.014 (0.008, 0.019)
Transferred from other facility	0.229*** (0.148, 0.310)	1.21 (1.13, 1.30)	0.026 (0.017, 0.036)
Transfusion	0.124*** (0.085, 0.162)	1.11 (1.07, 1.15)	0.015 (0.010, 0.019)
Major surgery	–0.118*** (–0.154, –0.082)	0.91 (0.88, 0.93)	–0.014 (–0.018, –0.009)
Infection	0.089*** (0.057, 0.121)	1.08 (1.05, 1.11)	0.010 (0.007, 0.014)
Any patient safety indicator	0.220*** (0.119, 0.321)	1.20 (1.102, 1.30)	0.027 (0.014, 0.041)
DRG-adjusted length of stay			
Within 1 d	—	—	—
1–7 d less	–0.045** (–0.078, –0.012)	0.96 (0.94, 0.99)	–0.005 (–0.009, –0.001)
> 7 d less	0.124 (–0.045, 0.292)	1.11 (0.95, 1.27)	0.014 (–0.006, 0.035)
1–7 d more	0.188*** (0.152, 0.224)	1.17 (1.14, 1.21)	0.022 (0.018, 0.027)
> 7 more	0.423*** (0.369, 0.476)	1.42 (1.36, 1.48)	0.054 (0.047, 0.062)
Discharge disposition			
Home or community	—	—	—
Nursing home	0.184*** (0.141, 0.228)	1.17 (1.13, 1.21)	0.021 (0.016, 0.025)
Home health care	0.097*** (0.049, 0.146)	1.09 (1.04, 1.13)	0.011 (0.005, 0.016)
Other	0.041 (–0.088, 0.170)	1.04 (0.92, 1.15)	0.004 (–0.010, 0.018)
Nonteaching	0.025 (–0.025, 0.075)	1.02 (0.98, 1.06)	0.003 (–0.003, 0.009)
Rural hospital	0.062 (–0.018, 0.141)	1.05 (0.98, 1.12)	0.007 (–0.002, 0.017)
Trauma center	–0.063* (–0.114, –0.012)	0.95 (0.91, 0.99)	–0.007 (–0.013, –0.001)
Ownership			
For profit	—	—	—
Nonprofit	–0.071** (–0.121, –0.021)	0.94 (0.90, 0.98)	–0.008 (–0.014, –0.002)
Government owned	–0.047 (–0.119, 0.025)	0.96 (0.90, 1.02)	–0.006 (–0.014, 0.003)
Bed size			
Small	–0.041 (–0.097, 0.015)	0.97 (0.92, 1.01)	–0.005 (–0.011, 0.002)
Medium	–0.016 (–0.059, 0.027)	0.99 (0.95, 1.02)	–0.002 (–0.007, 0.003)
Large	—	—	—

* $P < 0.05$; ** $P < 0.005$; *** $P < 0.0005$.[†]On the basis of patient's 3 most severe injuries, regardless of the region where the injuries occurred.

CI indicates confidence interval.

counties (RR=0.92) and in micropolitan counties (RR=0.85) had lower readmission rates than patients living in large metropolitan counties. Patients living in a community with the lowest income quartile had higher risk (RR=1.06) than patients living in a community with the highest income quartile. Despite the inclusion of all these risk factors, State effects based on hospital location were still associated with readmission risk, with State effects varying by as much as 3.1 percentage points.

We also ran the same equation with the dependent variable defined as any 30-day revisit (including 30-day treat-and-release ED revisits) (results not shown). There were only a few additional risk factors identified. Patients in rural

hospitals had a higher readmission rate than patients in urban hospitals (RR=1.09). Patients living in micro-noncore counties had a lower risk than patients in large metropolitan areas (RR=0.92). Patients living in lower income communities had higher risks—RR=1.04 for the third lowest quartile, and RR=1.07 for the lowest quartile.

DISCUSSION

This study examines 30-day, all-cause readmission rates for elderly patients with injury-related index hospital admissions from 11 States. The estimated all-cause, 30-day readmission rate of 13.7% is lower than estimates for pneumonia

(17%–21%),^{37,38} acute myocardial infarction (20%)³⁹ and HF (23%–24%).^{39,40} The closest study to compare our findings with is a study of elderly veterans that were admitted to VA and Medicare hospitals for treatment of hip fractures. Comparing the subpopulation of hip fracture patients in our study with that of the VA study, we had a readmission rate of 14% versus 18%. The difference can be partially explained by the higher percent in our study that are female coupled with our finding that women have lower readmission rates. In addition, the rate differences may also be affected by differences in the hospitals included and statistical methods used in the studies. The VA study and this study also had comparable readmission patterns for persons with 30-day readmissions. In the VA study the proportions of hip fracture patients with 30-day readmissions who were readmitted within 7, 14, and 21 days were 30%, 60%, and 82%, respectively. In this study, for the subpopulation of hip fracture patients, the proportions were: 36%, 61%, and 81%, respectively.

This study also estimated the extent to which some patients just had treat-and-release ED revisits within 30 days and found an additional 5%. This provides a broader view of the burden of readmission associated with injury-related hospitalizations than a strict focus on inpatient readmissions. Including these cases in the risk factor analysis did not substantively change the risk factors results.

The strength and weaknesses of this study are mainly related to the reliance on HCUP data and the limitations of a retrospective cohort design. Data available to estimate readmission rates were restricted to 11 States and therefore not necessarily representative of the nation. Nevertheless according to calculations from the HCUP Nationwide Inpatient Sample,⁴¹ the 11 States include approximately 19.6% of all injury-related hospitalizations in the country. Additional data limitations include lack of race data across all States and the inability to identify whether the patient was in a NH before the index admission. An additional limitation is that the data come from discharge records. By defining the sample using principal diagnosis, injury is the main reason for the admission, but for certain variables (eg, PSI event, infection) it is not possible to determine whether the event occurred before admission or during the index hospitalization with the available data. A further limitation is the study design, which permits us to note association but not to determine causation.

An important strength of this study is the ability to identify discharge disposition. Despite controlling for patient characteristics with comorbidities and injury characteristics, some of the RRs for associated health experiences and hospital characteristics may be biased because of unmeasured health and disability. This may have the largest impact on the disposition estimates as patients with more disability at discharge are more likely to be discharged to NHs or HHC than routinely discharged.¹¹

This study expands evidence for the influence of injury characteristics on readmission rates. Patients with severe injuries, SCI, TBI, and VCI had higher readmission rates. This study also provides evidence about hospital experiences associated with readmission rates. Patients receiving transfusions during their index hospitalization were associated with higher readmission rates. Having an excess of 7 days

above the expected DRG LOS raised the readmission rate to 18%. Infections and PSI events were associated with higher readmission rates. These findings suggest that a focus on preventing complications and infections during the hospital stay may help reduce hospital-specific readmissions for injury-related inpatient encounters.

The results also suggest that a strategy for reducing hospital readmissions need to involve long-term care as well. Three quarters of injury patients were discharged to either NH or with HHC and these patients had higher readmission rates. Although some of the readmissions from NHs and HHC may be appropriate, research suggests that a high proportion of hospitalizations after an NH or HHC visit are preventable.^{39,42} NHs that have higher RN staff ratios, and have available nurse practitioners or physician assistants have fewer hospitalizations.^{43,44} Skilled care NHs that manage respiratory and UTIs in the NH, improve palliative care plans, and engage in multidisciplinary root-cause analysis for persons who are hospitalized, have fewer hospitalizations.^{44–46} Using a transition coach or nurse to help coordinate care after discharge to home, coupled with patient education, and a pharmacist reinforcing the care plan and reviewing medications can reduce readmission rates.^{6,47,48}

Finally, large State variation in readmission rates remained, likely reflecting local area practice patterns as well as State policy differences.⁴⁹ States with higher reimbursement have lower hospitalization rates for NHs, whereas bed-hold policies are associated with higher rates.^{49,50} This suggests that an overall strategy for reducing readmissions cannot solely focus on clinical practices, but needs to align financial incentives as well.

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