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Early hospital readmission in the trauma population: Are the risk factors different?

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Abstract

Introduction—Hospital readmission rates will soon impact Medicare reimbursements. While risk factors for readmission have been described for medical and elective surgical patients, little is known about their predictive value specifically in trauma patients.

Patients and methods—We retrospectively identified all admissions after trauma resuscitation to our urban level 1 trauma centre from 1/1/2004 to 8/31/2010. All patients discharged alive were included. Data collected included demographics, Injury Severity Score (ISS), and length of stay (LOS). We analyzed these index admissions for the development of complications that have previously been shown to be associated with readmission. Readmissions that occurred within 30 days of index admission were identified. Univariable and multivariable analyses were performed. $p < 0.05$ was considered significant.

Results—We identified 10,306 index admissions, with 447 (4.3%) early (within 30 days) readmissions. Mean ISS was 11.1 (SD 10.4). On multivariable analysis, African-American race (OR 1.3, $p = 0.009$), preexisting chronic obstructive pulmonary disease (COPD) (OR 1.5, $p = 0.02$), and diabetes mellitus (OR 1.8, $p < 0.001$) were associated with readmission, along with higher ISS (OR 1.01, $p < 0.001$), ICU admission (OR 2.1, $p < 0.001$), and increased LOS (OR 1.01, $p < 0.001$). Among many in-hospital complications examined, only the development of surgical site infection (SSI) (OR 1.9, $p = 0.02$) was associated with increased risk of readmission.

Conclusions—Trauma patients have a low risk of readmission. In contrast to elective surgical patients, the only modifiable risk factor for readmission in our trauma population was SSI. Other risk factors may present clinicians with opportunities for targeted interventions, such as proactive follow up or early phone contact. With future changes to health care policy, clinicians may have even greater motivation to prevent readmission.

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Keywords

Trauma; Readmissions; Risk factors

Introduction

Hospital readmission has always been a vexing problem. Readmissions have taken on new significance with passage of the Patient Protection and Affordable Care Act (PPACA) in 2010.[1] This bill includes a penalty in Medicare payments for hospitals that have higher-than-expected risk-adjusted readmission rates for patients treated for acute myocardial infarction, heart failure, and pneumonia. While hospitals are not currently slated to be penalized for high readmission rates among trauma patients, beginning in the FY 2015 the Health and Human Services Secretary can expand the list of conditions for which penalties may be incurred. Given that nearly 35% of all trauma patients have some form of government-assisted source of primary payment,[2] it is not unreasonable to assume that "trauma" may become one of the conditions that could put hospital reimbursement in jeopardy.

Unlike other patient populations, the readmission rate for trauma patients has not been extensively reported. In a previous report, we described the early hospital readmission rate from a mixed surgical unit in our institution, with trauma patients comprising 60% of this patient cohort.[3] In that study, we found that hospitalization after traumatic injury was associated with a decreased risk (OR 0.37, $p = 0.004$) of early readmission. This finding prompted us to examine the rates of early readmission in the trauma population in our urban, academic, tertiary referral trauma centre. Furthermore, we wished to analyze the risk factors and reasons for these readmissions to determine if markers for readmission exist that would allow for prospective identification of those patients most at risk for readmission.

Patients and methods

With IRB approval, we retrospectively identified all admissions after trauma resuscitation to our urban level 1trauma centre from 1/1/2004 to 8/31/2010. All patients discharged alive were included. Data collected included demographics, Injury Severity Score (ISS), length of stay (LOS), and insurance information (defined as either "Public" for Medicare- and Medicaid-affiliated programmes, and "Private" for all others). Although many of our patients are uninsured at the time of their injury, most, if not all, of these patients are enrolled in some form of medical assistance by the time they leave the hospital. We analyzed these index admissions for the presence of comorbidities and development of complications that previously have been shown to be associated with readmission in other populations, including chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), surgical site infection (SSI), deep venous thrombosis (DVT), pulmonary embolism (PE), pneumonia, or acute or chronic renal failure (ARF and CRF).[4–12] Standard definitions of disease states and complications, in accordance with the Agency for Healthcare Research and Quality (AHRQ) were used.[13] The presence of complications and comorbidities during the index admission were determined from the presence of ICD-9 codes associated with that

admission. Readmissions that occurred within 30 days of index admission were then identified and analyzed.

Univariable analyses were performed with Chi-square, Fisher's Exact, and two-tailed Student *t*-tests where appropriate. Significant variables on univariable analysis were then used in a linear logistic regression analysis to determine if these factors were predictive of readmission. $p < 0.05$ was considered significant.

For each case, the reasons for readmission were examined and classified into broad categories that included (1) infectious reasons (including surgical site and traumatic wound infections), (2) noninfectious complications clearly related to the injury or hospitalization, (3) complications of pre-existing conditions, (4) complications of nonoperative therapy, (5) pain control, (6) the need for ongoing surgical treatment, and (7) unrelated readmissions. Univariable regression analyses were performed for each risk factor to determine their predictive value for each specific category of readmission. Significant variables on univariable regression were then used in a backward step-wise multivariable logistic regression model for each readmission category. All statistical tests and analysis were performed with Stata® (StataCorp, 2011. Stata Statistical Software: Release 12, College Station, TX: StataCorp, LP).

Results

We identified 10,306 index admissions that occurred during the study period. The mean age was 44.9 years (SD 21.3) and 70% were male. Patients were predominately African American (47%) or Caucasian (44%, see Table 1). The mean ISS was 11.1 (SD 10.4). The majority of patients (72%) were not severely injured, with ISS ≤ 15. Twenty-six percent of patients had ISS between 16 and 40, with a small minority (2%) with ISS > 40.

A total of 424 patients were readmitted 447 times within 30 days of index admission (4.3% of index admissions). Any readmission to our hospital was captured, not only readmissions to the trauma service. The demographics of the readmitted patients did not differ significantly, although African American patients were more likely to be readmitted (OR 1.2, $p = 0.03$) when compared to patients of other races.

Injury severity was associated with the need for readmission (see Table 1). The mean ISS of readmitted patients was significantly higher (15.1 vs. 10.9, $p < 0.001$) and a greater proportion of these patients were admitted to the ICU during the index hospitalization (48% vs. 25%, OR 2.7, $p < 0.001$). More readmitted patients had spinal cord injury (6% vs. 2%, $p < 0.001$). The median LOS of the initial hospitalization was longer (8 vs. 4 days, $p < 0.001$) for patients who were readmitted. In addition, patients who were readmitted were more likely to be initially discharged to an environment with some level of medical follow up – such as home health assistance, skilled nursing, rehabilitation centre, law enforcement, etc. (51% vs. 44%, OR 1.3, $p = 0.002$).

Readmitted patients had significantly higher rates of comorbidities at their initial hospitalization (see Table 2). Higher rates of COPD (10% vs. 7%, $p = 0.01$), DM (15% vs. 9%, $p < 0.001$), CRF (4% vs. 2%, $p = 0.002$), and CHF (7% vs. 4%, $p = 0.001$) were

observed. The documented presence of CAD/angina was infrequent in both groups (<1%) and the difference was not statistically significant ($p = 0.06$).

Complications during the index hospitalization occurred more frequently in patients who were subsequently readmitted (Table 3). Complications included SSI (4% vs. 1%, <0.001), DVT (5% vs. 3%, $p = 0.01$), PE (2% vs. <1%, $p = 0.005$), aspiration/pneumonia (9% vs. 4%, <0.001), and ARF (7% vs. 3%, <0.001).

On multivariable analysis, several risk factors were significantly associated with readmission (see Table 4). The strongest predictors were ICU admission (OR 2.1, $p < 0.001$) and surgical site infection (OR 1.9, $p = 0.02$) during the index hospitalization. A pre-existing diagnosis of DM (OR 1.8, $p < 0.001$) and COPD (OR 1.5, $p = 0.02$) also predicted readmission. African-American race (OR 1.3, $p = 0.009$) and discharge to any level of care other than home (OR 1.3, p 0.003) remained predictive of readmission. Although increased severity of injury (OR 1.01, $p = 0.004$) and longer LOS (OR 1.01, $p < 0.001$) retained statistical significance in our model, the increased risk was low.

The reasons for readmission were difficult to categorize, as each patient readmission was somewhat unique. We attempted to group these reasons for readmission into several broad categories, including infection (predominantly SSI and traumatic wound infections), noninfectious complications of the injury or hospitalization, pain control, complications of prior medical conditions, complications of nonoperative therapy, ongoing treatment of the injury (i.e. further surgical procedures), failure of discharge planning or communication ("Systems failures" in Table 5), and reasons unrelated to the injury. Various risk factors were significantly associated with the specific reason for readmission on multivariable analysis.

Discussion

Our report is one of the first large-scale studies investigating the rates of hospital readmission in the trauma population, along with a description of associated risk factors. Overall, the rate of early hospital readmission for trauma patients in our urban, academic, tertiary-referral centre was low (4.3%). Other studies that have described the readmission rate for injured patients have generally grouped them by injury type, i.e. hip fracture, spinal cord injury, etc.,[14–16] and did not specifically focus on hospital readmissions within 30 days of initial hospital discharge. Other reports in nontrauma surgical populations demonstrate readmission rates of 10–20%.[4,14,17,18] Direct comparison between our cohort and these studies should be done with caution, however, as our results are likely heavily influenced by the presence of a broad mix of mild and severely injured patients.

A recent report by Ladha et al.,[19] examined the rate of representation to the Emergency Department after traumatic injury. During an eleven-year period, 117 of 6675 (1.7%) trauma patients were re-evaluated in the emergency department within 30 days of initial hospital discharge. While their report did not focus specifically on hospital readmissions, several comparisons can be made with our report. First, Ladha and colleagues found that patients with public insurance were more likely to re-present to the ED and the rates of return were

not different among patients of different races. In contrast, we did not find insurance status to be a factor for readmission in our study and we did find a higher likelihood of readmission for African-American patients. Similar to our data, Ladha et al. found an increased risk of return for patients with more comorbidities and higher ISS. Another interesting difference between the two studies was the discharge status.In our report, patients who were discharged to any level of care other than home (including home with nursing visits, skilled nursing facility, rehabilitation centre, long-term acute care facility, and law enforcement) were more likely to be readmitted to the hospital, while Ladha and colleagues found that discharge to rehabilitation, nursing, or acute care was protective (OR 0.31, 95% CI 0.21–0.45). While this comparison is interesting, their report did not capture all readmissions to the hospital and it may be that many of our patients who were readmitted from care facilities were more likely to be directly admitted to the hospital and bypass the ED.

Similar to previous reports of readmission in medical patients, trauma patients with pre-existing medical conditions and those who experienced complications during the index hospitalization were more likely to be readmitted, although the only independent predictive risk factors we found were COPD, DM, and SSI.[5–8] It is not clear why the other risk factors studied did not reach significance on multivariable analysis, although it is possible that there is a co-linear relationship with some of the factors (COPD and pneumonia, for example) that resulted in non-significance in the logistic regression model. Another possibility is that the complications that developed had resolved or stabilized by the time of discharge and were not clinically significant at that time.

The reasons our patients were readmitted varied considerably. The most common reason for readmission was infection, followed by noninfectious complications of the initial trauma or hospitalization. Unrelated complications and those related to prior conditions or discharge issues also were present but to a lesser degree. Although we did find some specific risk factors, which were significantly associated with each readmission indication, it is difficult to draw conclusions from these associations.

The development of SSI was the only risk factor for early readmission we identified that may be potentially modifiable. The other risk factors, however, may help identify patients who could benefit from other targeted interventions. Many interventions have been proposed, such as early follow up, contact from providers, and more specific discharge instructions. The debate over the value of these interventions continues, however, as some studies have shown a reduction in the rate of readmissions,[20,21] while others have not.[22,23] The published studies have been conducted only in the medical patient population. It is unknown whether any of these interventions would result in decreased readmissions in the trauma patient population.

There are several limitations to our study, the most important of which is the inability to identify readmissions at hospitals outside of our health system. Unfortunately, due to the number of patients involved in this study, individual readmission tracking was not feasible. Another limitation of this study is the reliance on administrative data, with its known limitations,[24] for tracking of comorbidities and complications.

Conclusions

Trauma patients have an overall low rate of readmission. Certain patients, however, are at increased risk, including African American patients, patients with DM or COPD, those that are more severely injured, and those who require ICU admission. As the cost of health care inevitably continue to rise, it is likely that greater scrutiny will be applied to hospital readmissions of all types, especially in fields such as trauma, which rely heavily on government funding. Interventions to reduce SSI, along with proactive post-discharge follow up, may lead to lower rates of early return to the hospital.

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Table 1

Patient demographics and characteristics of initial injury and index hospitalization. Univariate analysis.

	Patients not readmitted (%)	Patients readmitted (%)	OR	95% CI	*p*
N = 10,306	9859 (95.7)	447 (4.3)			
Mean age (SD) (yrs)	44.8 (21.3)	46 (21.5)	*a*		0.24
Male:female	2.2:1	2.6:1	1.2	0.9–1.4	0.19
Race[b]					
Caucasian	4373 (44)	179 (40)	0.84	0.69–1.02	0.07
Afr. Amer.	4618 (47)	233 (52)	1.2	1.0–1.5	0.03
Asian	206 (2)	15 (3)	0.85	0.4–1.7	0.66
Latino	253 (3)	8 (2)	0.69	0.29–1.2	0.31
Other	409 (4)	12 (3)	0.65	0.3–1.2	0.14
Insurance					
Private	4362 (44)	195 (44)	1.0	0.8–1.2	0.8
Public	5497 (56)	252 (56)			
Mean ISS (SD)	10.9 (10.3)	15.1 (12.6)	*a*		<0.001
ICU admission	2472 (25)	213 (48)	2.7	2.2–3.3	<0.001
Discharged to:					
Home	5542 (56)	218 (49)	0.7	0.6–0.9	0.002
Assistance	4317 (44)	229 (51)			
Median LOS, days (25–75 IQR)	4 (2–7)	8 (4–17)	1.02	1.01–1.02	<0.001

Discharged to “Assistance” indicates patients who had some level of guaranteed healthcare assistance (skilled nursing visits, skilled facility, rehab, law enforcement, etc.) arranged at discharge. OR, odds ratio; CI, confidence interval; ISS, Injury Severity Score; LOS, length of stay; IQR, interquartile range.

[a] *T*-tests were used for comparison of continuous variables, where appropriate.

[b] For racial comparisons, each category was compared individually in a binary fashion. ORs quoted, therefore reflect the odds a patient was Caucasian vs. any other race, or Afr. Amer. vs. any other race, etc.

Table 2

Comorbidities identified during the index hospitalization. Univariable analysis.

Comorbidities	Patients not readmitted (%)	Patients readmitted (%)	OR	95% CI	*p*
COPD	650 (7)	43 (10)	1.5	1.0–2.1	0.01
DM	881 (9)	68 (15)	1.8	1.4–2.4	<0.001
CRF	205 (2)	19 (4)	2.1	1.2–3.4	0.002
SCI	242 (2)	29 (6)	2.8	1.8–4.1	<0.001
CAD/angina	22 (<1)	3 (<1)	3.0	0.6–10.1	0.16
CHF	362 (4)	30 (7)	1.9	1.2–2.8	0.001

OR, odds ratio; CI, confidence interval; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; CRF, chronic renal failure; SCI, spinal cord injury; CAD, coronary artery disease; CHF, congestive heart failure.

Table 3

Complications during the index hospitalization. Univariable analysis.

Complications	Patients not readmitted (%)	Patients readmitted (%)	OR	95% CI	*p*
SSI	123 (1)	18 (4)	3.3	1.9–5.5	<0.001
DVT	284 (3)	23 (5)	1.8	1.1–2.8	0.01
PE	65 (<1)	8 (2)	2.7	1.1–5.8	0.005
Aspiration/pneumonia	414 (4)	38 (9)	2.1	1.5–3.0	<0.001
ARF	257 (3)	30 (7)	2.7	1.8–4.0	<0.001

OR, odds ratio; CI, confidence interval; SSI, surgical site infection; DVT, deep venous thrombosis; PE, pulmonary embolism; ARF, acute renal failure.

Table 4

Multivariable regression analysis of readmission risk factors.

Risk factor	OR	95% CI	*p*
Demographics			
Race=Afr. Amer.	1.3	1.1–1.6	0.009
Injury characteristics			
ISS	1.01	1.0–1.02	0.004
ICU admission	2.1	1.7–2.6	<0.001
LOS	1.01	1.0–1.02	<0.001
Comorbidities			
DM	1.8	1.3–2.3	<0.001
COPD	1.5	1.1–2.1	0.02
Complications			
SSI	1.9	1.1–3.2	0.02
Discharge status			
Assistance	1.3	1.1–1.6	0.003

OR, odds ratio; CI, confidence interval; ISS, Injury Severity Score; LOS, length of stay; DM, diabetes mellitus; COPD, chronic obstructive pulmonary disease; SSI, surgical site infection, “Discharge: assistance” indicates patients who had some level of guaranteed healthcare assistance (skilled nursing visits, skilled facility, rehab, law enforcement, etc.) arranged at discharge.

Table 5

Multivariable regression analysis of the risk factors as predictors of specific reason for the 447 readmissions.

Readmission reason	*N* (% of readmits)	Associated risk factor	*p*
Infection (Other than below)	51 (11)	ICU	0.02
		PE	0.04
		LOS	<0.001
Surgical site	75 (17)	ICU	0.002
		SSI	<0.001
		ISS	0.04
		Male	0.02
Traumatic wound infection	37 (8)	Black race	0.01
		DVT	0.006
Noninfectious complications	114 (26)	ICU	<0.001
		COPD	<0.001
		CAD	0.01
		SSI	0.03
		DC home	0.05
		ISS	0.004
Unrelated	43 (10)	DM	<0.001
Prior medical problems	38 (9)	DM	0.04
		ARF	0.02
		Age	0.001
Comp. of nonop treatment	27 (6)	ICU	<0.001
		ISS	0.004
Pain	19 (4)	SSI	0.009
Systems failures	16 (4)	SCI	0.006
		ARF	0.004
		LOS	0.03

All risk factors considered in univariable analysis. Denominator for comparisons =447. Significant ($p \leq 0.05$) variables on univariable regression were then used in multivariable logistic regression. Only variable significant on multivariable analysis are shown in table. ICU, intensive care unit admission; ARF, acute renal failure; CRF, chronic renal failure; SSI, surgical site infection; LOS, length of stay; DVT, deep venous thrombosis; COPD, chronic obstructive pulmonary disease; CAD, coronary artery disease; DM, diabetes mellitus. No risk factors were significantly associated with readmission for “Ongoing treatment,” thus numbers in table do not sum to total readmissions (447).