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Postdischarge complications following nonoperative management of blunt splenic injury

Gil Freitas, M.D.[a], Olubode A. Olufajo, M.D., M.P.H.[a,b], Khaled Hammouda, M.D.[c], Elissa Lin, B.A.[d], Zara Cooper, M.D., M.Sc.[a,b], Joaquim M. Havens, M.D.[a,b], Reza Askari, M.D.[a,b], Ali Salim, M.D.[a,b,*]

[a]*Division of Trauma, Burn and Surgical Critical Care, Department of Surgery, Brigham and Women's Hospital, 75 Francis Street, Boston, MA 02115, USA;* [b]*Center for Surgery and Public Health, Department of Surgery, Brigham and Women's Hospital, Harvard Medical School and Harvard T.H. Chan School of Public Health, 1620 Tremont Street, Boston, MA 02120, USA;* [c]*Surgical ICU Translational Research Center, Department of Surgery, Brigham and Women's Hospital, Boston, MA 02115, USA;* [d]*Faculty of Arts and Sciences, Harvard University, Cambridge, MA 02138, USA*

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Risk factors;
Splenic injury;
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Abstract

BACKGROUND: Nonoperative management (NOM) is the standard of care in majority of blunt splenic injuries. However, little is known about the postdischarge complications.

METHODS: Patients admitted for blunt splenic injury were identified in the California State Inpatient Database (2007 to 2011). We examined patterns and risk factors for postdischarge complications among these patients.

RESULTS: In total, 2,704 (61.45%) patients had NOM without splenic artery embolization (SAE) and 257 (5.84%) had NOM with adjunct SAE. Thirty-day readmission rate was higher in those who had adjunct SAE (12.84% vs 7.36%, $P = .002$). Subsequent operations during readmission were seen in 18.10% of readmitted patients and 38.10% of all patients were readmitted at nonindex hospitals. Major diagnoses on readmission were spleen injury (36.2%) and respiratory complications (9.05%). Adjunct SAE was an independent risk factor for readmission (adjusted odds ratio 1.82, 95% confidence interval 1.19 to 2.78).

CONCLUSIONS: Nearly one fifth of readmitted patients initially managed nonoperatively required an operative intervention. Improving predischarge assessments and postdischarge follow-up may reduce readmissions among these patients.

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Nonoperative management (NOM) of blunt splenic injury (BSI) has been well established to be the standard of care in hemodynamically stable patients.[1] Although there are ample data that support the choice of NOM for treating BSI in stable patients,[1] few studies focus on outcomes of these patients following discharge. Failure of

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* Corresponding author. Tel.: +1-617-732-8042; fax: +1-617-566-9549.

E-mail address: asalim1@partners.org

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NOM has been extensively studied among hospitalized patients, with failure usually occurring within 3 days of injury for the majority of patients.[2,3] "Successful" cases of NOM in these studies are those who are discharged without having operations, thus forming the basis of recommending NOM in certain groups of patients. Because patients with traumatic injuries are at risk for complications following discharge[4] and late complications of BSI have been previously reported,[5,6] it is important to assess these complications among patients managed nonoperatively.

Studies that have assessed postdischarge outcomes in this patient population have been limited to single institution studies.[2,7] There is evidence that trauma patients often return to hospitals different from the hospital of initial presentation.[4] This implies that the majority of these studies do not provide a complete depiction of the outcomes in these patients following discharge. In addition, because individual hospitals have distinct management protocols before discharge, the results of these studies are not necessarily generalizable. Furthermore, previous studies do not distinguish patients who received adjunct splenic artery embolization (SAE) from other patients managed nonoperatively.[8] Because of the unique selection criteria of these patients as well as the exposure to invasive procedures, it is possible that their postdischarge characteristics may differ from other patients.

Therefore, to accurately measure the postdischarge complications following NOM of BSI regardless of the hospital of presentation, we performed a statewide analysis of BSI patients discharged after successful NOM. To observe subtle differences between groups, we examined NOM patients who had adjunct SAE and those who did not separately.

Methods

Data source and study population

The California State Inpatient Database is a data repository of the Healthcare Cost and Utilization Project,[9] Agency for Healthcare Research and Quality and comprises all discharge records from more than 98% of the hospitals in the State of California. Between 2007 and 2011, 19,920,098 discharge records were entered into the database.[9] Individual patients are assigned unique patient identifiers that make it possible to track multiple admissions regardless of the hospital they are admitted. Diagnoses and procedures associated with each admission are recorded using International Classification of Disease, 9th revision (ICD-9) codes.[10] This study was deemed Institutional Review Board exempt by the Partners Institutional Review Board, with protocol number 2014P002072.

Patients between 18 and 64 years old discharged from January 2007 to November 2011 with admitting ICD-9 diagnosis codes corresponding to splenic injury were included. Patients who were transferred to another acute care facility or those who had E-codes indicating penetrating causes of injury were excluded.

Patients who had any procedure during their admission that corresponded to operations performed for BSI were classified as having operative management of BSI. All other patients were classified as having NOM. The subgroup of patients who had adjunct SAE was identified by the presence of ICD-9 procedure codes associated with SAE during a BSI admission. The full list of ICD-9 codes used to make these classifications can be found in Appendix A.

Study variables

We assessed demographic variables of the patients including age (<45, ≥ 45), sex, race/ethnicity (White, Black, Hispanic, Others), and insurance type (public, private, self-pay, others including Worker's Compensation, County Indigent Programs, and other Government aids).

We included details of clinical characteristics such as comorbidities as measured by the Charlson Comorbidity Index, which was calculated by the CHARLSON module in Stata 13 (StataCorp, Cary, NC).[11] The Charlson Comorbidity Index includes 19 diseases weighted on the basis of their association with mortality, ranging from 0 to 37 with a higher score indicating greater comorbidity.[11] The Charlson score was categorized as less than 2 and greater than or equal to 2. Anatomic severity of injury was measured by the Injury Severity Score (<9, 9 to 15, 16 to 24, ≥ 25), calculated with the ICD Programs for Injury Categorization (ICDPIC) module in Stata.[12,13] The American Association for the Surgery of Trauma grade of splenic injury (I/II, III/IV,V) was derived from the ICD-9 codes.[14]

Other variables measured include length of index admission stay (0 to 3, 4 to 7, >7), discharge disposition (home, skilled nursing facility/intermediate care facility, Home Health Care, leave against medical advice), and the presence of in-hospital complications determined by new diagnoses made during admission.

Assessment of postdischarge complications and characteristics of readmission

All patients who were readmitted to a hospital within 30 days of discharge were identified. The reasons for readmission were assessed using the admitting ICD-9 diagnosis codes on readmission. These ICD-9 diagnosis codes were classified into previously described categories including gastrointestinal, infectious, respiratory, psychiatric, musculoskeletal, and pain-related complications.[15] Additional categories were included for this unique population namely diagnosis of spleen injury and musculoskeletal complaints.

The location of readmission was also assessed. Patients who were readmitted at hospitals different from the hospitals they were initially admitted were identified. Other characteristics of readmitted patients assessed include the

lengths of stay and the proportion of patients who eventually required operative interventions on readmission.

Statistical analysis

Patient demographic and admission characteristics of patients managed nonoperatively who had adjunct SAE and those who did not were compared using chi-square and Fisher's exact tests for categorical variables and Wilcoxon rank-sum tests for continuous variables. Univariate logistic regression models were built to assess relationships between the individual characteristics and 30-day readmission. Factors that were significantly associated with readmission at the P value less than .1 level were included in a multivariate logistic regression model. These factors were age, race, insurance type, Charlson score, Injury Severity Score category, presence of complications, discharge disposition, and mode of management. For the multivariate logistic regression analyses, we did complete case analyses and only examined individuals who had the complete set of variables. Because the proportion of missing data was small or absent for most variables, we assumed minimal bias as a result of missing data.

All analyses were performed using Stata Statistical Software: Release 13 (StataCorp LP, College Station, TX) and the significance level was set as P value less than .05.

Results

Demographic and admission characteristics

There were 4,400 patients with BSI included in our study cohort. Among these patients, 1,439 (32.70%) were managed operatively, 2,704 (61.45%) were managed nonoperatively without SAE, and 257 (5.84%) received adjunct SAE. About two thirds of the patients managed nonoperatively were male and the mean age was about 40 years. Table 1 includes other demographic characteristics of the patient groups.

Patients who had adjunct SAE had significantly more severe injuries than those who did not have SAE (Table 1). Patients who had SAE also had higher in-hospital complication rates (38.91% vs 13.61%, $P < .001$) and longer mean lengths of stay (8.83 vs 5.04 days, $P < .001$) compared with those who did not have SAE.

Postdischarge complications and characteristics of readmission

The 30-day readmission rates were 12.84% in patients who had adjunct SAE and 7.36% in those who did not ($P < .001$). The reasons for readmission were more likely due to diagnoses of spleen injury in patients who did not have SAE (39.69%) and to gastrointestinal complications, including splenic abscesses, in patients who had SAE (15.63%) (Table 2). The mean lengths of stay on readmission was longer in patients who had SAE compared with those who did not have SAE (9.13 vs 5.31 days, $P = .003$). The number of days between the initial discharge and readmission was also slightly longer in patients who had SAE (8.81 vs 7.19 days, $P = .003$).

Among the patients who were readmitted, 18.10% had operative interventions for their splenic injury (24.24% in those who had SAE and 17.10% in those who did not). An assessment of location of hospital readmission showed that

Table 1 Demographic, admission and readmission characteristics of study population, California State Inpatient database 2007 to 2011

Characteristics	No of patients (%) NOM without SAE	NOM with SAE	P value
Age (y)			
<45	1,764 (65.24)	148 (57.59)	<.001
≥45	940 (34.76)	109 (42.41)	
Sex			
Male	1,806 (69.14)	182 (71.37)	.460
Female	806 (30.86)	73 (28.63)	
Race/Ethnicity			
White	1,601 (65.43)	172 (71.07)	.369
Black	128 (5.23)	11 (4.55)	
Hispanic	568 (23.21)	47 (19.42)	
Other	150 (6.13)	12 (4.96)	
Insurance status			
Public	475 (17.57)	51 (19.84)	.016
Private	1,335 (49.37)	101 (39.30)	
Self-pay	406 (15.01)	44 (17.12)	
Other	488 (18.05)	61 (23.74)	
Injury Severity Score category			
<9	931 (34.43)	38 (14.79)	<.001
9–15	697 (25.78)	48 (18.68)	
16–24	680 (25.15)	88 (34.24)	
≥25	396 (14.64)	83 (32.30)	
Grade of splenic injury			
I/II	676 (35.60)	40 (17.47)	<.001
III/IV	1,080 (56.87)	159 (69.43)	
V	143 (7.53)	30 (13.10)	
Length of stay (days)			
0–3	1,285 (47.52)	39 (15.18)	<.001
4–7	1,032 (38.17)	122 (47.47)	
>7	387 (14.31)	96 (37.35)	
Charlson score			
<2	2,608 (96.45)	244 (94.94)	.220
≥2	96 (3.55)	13 (5.06)	
Complications during admission			
No	2,336 (86.39)	157 (61.09)	<.001
Yes	368 (13.61)	100 (38.91)	
Discharge disposition			
Home	2,374 (87.89)	207 (80.86)	<.001
SNF, ICF, others	139 (5.15)	37 (14.45)	
Home Health Care	102 (3.78)	10 (3.91)	
AMA	86 (3.18)	2 (.78)	
30-Day readmission	199 (7.36)	33 (12.84)	.002

AMA = against medical advice; ICF = intermediate care facility; NOM = nonoperative management; SAE = splenic artery embolization; SNF = skilled nursing facility.

Table 2 Characteristics of patients readmitted within 30 days after nonoperative management of splenic injury

Characteristics	No. of patients (proportion)		*P* value
	NOM without SAE	NOM with SAE	
Time between discharge and readmission (days)	8.81	7.19	.003
Mean readmission length of stay (days)	5.31	9.13	.003
Operative intervention performed	34 (17.10)	8 (24.24)	.314
Major reasons for readmissions			
Spleen injury*	77 (39.69)	7 (21.88)	.053
Gastrointestinal complications	6 (3.09)	5 (15.63)	.002
Infectious complications	7 (3.61)	0 (.00)	.275
Respiratory complications	17 (8.76)	4 (12.50)	.500
Psychiatric complications	8 (4.12)	0 (.00)	.242
Musculoskeletal complications	10 (5.15)	0 (.00)	.189
Pain-related complications	1 (.52)	1 (3.13)	.144
Patients managed nonoperatively requiring operative interventions during readmission			
Mean length of stay (days)	6.50	8.13	.113
Readmission diagnosis of spleen injury	30 (88.24)	3 (37.50)	.002
Readmission at different hospitals	72 (37.11)	12 (37.50)	.967
Patients who were readmitted with diagnoses of spleen injury			
Operative intervention on readmission	30 (38.96)	3 (42.86)	>.999
Readmission at different hospitals	29 (37.66)	2 (28.57)	>.999
Second readmission following discharge	4 (5.19)	1 (14.29)	.360

*Likely the previous diagnosis of spleen injury made on index admission which was unresolved.

38.10% of BSI patients managed nonoperatively were readmitted at hospitals different from where they received their initial care. There was no significant difference in the probability of readmission at a different hospital among those who initially had SAE and those who did not.

Predictors of 30-day readmission following nonoperative management of blunt splenic injury

On multivariate analyses, the strongest predictor of readmission was discharge against medical advice (adjusted odds ratio [aOR] 2.85, 95% confidence interval [CI], 1.58 to 5.15, $P = .001$) (Table 3). Other predictors of readmission were Charlson score greater than or equal to 2 (aOR 1.91, 95% CI 1.11 to 3.28, $P = .020$), age greater than or equal to 45 (aOR 1.83, 95% CI 1.38 to 2.44, $P < .001$), and being on public insurance (aOR 1.51, 95% CI 1.05 to 2.17, $P = .028$). Adjunct SAE was an independent risk factor for readmission when compared with NOM without SAE (aOR 1.82, 95% CI 1.19 to 2.78, $P = .005$).

Comments

Postdischarge complications of surgical management have gained increasing attention over the years. The efforts of the American College of Surgeons National Surgical Quality Improvement Program[16] and the recent readmission penalties imposed by the Centers for Medicare and Medicaid Services[17] have played significant roles in improving the awareness of these complications and their attendant consequences. Our study showed that significant proportions of patients managed nonoperatively have complications requiring readmission within 30 days of discharge. Importantly, among those readmitted, one fifth of them required operative interventions highlighting a significant proportion of cases which may have been classified as being successfully managed at the time of initial discharge.

Although one of the arguments for the use of adjunct SAE in BSI is that patients have reduced need for eventual operative management,[18,19] our study showed similar rates of operations following discharge among those who had SAE and those who did not. Because the patients who receive SAE have more severe injuries, the similar rates of eventual operations may not be a reflection of equal efficacy between the strategies. Instead, this could point to a measure of the inability of the current methods to appropriately identify the best candidates for operative interventions. Furthermore, the reasons for readmission in patients who required operations on readmission varied significantly. Although the majority of those who were initially managed without SAE were readmitted with diagnoses of splenic injuries, only about a third of those who had SAE were readmitted for similar diagnoses. In addition, readmitted patients who initially had SAE were more likely to have other gastrointestinal complications compared to those who did not. These data suggest that there are significant variations in the types of complications seen in patients based on the management they receive. Understanding these long-term consequences is useful for clinicians in deciding the optimal treatment strategy for the stable BSI patient and adequately preparing for potential complications.

Table 3 Multivariate analyses of factors associated with 30-day readmissions in splenic injury patients managed nonoperatively

Characteristics	Adjusted odds ratio (95% confidence interval)
Age (y)	
18–44	Reference
45–64	**1.83 (1.38–2.44)**
Race/Ethnicity	
White	Reference
Black	1.17 (.66–2.10)
Hispanic	1.21 (.86–1.68)
Other	**.36 (.14–.89)**
Insurance type	
Private	Reference
Public	**1.51 (1.05–2.17)**
Self-pay	1.23 (.81–1.88)
Others	1.27 (.86–1.88)
Charlson score	
<2	Reference
≥ 2	**1.91 (1.11–3.28)**
Injury Severity Score category*	.90 (.79–1.04)
Complications during admission	
Absent	Reference
Present	1.42 (.98–2.04)
Discharge disposition	
Home	Reference
Home Health Care	1.79 (.98–3.30)
SNF, ICF, others	.64 (.33–1.21)
AMA	**2.85 (1.58–5.15)**
Mode of management	
NOM without SAE	Reference
NOM with SAE	**1.82 (1.19–2.78)**

Significant adjusted odds ratios written in bold.

AMA = against medical advice; ICF = intermediate care facility; NOM = nonoperative management; SAE = splenic artery embolization; SNF = skilled nursing facility.

*Injury Severity Score categorized as less than 9 (reference), 9 to 15, 16 to 25, and greater than or equal to 25.

Interestingly, close to 40% of patients managed nonoperatively were readmitted at hospitals different from the hospitals they were initially treated. Many studies which have examined postdischarge outcomes use data from single institutions grossly underestimating the potential complications associated with the treatment patients receive.[2,7] Our study indicates that results from studies of single hospital data should be interpreted with caution. It also highlights the level of care fragmentation associated with NOM of BSI. Care fragmentation has been associated with increased mortality and complication rates among surgical patients.[20] Improving the integration of care among these patients is important as it allows clinicians to truly assess the outcomes of their treatment and it potentially improves the outcomes among these patients. Ensuring early out-patient follow-up, involving primary care physicians in postdischarge care, and developing Local Access to Care Programs are strategies that have been suggested to reduce care fragmentation.[21,22]

Despite the fact that many of the risk factors for postdischarge complications leading to readmission are not readily modifiable, they serve as an indicator for patients who may require more detailed evaluation before discharge. The current practices that surround decisions regarding the treatment of BSI patients rely heavily on the clinical judgment of the care providers.[23] This study provides a platform for evidence-based decision making when considering the long-term implications of different strategies. We found that older patients, those on public insurance (which may be a surrogate marker of socioeconomic status), and patients with high levels of comorbidity are groups of patients who may require more intense surveillance for potential complications before discharge. Of note, we found that even after adjusting for demographic and injury characteristics, patients who had adjunct SAE still had higher odds of readmission than those who did not have SAE. The mechanism of this increased tendency remains unclear and should be the subject of further studies.

There are a number of limitations with our study. First, the database did not include emergency department visits. It is likely that some patients were managed in the emergency department without being readmitted. This means our study does not adequately describe all hospital encounters associated with this form of treatment. However, we included all postdischarge complications that are serious enough to require admission. Second, we do not have data on patients who may have died outside the hospital after discharge. However, because the short-term mortality after the initial in-hospital resuscitation in these patients is negligible, it is unlikely that this factor will significantly affect the interpretation of the readmission rates we measured. Finally, we do not have granular physiologic data and injury profiles that could provide a greater understanding of a patient's burden of injury. It is possible that other clinical factors may be associated with hospital readmission following NOM other than the factors we identified.

Conclusion

A significant proportion of patients managed nonoperatively for BSI have postdischarge complications leading to readmission within 30 days of discharge. Large numbers of these patients are readmitted at hospitals different from the location of their initial admission and many of them undergo operative interventions. Improving protocols for the management of BSI, incorporating standardized methods for assessing fitness for discharge, and ensuring early follow-up are possible strategies to reduce complications following NOM of BSI.

Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.amjsurg.2015.11.018.

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Appendix

ICD-9 codes for inclusion in identifying study population

865.00 to 865.19: Injury to spleen

ICD-9 codes for exclusion in identifying study population

E920: Accidents caused by cutting and piercing instruments and objects
E922: Accidents caused by firearm and air gun missile
E923: Accidents caused by explosive material
E955: Suicide and self-inflicted injury by firearms, air guns, and explosives
E956: Suicide and self-inflicted injury by cutting and piercing instruments
E966: Assault by cutting or piercing instrument
E970: Injury due to legal intervention by firearms
E971: Injury due to legal intervention by explosives
E974: Injury due to legal intervention by cutting and piercing instruments
E986: Injury by cutting and piercing instruments, undetermined whether accidentally or purposely inflicted

Endovascular management ICD-9 codes

38.86.
38.80.
38.91.
39.79.

Surgical management ICD-9 codes

41.5.
41.43.
41.95.
41.99.
41.41.
41.42.
54.51.
54.59.
ICD-9 = International Classification of Disease, 9th edition