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Title of the article: Conservative Management of High-Grade Renal Trauma Does Not Lead to Prolonged Hospital Stay

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Figure 1: Adjusted Competing Risk of Time to Discharge by Renal Exploration

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Table 1: Characteristics of Patients who Sustain High-Grade Renal Trauma by Disposition

Table 2: Predictors of decreased length of time to discharge (days)

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ABSTRACT

Objective

To evaluate the effect of conservative management of high-grade renal trauma on length of hospitalization, we aim to describe characteristics of patients with high-grade renal trauma that are associated with an increased length of stay (LOS) and the effect of conservative versus surgical management on hospital LOS.

Methods

A retrospective review of all patients who suffered unilateral high-grade renal trauma (grade 3 or higher) from 9/1977 to 8/2012 at San Francisco General Hospital in San Francisco, CA was performed. Patient's demographic information, mechanism of injury, injury grade, data about associated injuries, hospital LOS, and management were collected. Descriptive analysis was performed using chi-squared, ordered logistical regression, and linear regression analysis. Multivariable analysis was performed using a Fine-Gray model of competing risks survival analysis, adjusting for trauma type, grade, surgery, associated injury, and complications.

Results

The cohort consisted of 408 patients with high grade unilateral renal trauma of whom 257 patients underwent renal exploration. Adjusted multivariable analysis found that trauma type, injury grades, non-genitourinary surgery, associated injuries, and complications were associated with increased hospital LOS ($p < 0.01$ for all). Renal exploration compared to conservative management for high grade renal trauma was not associated with an increased hospital LOS ($p = 0.010$).

Conclusion

There is no significant difference between conservative and surgical management of high-grade renal trauma in terms of hospital LOS. Conservative management of high-grade renal trauma does not impact patients' length of hospitalization.

MANUSCRIPT

INTRODUCTION

Trauma is an expensive public health issue in the United States with estimated costs of up to \$600 billion annually [1]. As the costs of medical care continue to rise and reimbursements decrease, there is an increased emphasis by the medical community on providing high quality care at a lower cost. Trauma patients commonly incur high rates of complications and longer hospitalizations, thus costs related to their care are high [2, 3].

Renal trauma accounts for approximately 1-5% of all trauma and approximately 10% of abdominal trauma [4]. Historically, renal injuries were managed by open surgical intervention, often resulting in nephrectomy [5, 6]. However, a paradigm shift has occurred in the past few decades, with growing evidence supporting the conservative management of renal injuries in hemodynamically stable patients [7-10]. Conservative management of most low-grade renal injuries has become the standard of care, and emerging evidence also supports conservative management in properly selected patients with high-grade renal injuries [8, 11].

Protocols for conservative management of renal trauma vary between institutions and depend not only on the hemodynamic stability of the patient but also on the severity of injury. Immediate non-operative management of high-grade renal trauma includes bed rest, hydration, analgesia, and close monitoring including serial physical examinations and laboratory studies [9, 11]. As the shift toward non-operative management of high-grade renal trauma unfolds, the impact on costs remains unknown. We sought to understand the effect of this management change by evaluating hospital LOS as a proxy for understanding the costs and complications associated with differences in renal trauma management. We hypothesize that conservative

versus surgical management of high-grade renal trauma does not have a difference in hospital LOS.

METHODS

A retrospective review was performed of all patients who sustained unilateral high-grade renal trauma at San Francisco General Hospital in San Francisco, CA between 9/1977 through 8/2012. The patient's demographic information, mechanism of injury, injury grade, data about associated injuries, and management were abstracted from the database. Hospital LOS was determined by admission and discharge/transfer/death date; these dates were only available in our database through 8/2012. Patients were excluded if they had missing variables, bilateral renal trauma, or the length of hospital stay could not be determined. IRB approval was obtained.

Descriptive analysis of the cohort by hospital LOS and disposition was performed using chi-squared, ordered logistical regression, and linear regression analysis. Multivariable analysis was performed using a Fine-Gray model of competing risks survival analysis, adjusting for trauma type, grade, surgery, associated injury, and complications. Discharge was defined as the event of interest and death was considered a competing event, with transfers treated using censoring. Utilization of the Fine-Gray model as opposed to a traditional Cox model allowed us to account for the possibility that covariates may be associated with death. Model diagnostics were run and an interaction term for renal exploration and non-genitourinary (GU) surgery was included due to significant collinearity identified in model testing. STATA (StataCorp. 2013. *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP) was utilized for statistical analysis and a p-value of < 0.05 was considered significant.

RESULTS

From 9/1977 to 8/2012, 408 individuals were identified with high grade (grade 3 or higher) unilateral renal trauma. Of those patients, 257 underwent renal exploration. Hospital stay was terminated via three dispositions: discharge from the hospital (n=298), transfer from the hospital (n=82), and death (n=28). Patients who were transferred had a mean 5.8 days longer hospital LOS than those who were discharged, while those patients who suffered death had a mean 6.6 days shorter hospital LOS than those who were discharged ($p < 0.01$). There were significant differences among the injury type (penetrating versus blunt), injury grade, associated injuries, and complications by disposition ($p < 0.01$ for all). Patients who suffered death or were transferred had overall more blunt trauma, higher injury grades, more associated injuries, and higher complication rates than those who were discharged. (Table 1)

(Table 1. Characteristics of Patients who Sustain High-Grade Renal Trauma by Disposition)

An adjusted multivariable analysis was performed to identify significant predictors of increased hospital LOS. (Table 2) On analysis, blunt trauma versus penetrating trauma, grades 4 and 5 renal trauma versus grade 3 renal trauma, undergoing non-GU surgery for traumatic injuries, having any associated non-GU injuries, and having a complication during the hospitalization were associated with an increased hospital LOS ($p < 0.01$ for all). Renal exploration for high-grade renal trauma was not significantly associated with increased hospital LOS in adjusted analysis ($p = 0.10$), although the median LOS for patients who received renal exploration for

high-grade renal trauma was 13 days while those who were managed conservatively had a median LOS of 10 days. (Figure 1)

(Table 2. Predictors of decreased length of time to discharge (days))

(Figure 1: Adjusted Competing Risk of Time to Discharge by Renal Exploration)

DISCUSSION

In this study, we evaluated predictors of increased hospital LOS for patients with high-grade renal trauma at our institution and identified the effect of conservative and surgical management on high-grade renal trauma with respect to hospital LOS. In our cohort, we found multiple factors associated with an increased hospital LOS in multivariate analysis; however, undergoing renal exploration was *not* found to have a significant impact on hospital LOS. This finding demonstrates that the notion of performing a surgical intervention to definitively address the renal trauma does not help patients leave the hospital quicker compared to conservative management. In fact, our analysis showed that patients undergoing conservative management have a shorter median length of hospital stay, although this was not found to be a significant difference. These findings suggest that other factors drive hospital LOS in these patients, and that management of high-grade renal traumas can be performed conservatively without an impact on length of hospitalization. Our analysis shows that these other factors, such as having grade 4 or 5 trauma, sustaining blunt injury, having associated non-GU injuries, having non-GU surgery, and having any complication during hospitalization were predictive of a longer hospital stay.

These patients likely have more complex and multiple injuries, and what is driving length of hospitalization is not the renal trauma itself, but management of the other injuries sustained.

The prospect of conservative management for high-grade renal trauma has been supported throughout the literature and other studies echo our findings that conservative management does not increase length of hospitalization. In a recent study, van der Wilden et al studied 206 patients with grades 4 and 5 renal injuries across New England and managed approximately 75% of those patients with conservative management. Nonoperative management only failed in 6.5% of those patients due to their renal injury [12]. Similarly, Elashry et al managed 51/72 patients with grades 4 and 5 renal injuries conservatively. Those patients managed conservatively were found to have lower transfusion requirements, shorter hospital LOS, and fewer complications than those who were managed with surgical exploration [8]. These findings were also demonstrated by Altman et al in which 6 of 13 patients with grade 5 renal trauma were treated with conservative management. They found those patients treated conservatively had shorter LOS in the intensive care unit (ICU), lower transfusion rates, and fewer complications [13]. The paradigm shift in management based on clinical status rather than severity of the injury may be attributed to improved radiographic techniques resulting in improved grading of the injury, advancements in resuscitation techniques, and the availability of interventional radiology [14, 15]. Advancements in angioembolization have likely aided in shifting practice patterns. Brewer et al reported success of angioembolization in patients with grade 5 renal trauma. Clinical success was found in 9 patients who suffered grade 5 renal injuries secondary to blunt trauma and were treated with angioembolization. None of these patients required any further surgical or radiological interventions [16].

In our cohort, undergoing non-GU surgery and associated injuries were significant contributors to LOS. Patients presenting with polytrauma have other associated injuries that may influence the hospital LOS more than the renal injury. A recent study by Moore et al found that not only the severity of traumatic injury as a predictor of hospital LOS but the body region with the most severe injury was also a predictor. They determined that patients with spinal injuries, for example, stayed 3.1 days longer than patients with lower extremity injuries [17]. Complications during hospitalization were also a significant contributor to LOS in our cohort. Böhmer et al explored factors that increase ICU LOS in patient's suffering traumatic injuries and found similar results. The severity of traumatic injury influenced their ICU LOS as well as secondary effects or complications of treatment. Patients who developed sepsis had a 7.8 days longer ICU stay and patients with respiratory failure had a 4.9 days longer ICU stay [18]. They also determined that patients with an initial Glasgow Coma Scale ≤ 8 had significantly longer ICU stay [18].

The results illustrate potential economic implications as conservative management of high-grade renal trauma may not incur higher medical costs related to longer hospitalizations. Conservative management allows high-grade renal trauma patients to avoid complications associated with surgical procedures which can also lead to an extended LOS. Fakhry et al explored the financial results of treating injured patients at a trauma center with respect to the patient's hospital LOS. They found that a trauma patient's hospital LOS closely correlates with the center's profitability. In their cohort, the center made majority of their profit if the patient stayed less than 11 days and defined that day as a "point of inflection" [19]. Identifying a trauma center's "inflection point"

can serve as a benchmark for institutions to develop treatment protocols. This becomes increasingly important as trauma centers are closing more frequently in the United States and closures are related to profitability [19, 20]. A recent study estimated the annual cost of readiness for a trauma center is \$2.7 million dollars and coupling this cost with low rates of reimbursement and uninsured patients creates a financial burden on a trauma center to stay open [20, 21].

Ultimately, closures of trauma centers are often related to financial constraints and can have a profound impact on patient care/outcomes. Hsia et al identified a relationship between closure of trauma centers and increased mortality in patients suffering traumatic injuries as they have to travel further to receive treatment [20]. A cost analysis comparing surgical management and conservative management of high-grade renal trauma is necessary to further elucidate the economic implications.

This study has several limitations. First, the study was retrospective in nature and may introduce possible selection bias. In efforts to control this potential selection bias, the provider-based database was analyzed to assess the quality of data collection over time. Evaluation by grade revealed significant variability in the cases per year of low-grade renal trauma, whereas the incidence of high-grade renal trauma remained relatively stable over time. This suggests that the database was adequately maintained for high-grade renal traumas. Second, our institution had a unique modality of disposition where patients can be transferred back to the referring institution once the patient has received appropriate treatment and is medically stable. Transferring patients back to referring institutions is not applicable to all trauma centers and our results demonstrated an increased hospital LOS for patients with high-grade renal trauma compared to those discharged. This increase in hospital LOS can be reflective of transfer logistics rather than the

clinical stability of the patient. Furthermore, the ultimate discharge date for patients transferred back to their referring institution is unknown and their discharge date from our institution is not reflective of their discharge from the hospital. For these reasons, we chose to utilize censoring to account for these patients in our multivariable analysis. Lastly, patients who ultimately suffered death from their traumatic injuries may have passed from their associated injuries not related to their high-grade renal trauma. Patients who suffered death had a mean hospital LOS that was 6.6 days shorter than those discharged ($p < 0.01$) and these results may relate to associated injuries rather than renal injury. All patients who suffered death in our cohort had associated injuries.

CONCLUSION

We found no significant difference between conservative and surgical management of high-grade renal trauma in terms of hospital LOS. This suggests that conservative management of high-grade renal trauma does not extend patients' length of hospitalization. These results echo growing evidence that conservative management is feasible for select patients with high-grade renal trauma and that it will not affect hospital LOS.

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FIGURE LEGEND

Figure 1: Orange line = Renal surgery; Blue line = No renal surgery

Table 1. Characteristics of Patients who Sustain High-Grade Renal Trauma by Disposition

	All	Discharge	Transfer	Death	p-value
Characteristic	<i>n</i> = 408	<i>n</i> = 298 (73.0%)	<i>n</i> = 82 (20.1%)	<i>n</i> = 28 (6.9%)	
Hospital days, mean	16.0	15.4	21.2	8.8	<0.01 ^a
Age, mean (yrs)	30.7	29.3	33.3	37.4	<0.01 ^a
Male, n (%)	352 (85.2)	263 (88.3)	65 (79.3)	19 (67.9)	<0.01
Penetrating, n (%)	248 (60.1)	197 (66.1)	37 (45.1)	13 (46.4)	<0.01
Injury Grade, n (%)					<0.01
Grade 3	178 (43.1)	142 (47.7)	23 (28.1)	11 (39.3)	
Grade 4	188 (45.5)	130 (43.6)	46 (56.1)	9 (32.1)	
Grade 5	47 (11.4)	26 (8.7)	13 (15.9)	8 (29.6)	
Surgery, n (%)	289 (70.0)	211 (70.8)	52 (63.4)	23 (82.1)	0.15
Renal (GU) surgery	257 (62.2)	197 (66.1)	42 (51.2)	16 (57.1)	0.04
Non-GU surgery	249 (60.3)	179 (60.1)	48 (58.5)	20 (71.4)	0.46
Associated injuries, n (%)	331 (80.2)	228 (76.5)	72 (87.8)	28 (100)	<0.01
Complication, n (%)	182 (44.1)	117 (39.3)	43 (52.4)	21 (75.0)	<0.01
GU-related complication	82 (19.9)	48 (16.1)	16 (19.5)	18 (64.3)	<0.01

χ^2 exact test of trend used for all tests of statistical significance except as otherwise noted

^a – p-value refers to a linear regression

Table 2. Predictors of Decreased Length of Time to Discharge (days) in a Multivariate Competing Risk Model

Predictor	SHR	95% CI	p-value
Penetrating Trauma	1.88	1.37 – 2.57	<0.01
Trauma Grade			
Grade 4	0.69	0.54 – 0.88	<0.01
Grade 5	0.43	0.29 – 0.63	<0.01
Renal surgery	0.70	0.46 – 1.07	0.10
Non-GU surgery	0.29	0.16 – 0.52	<0.01
Associated injuries	0.49	0.35 – 0.69	<0.01
Any complication	0.72	0.57 – 0.92	<0.01

SHR = subdistribution hazard ratio as determined by the Fine-Gray model for competing risks survival analysis

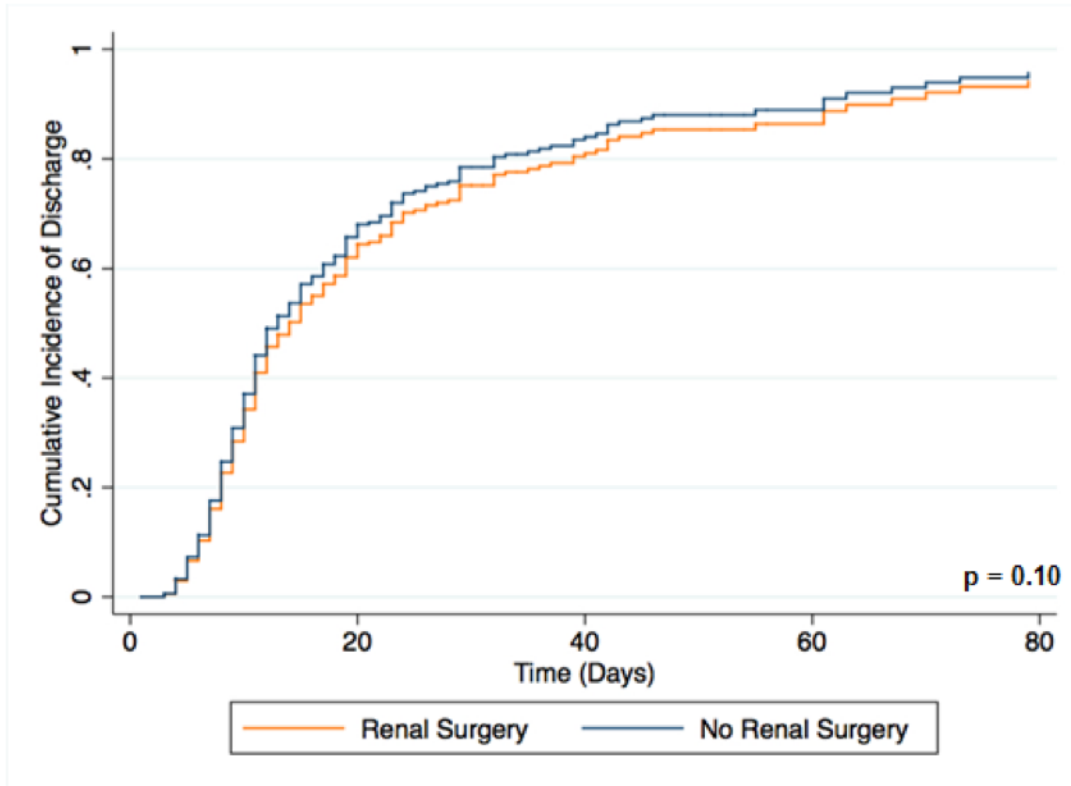


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