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ORIGINAL PAPER

Analysis of factors associated with length of stay in renal trauma patients: A single-centre retrospective study

Paksi Satyagraha, Besut Daryanto, Bagas Wilianto, Fauzan Kurniawan Dhani

Department of Urology, Faculty of Medicine Universitas Brawijaya, Dr. Saiful Anwar General Hospital, Malang, Indonesia.

Summary *Background: Renal trauma represents a critical injury requiring precise management with the length of hospital stay (LOS) serving as a key metric for trauma care. Recognizing the factors contributing to extended LOS is essential for optimizing treatment strategies and enhancing patient outcomes. This study aims to analyse the risk factors influencing LOS in patients with renal trauma.*
Methods: This retrospective cohort study was conducted at Dr. Saiful Anwar General Hospital, Malang, analysing medical record data of renal trauma patients from 2013 to 2023. Collected variables included demographics, mechanism of injury, associated injuries, hemodynamic status upon admission, injury severity, haemoglobin levels, LOS, management approach, and mortality outcomes. Univariate and multivariate analyses were performed to assess the impact of each variable on LOS.
Results: 119 renal trauma patients were included. The average age was 40.1 ± 16.86 years, and 77.3% of the participants were male. The average LOS was 6.85 ± 3.85 days. Blunt renal trauma was the predominant mechanism, accounting for 95.8% of cases, while associated injuries were observed in 53.1% of patients. Upon hospital admission, 66.4% of cases presented with stable hemodynamic status, and non-operative management was employed in 92.4% of cases. Prolonged LOS was significantly associated with age, blunt trauma, associated injuries, hemodynamic instability, and low haemoglobin levels in both univariate and multivariate analyses.
Conclusions: Age, mechanism of injury, associated injuries, hemodynamic status at admission, and haemoglobin levels significantly impact LOS in renal trauma patients. Identifying these factors may aid in improving patient management and reducing hospitalization duration.

KEY WORDS: Length of stay; Renal; Risk factors; Trauma.

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INTRODUCTION

Renal trauma is an injury to the blood vessels and/or parenchyma of the kidney, resulting in bleeding or injury to the collecting system with possible urine leakage (1). The kidney is the third most commonly injured organ in abdominal trauma, after the spleen and liver (2). Renal trauma contributes about 1% to 5% of all traumas, most of which are caused by blunt abdominal trauma (80% to 90%) (3, 4). Although uncommon, penetrating renal trauma may account up to 20%, depending on the location and registry (3). Young males (mean age 30 years) who participate in sports, motor vehicle accidents, assaults, or falls are more likely to sustain traumatic renal injuries. In the paediatric population, falls (27%) and pedestrian accidents (13%), rather than *motor vehicle accident* (MVA) (30%), were the primary causes of blunt trauma (2, 5). Renal trauma caused by motor vehicle crashes is associated with high morbidity and mortality. In addition, these events can cause a loss of 1-1.5% of the gross national product in developing countries (6).

The priority of renal trauma management is primarily to prevent death by controlling haemorrhage, preserving nephrons, and avoiding complications. In recent decades, trauma management has evolved toward a non-invasive approach through *non-operative management* (NOM). It maintains safety with better outcomes (7-9). This approach applies to both paediatric and adult populations. The absolute indications for renal intervention are hemodynamic instability, unresponsiveness to aggressive resuscitation due to renal haemorrhage, grade 5 vascular injury, and extensive perirenal hematoma found during laparotomy for associated injuries. In addition to the medical approach and interventions required, bed rest after renal trauma is a very common practice until haematuria resolves (7, 10, 11). However, this policy appears to be controversial, mainly because the degree of haematuria does not seem to correlate with improvement in symptoms or mobility that can lead to prolonged *length of stay* (LOS) with associated risks of *venous thromboembolism* (VTE) and hospital-acquired infections (12-14). In addition, hospitals may experience resource loss and functional decline. LOS can be influenced by the patient's age, gender, complications, comorbidities, and history of mental illness. The severity of the injury and the interventions received may also be the best predictors of LOS. Furthermore, post-traumatic pain and surgery can extend a patient's LOS. Some studies have shown that prolonged LOS may increase the mortality rate of trauma patients in the hospital (15, 16).

Several studies have reported that the average safe LOS is less than 4 days for isolated renal injury at all levels of trauma, using a more relaxed policy regarding mobilization, and less than 2 days for hepatosplenic trauma, without readmission (17). This suggests that a short rest period remains safe in renal trauma. This study was conduct-

ed to analyse the risk factors that influence the LOS of renal trauma patients at *Dr. Saiful Anwar General Hospital in Malang, Indonesia*.

Materials and methods

Study design

This study is a retrospective cohort study conducted at *Dr. Saiful Anwar General Hospital Malang, Indonesia*, based on medical record data. The study population included all patients who experienced renal trauma from January 2013 to December 2023. This research adheres to the principles outlined in the Declaration of Helsinki and has received approval from the *Dr. Saiful Anwar General Hospital Ethics Committee* under protocol number 400/223/K.3/102.7/2024.

The inclusion criteria were trauma patients aged >18 years admitted to *Emergency Department* (ED) of *Dr. Saiful Anwar General Hospital* diagnosed with renal trauma, confirmed by contrast-enhanced CT imaging or intraoperative findings. Those who injured > 2 weeks before admission were excluded. The exclusion criteria were extended to patients from another hospital or with iatrogenic renal injuries.

Trauma patients are initially assessed by emergency medicine physicians and subsequently co-managed with the trauma surgery team. Renal trauma is typically identified via contrast-enhanced CT imaging in hemodynamically stable patients, while unstable patients may undergo immediate surgical exploration.

Patient data

Data were extracted by authors *BW* and *FKD*. A random 10% sample of records underwent double data entry for consistency. Definitions of comorbidities were based on ICD-10 codes, and considered clinical variables were hypotension (defined as systolic blood pressure < 90 mmHg), age, gender, mechanism of injury, associated injuries, haemoglobin levels, and hemodynamic status upon arrival, as well as injury severity, LOS, patient management, and mortality rate.

Associated injuries included other traumas aside from renal trauma, such as injuries to the brain, gastrointestinal tract, thorax, and bones. The *American Association for the Surgery of Trauma* (AAST) grading system was applied to assess renal trauma, with AAST Grades I-III classified as low grade and AAST Grades IV-V as high grade. LOS was determined from the time the patient arrives at the ED until discharge or death. Operative therapies performed include percutaneous urinoma drainage, DJ stent insertion, renorrhaphy, and nephrectomy.

Statistical analysis

Continuous variables were summarized as medians with *interquartile ranges* (IQR) due to non-normal distribution, while categorical variables were presented as frequencies and percentages. Univariate analysis was conducted using the Chi-square test to evaluate associations between categorical variables and LOS. Variables with clinical relevance or a p-value < 0.10 in univariate analysis were included in a multivariable linear regression model to identify independent predictors of increased LOS in renal trauma patients. Statistical significance was defined as a two-tailed p-value < 0.05. All analyses were performed using IBM SPSS Statistics for Windows, version 23.0 (*IBM Corp., Armonk, NY, USA*).

Results

The total number of patients studied was 119, consisting of 92 males (77.3%) and 27 females (22.7%), as shown in Table 1. The average age of patients with renal trauma was 40.1 + 16.86 years, and the average haemoglobin level of 11.41 + 7.98 g/dL. The most common mechanism of injury was blunt injury, with 114 cases (95.8%) with an average length of stay of up to 6.85 days, or approximately 1 week. In addition, 62 patients (52.1%) had injuries restricted to renal trauma, and 57 patients (47.9%) did not. On arrival, 79 patients (66.4%) had stable hemodynamic status, and 40 patients (33.6%) had unstable hemodynamic status. Non-operative management was the predominant approach, implemented in 110 cases (92.4%), while immediate operative management was performed in 9 cases (7.6%). The operative interventions included nephrectomy in six cases, renorrhaphy in two cases, and percutaneous urinoma drainage and DJ stent insertion in one case. Based on injury severity, 84 patients (70.6%) had low-grade injuries (Grades I-

Table 1.
Patient characteristics.

	N	%
Number of patient	119	
Age, years (median)	40.1 ± 16.86	
Gender		
Male	92	77.3
Female	27	22.7
Haemoglobin, g/dL (SD)	11.41 ± 7.98	
LOS, days (SD)	6.85 ± 3.85	
MOI		
Blunt	114	95.8
Penetrating + Iatrogenic	5	4.2
Associated Injuries	62	52.1
Brain	4	6.5
GI	32	51.6
Thorax	9	14.5
Bone	17	27.4
Haemodynamic		
Stable	79	66.4
Unstable	40	33.6
Renal Trauma Grade		
Low (I, II, III)	84	70.6
High (IV, V)	35	29.4
Management		
Non-Operative	110	92.4
Operative	9	7.6
Nephrectomy	6	66.7
Renorrhaphy	2	22.6
DJ Stent Insertion + Percutaneous Urinoma Drainage	1	10.7

SD: Standard Deviation; LOS: Length of Stay; MOI: Mode of Injury.

Table 2.
Characteristic renal trauma patient mortality.

	N	%
Mortality	12/119	10
Renal Trauma Grade		
Low (I, II, III)	10	83
High (IV, V)	2	17
Haemodynamic		
Stable	5	42
Unstable	7	58
Associated Injuries		
Brain	3	25
GI	5	42
Thorax	4	33

III), while 35 patients (29.4%) had high-grade injuries (Grades IV-V). The mortality rate was 10.1% (12 patients), while 107 patients (89.9%) survived.

Based on the analysis of patient mortality data, a total of 12 deaths were recorded among 119 patients (Table 2). Of these 12 cases, none were attributed solely to renal trauma. Notably, 3 patients (25%) presented with concomitant head trauma, 5 patients (42%) had gastrointestinal trauma, and 4 patients (33%) experienced thoracic trauma.

Univariate analysis indicated that patients over 60 years of age had a 2.47-fold increased risk of prolonged LOS ($p = 0.018$). Regarding the MOI, penetrating or iatrogenic trauma was associated with an 8.00-fold higher risk of prolonged LOS compared to blunt trauma ($p = 0.033$). The presence of associated injuries significantly increased the risk of prolonged LOS (OR 9.26; 95% CI: 3.63-23.63; $p < 0.001$). Furthermore, patients presenting with unstable hemodynamics (OR 10.38; 95% CI: 5.37-33.38; $p < 0.001$) and hemoglobin levels below 10 g/dL (OR 24.62; 95% CI: 8.99-63.70; $p < 0.001$) were at markedly higher risk of prolonged LOS (Table 3).

Multivariate analysis confirmed the independent association of all five factors with prolonged hospital stay: age > 60 years (OR 2.79; 95% CI: 1.60-18.92; $p = 0.019$), penetrating or iatrogenic trauma (OR 4.47; 95% CI: 3.03-75.14; $p = 0.009$), presence of associated injuries (OR 1.80; 95% CI: 1.32-28.04; $p = 0.020$), unstable hemodynamics (OR 2.22; 95% CI: 2.33-37.04; $p = 0.002$), and hemoglobin < 10 g/dL (OR 3.93; 95% CI: 8.74-96.02; $p < 0.001$) (Table 3).

Table 3.
Uni- and multivariate regression analysis for factors associated with LOS in renal trauma patients.

	Univariate analysis			Multivariate analysis		
	OR	95% CI	P value	OR	95% CI	P value
Age						
< 60 *vs* > 60	2.47	0.62-9.73	0.018 *	2.799	1.60-18.92	0.019 *
Gender						
Male *vs* Female	1.10	0.42-2.69	0.829			
MOI						
Blunt *vs* Penetrating + Iatrogenic	8.00	0.86-74.08	0.033 *	4.473	3.03-75.14	0.009 *
Associated Injuries						
Yes *vs* No	9.26	3.63-23.63	0.000 *	1.807	1.32-28.04	0.020 *
Haemodynamic						
Stable *vs* Unstable	10.38	5.37-33.38	0.000 *	2.229	2.33-37.04	0.002 *
Grade						
Low *vs* High	2.53	1.16-5.51	0.170			
Haemoglobin						
> 10 *vs* < 10	24.62	8.99-63.7	0.000 *	3.929	8.74-96.02	0.000 *
Management						
Non-Operative *vs* Operative	4.11	0.97-17.39	0.060			
Mortality						
Yes vs No	1.97	0.59-6.55	0.261			

* *Significant result.*
MOI: Mechanism of Injury; CI: Confidence Interval; OR: Odd Ratio.

Discussion

The age of patients with renal trauma in this study was 40.1 years, and male gender was more frequent. In a study conducted in South Africa in 2019, the average age of patients with renal trauma was 27 years (18). Similarly, a 2019 study in New York found that the average kidney trauma patient was male, with an average age of 33 (19). According to a report from the Japan Trauma Database from 2004-2018, 74.2% of renal trauma patients were males aged below 60 years, with the most common mechanism of injury being blunt trauma caused by traffic accidents and falls from heights (20). The probable explanation for this is that renal injuries become more common in this age group because the subjects included are more frequently involved in high-risk activities and mobility, particularly in traffic and sports. Additionally, Indonesian males generally use motorcycles for transportation, raising the risks of MVAs (21). In this study, age was one of the factors that could prolong LOS, but gender was not a significant factor.

The mechanism of injury in renal trauma is mostly due to blunt force injuries caused by motor vehicle collisions, falls from height, and sports injuries. A study showed that blunt renal trauma is one of the predictive factors for longer LOS compared to penetrating trauma (6, 16).

A study reported the mean LOS of road traffic related injuries was 6.8 days with a LOS range of 1 to 105 days (22). However, another study showed significantly different results, in which the median LOS was 2.85 days (6, 16).

Other associated injuries also have the potential to prolong LOS due to the additional interventions and follow-up care required. Moore et al. found that the anatomical location of the injury can be a predictor of prolonging LOS in patients, such as in patients who also had spinal cord injuries, which resulted in 3.1 days longer LOS than patients with lower limb injuries (6, 22).

Traumatic incidents may cause hemodynamic problems due to bleeding and vascular injury. The hemodynamic condition of a renal trauma patient on arrival determines both the management and the length of stay.

Hemodynamic instability may include hypotension, shock due to hematoma, and massive bleeding, resulting in decreased haemoglobin. Low haemoglobin levels (< 10 g/dL) will also delay discharge. Hemodynamic instability increases the risk of prolonged LOS. Meanwhile, patients with stable hemodynamic do not need to undergo operative procedures, so their length of stay will be shorter (6). Patients who arrived with hemodynamic stability, despite having a high severity of injury, were recommended to NOM. In this study, renal trauma management was not associated with a significant risk of patient LOS. A study showed that there is a correlation between the medical management provided and the patient's LOS, i.e., patients with NOM tend to have a shorter LOS than patients with operative management (6, 20).

Many studies have confirmed the safety of NOM in renal trauma, and it has become the standard of care for most patients with renal trauma (20, 23, 24). The success rate of NOM in hemodynamically stable patients reaches 80%, even in patients with high-grade severity (24).

Nevertheless, emergency operative treatment of injuries in patients with hemodynamic instability is still performed for certain indications (12), NOM has demonstrated favourable outcomes and remains the preferred initial treatment for isolated renal trauma in patients with stable hemodynamic status, even in cases of high-grade injuries. In cases where complications arise (like urinoma, or infection), minimally invasive procedures such as percutaneous drainage of urinomas can be employed effectively (25). Factors that determine the choice of management include patient stability, the degree of renal injury, and the presence of associated injuries, which are the most common reasons for renal surgical exploration (26).

The study showed that 10.1% of renal trauma patients died (26). Our study also indicates that renal trauma patients, in the absence of associated injuries, did not experience any fatalities. All fatalities in renal trauma cases were observed exclusively in the presence of concomitant injuries. This is consistent with findings from a 9-year study on renal injury conducted in Australia, which reported that renal injury was not identified as the cause of death in any of the cases. Overall, 17 patients in that study succumbed within the first 24 hours of admission due to severe multi-trauma (27). Post-traumatic mortality was also not a significant factor affecting LOS. This is consistent with the results of the San Francisco study, which found that patients who died had a mean LOS of 6.6 days shorter than patients who were discharged ($p < 0.01$) (6). A patient's hospital care may conclude upon their discharge, transfer, or death. The mean LOS for transferred patients was 5.8 days longer than for discharged patients (6, 28).

This study has several limitations that need to be considered in interpreting the results. Firstly, the retrospective design of the study, which was conducted in one healthcare center, limits the generalizability of the findings to a wider population or to hospitals with different characteristics. In addition, the relatively limited sample size may also affect the statistical power and external validity of the findings. Therefore, further studies with a prospective design and multicentre coverage are needed to verify the results and improve the validity of the findings.

Conclusions

This study concludes that older age, blunt force injury, associated injuries, hemodynamic instability, and haemoglobin level all have an impact on the length of hospital stay in patients with renal trauma. Proper management and clinical condition at the time of admission also determine the length of hospital stay, which affects patient outcome. Further studies with larger samples and other parameters that play a role in the hospital management of renal trauma patients are needed to reduce disability and mortality rates and improve survival.

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Declarations

Ethical approval and consent for participate: *This research adheres to the principles outlined in the Declaration of Helsinki and has received approval from the Dr. Saiful Anwar General Hospital Ethics Committee under protocol number 400/223/K.3/102.7/2024.*

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Correspondence

Besut Daryanto (Corresponding Author)
urobes.fk@ub.ac.id
Department of Urology, Faculty of Medicine Universitas Brawijaya,
Dr. Saiful Anwar General Hospital, Malang, Indonesia
Jaksa Agung Suprapto No. 2, Klojen, Malang, East Java, Indonesia 65111

Paksi Satyagraha
uropas.fk@ub.ac.id

Bagas Wilianto
bagaz.dr@gmail.com

Fauzan Kurniawan Dhani
fauzankurniawandhani@gmail.com

Department of Urology, Faculty of Medicine Universitas Brawijaya,
Dr. Saiful Anwar General Hospital, Malang, Indonesia