# Risk factors for injury acute renal in patients with severe trauma and its effect on mortality

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## ABSTRACT

The studies which associated acute kidney injury (AKI) and trauma emerged during the Second World War, and since then we have seen a progressive evolution of healthcare aiming at AKI prevention. However, establishing the risk factors for post-trauma AKI development remains crucial and may help reduce this complication. **Objective:** This study aims at identifying risk factors vis-à-vis the development of AKI in patients with severe trauma and its impact on mortality. This is a retrospective study of 75 patients with severe trauma. Six were taken off because they arrived at the hospital past the point of resuscitation. **Method:** The variables considered were age, gender, trauma severity according to the Injury Severity Score (ISS) and the Glasgow Coma Scale (GCS), trauma mechanism, mean blood pressure upon admission, fluid replacement in the first 24 hours , serum creatinine levels, use of nephrotoxic antibiotics, length of hospital stay, need for ICU admission and mortality. **Results:** The prevalence of AKI in severe trauma patients was 17.3%, and the factors associated with ARF in this sample were Head Injury and GCS < 10. Mortality, length of hospital stay and the need for ICU were significantly higher in patients who developed AKI. **Conclusions:** The identification of these risk factors is of paramount importance for the development of care strategies for patients suffering from severe trauma, for the prevention of acute kidney injury and the associated high mortality.

**Keywords:** acute kidney injury; mortality; traumatology.

## INTRODUCTION

Acute kidney injury (AKI) can be defined as the sudden loss of kidney function, potentially reversible regardless of etiology or mechanisms.[1-3] Recent criteria for AKI classification, such as AKIN and RIFLE, are currently considered as a reference standard for the evaluation of hospitalized patients.[4-7]

Patients who develop AKI have a high mortality rate, especially when requiring dialysis - with rates ranging from 37% to 88%.[1-3] Despite the advancement of new and continuous intensive care and dialysis methods, mortality remains high.[6,7]

Trauma is a leading cause of death in the first four decades of life, overwhelmed only by atherosclerosis and cancer as the leading cause of death in all age groups. Social costs are enormous, as well as the inherent suffering.[8]

The first studies reporting an association between AKI and acute trauma were published during the Second World War and since then there has been progressive technical and scientific development in patient care towards AKI prevention. However, establishing the risk factors for developing AKI after trauma remains crucial and may help reduce this complication, with prevention and earlier and more adequate treatment.

This study aims at identifying risk factors vis-à-vis the development of AKI in patients with severe trauma and its influence on mortality.

## METHODS

### SAMPLE

We retrospectively analyzed the medical records of 950 trauma patients admitted to the Trauma and Emergency Surgery ward at the Base Hospital in

São José do Rio Preto between July and August of 2004. Among them, 75 patients (7.9%) were included in the study because of severe trauma (ISS ≥ 16) (Table 1); six were taken off because they arrived at the hospital with no conditions for resuscitation.

**Table 1** Number of patients seen and trauma severity

| Trauma severity | N (%) |
|---|---|
| Mild (ISS < 16) | 875 (92.1%) |
| Severe (ISS ≥ 16) | 75 (7.9%) |
| Total | 950 |

The variables studied were age, gender, trauma severity according to the Injury Severity Score (ISS)[9] and the Glasgow Coma Scale (GCS), mechanism of injury, mean arterial pressure (MAP) on admission, fluid resuscitation, serum creatinine, use of nephrotoxic antibiotics, hospitalization duration and mortality.

Six patients were not under resuscitation conditions, and they were only pronounced dead, and taken off the study.

### Definitions

Trauma mechanisms were divided into traumatic brain injury (TBI), chest trauma (TTX), abdominal trauma (TAB) and musculoskeletal trauma (TME); and trauma patients with ISS greater than or equal to 16 and or GCS less than or equal to 10 were considered severe cases. Those patients with mean arterial pressure (MAP) less than or equal to 60 mmHg upon admission were considered hypotensive.

The volume replacement considered was the one made within the first 24 hours of the initial care and made with crystalloid solutions (ringer lactate or 0.9% saline). AKI was defined according to the AKIN criteria, considering an increase in serum creatinine greater than or equal to 0.3 mg/dl or oliguria defined as urine output less than 0.5 ml/kg per hour for six hours or more.[4,5]

Early AKI was defined as an increase in serum creatinine in the first three days of hospitalization. We considered nephrotoxic antibiotics, vancomycin and aminoglycosides used during hospitalization.

In this study, the patients were broken down into two groups for variable comparison purposes. The first group comprised the victims of severe trauma who developed AKI, and the second group had patients who did not develop this complication (S/AKI).

### Data analysis

The data was analyzed using the MINI-TAB, Statistical software version 12:22 - Minitab Inc. - Copyright 2000, by means of the following statistical tests: Kruskal-Wallis, Mood and binary logistic regression. Binary logistic regression was used to obtain an adjustment of the estimated odds ratio and find which risk factors were independently associated with AKI. We used a *p*-value below 0.05 as significant.

## Results

In the sample of 75 patients analyzed, 61 (81.3%) were males; with ages ranging between 17 and 66 years (median of 37 years). The ISS of these patients ranged between 16-75 (median 25). The GCS was between 3 and 15 (median 14). The most prevalent mechanism of injury was TME, corresponding to 24 patients (32%); followed by TCE with 23 occurrences (30.6%); TAB with 16 (21.3%) and TTX with 10 patients (13.3 %). Twenty-six patients (34.6%) had MAP below 60 mmHg on admission. Volume replacement in the first 24 hours ranged between 1,000-15,000 milliliters. Nineteen patients (25.3%) were given nephrotoxic drugs during their hospital stay. The mean hospital stay was 6 ± 9 days, and 15 patients (20%) required ICU care. There were 22 deaths (29.3%) (Table 2).

Thirteen patients (17.3%) developed AKI according to the definition. Among patients who had severe trauma, there was no significant difference between those who developed AKI and those who did not vis-à-vis age ($p = 0.448$), volume replacement ($p = 0.13$), admission SBP ($p = 0.796$) and use of nephrotoxic drugs ($p = 0.715$) (Table 3).

Patients who developed AKI had more severe trauma according to the ISS score ($p = 0.006$) and more severe neurological involvement according to the Glasgow Coma Scale ($p = 0.04$) (Table 3). Among patients with AKI, nine (69.2%) had the head injury as the primary mechanism of trauma ($p = 0.005$) (Table 3). Patients with AKI had an average hospital stay of 13 days ($p = 0.03$); there was greater need for ICU care ($p = 0.001$) among these. Eight patients died ($p = 0.001$). Dialysis was performed in only one

**Table 2** General traits of patients with severe trauma (ISS ≥ 16)

| General | | Mechanism | | Procedures | | Evolution | |
|---|---|---|---|---|---|---|---|
| Mean age (years) | 37 | TME | 24 (32.0%) | MAP (mmHg) | 80,5 | HS (days) | 6 |
| Females | 14 (18.7%) | TCE | 23 (30.6%) | Hidration (ml) | 2724 | ICU | 15 (20%) |
| Males | 61 (81.3%) | | | | | | |
| ISS | 25 | TAB | 16 (21.3%) | Nephrotoxic drugs | 19 (25.3%) | Death | 22 (29.3%) |
| GCS | 14 | TTX | 10 (13.3%) | | | | |

patient (7.6%), who developed oliguria according to the established criteria (Table 3). In the binary logistic regression model, the 1-point increase in the ISS represented 9% increase in the likelihood of kidney injury development, as it increases the risk of death by 7.5 fold.

**Table 3** Comparative analysis of the variables among patients with AKI and without AKI

| Variable | AKI | W/out AKI | *p* |
|---|---|---|---|
| Number of patients | 13 (17.3%) | 62 (82.6%) | - |
| Age (years) | 42 | 37 | 0.448 (NS) |
| MAP on admission (mmHg) | 63 | 67 | 0.796 (NS) |
| Volume replacement (ml) | 5250 | 2000 | 0.130 (NS) |
| Nephrotoxic drugs | 3 (15.7%) | 16 (84.2%) | 0.715 (NS) |
| ISS* | 30 | 25 | 6 |
| GCS* | 10 | 15 | 40 |
| TME | 4 (30.7%) | 20 (35.0%) | 0.767 (NS) |
| TCE | 9 (69.2%) | 14 (24.5%) | 5 |
| TAB | 4 (30.7%) | 12 (21.0%) | 0.755 (NS) |
| TTX | 5 (38.4%) | 5 (8.77%) | 0.798 (NS) |
| Hospital Stay (HS) (days) | 13 ± 20 | 3 ± 4 | 0.03 |
| ICU | 10 (76.9%) | 5 (8.0%) | 1 |
| Death | 8 (61.5%) | 9 (14.5%) | 1 |

* Median values; NS: Not significant.

## Discussion

In this study we analyzed the incidence of AKI and associated factors in victims of severe trauma. In retrospective studies of trauma patients, it is generally reported a low incidence of AKI (0.098 to 8.4%).[1,10,11] In our sample, this incidence was 17.3%, whereas the present study focused only in patients suffering from severe trauma (ISS ≥ 16), taking off the mild trauma cases. The definition used for AKI was more comprehensive than that used in other studies which included only patients who required dialysis and that defined AKI as an increase in baseline serum creatinine greater than 0.5 mg/dL, or an increase greater than 50 % of its basal level, or decrease in creatinine clearance greater than 50%, or renal dysfunction requiring dialysis.[1,6,11,12]

However, studies involving intensive care patients, presumably severe, reported an AKI incidence similar to that of patients with severe trauma of this study.[2]

In our analysis, age and gender were not considered factors associated with the development of AKI, although other studies indicate age as a predisposing factor for the development of this complication.[3] This observation is probably related to the fact that our sample is based only in patients suffering from severe trauma and, according to several studies, this is a happening that affects mainly young male adults.[8]

Current studies have shown that a reduction in renal perfusion has emerged as the most common cause of AKI, and hemoperitoneum, circulatory shock, and multiple fractures all able to induce hypovolemia, which can be elucidated by the drop in blood pressure and, consequently, kidney hypoperfusion. In our study, the MAP upon admission did not prove to be a predictive variable for the development of AKI, as this can not be considered the most reliable parameter of renal perfusion and there are other kidney-injury related known and unknown events.[13-15]

In a univariate analysis of this study, head injury was the main mechanism of trauma related to the development of AKI. Nonetheless, many studies show that the AKI is primarily attributable to the TME and rhabdomyolysis.[10,16,17] Studies have shown that traumatic brain injury can trigger a series of catabolic processes that result in decreased glomerular filtration and subsequent AKI.[12,18]

Furthermore, traumatic brain injury patients are exposed to a greater number of complications because they require greater ventilatory support and longer hospital stay.[1,2]

In the present study we noticed that severe trauma patients who developed AKI had higher volume replacement (5,200 ml) than those who did not (2,000 ml). The authors of a large study, showed that the increase in fluid administration in the first 24 hours in trauma patients has reduced the incidence of complications, including AKI.[1,13] However, some studies indicate that this treatment is not decisive for preventing the development of AKI in normovolemic patients.[10]

In this study, only one patient developed oliguria and was submitted to dialysis, and this patient had only one kidney, which was injured in the trauma, thus we cannot consider the effect of treatment in the AKI evolution; nevertheless studies which assessed this type of treatment reported no significant difference vis-à-vis mortality.[3]

The ISS analysis is directly proportional to the trauma severity. Several studies showed that the more compromised body segments by the trauma, the greater the likelihood of the patient developing kidney injury - because of hypovolemia, metabolic and inflammatory responses caused by the severe trauma.[3,14,19]

An important finding of this study was the association between AKI development and death.[20,21] In a univariate analysis we observed an increase of 7.5 fold in the risk of death in trauma patients who develop severe AKI, making it a significant predictive value of mortality ($p$ = 0.001), as observed in the analysis of studies of patients in the ICU, which have high AKI-related mortality.[1,2,20]

## Conclusions

The prevalence of AKI in severe trauma was significant (17.3%), and the factors associated with AKI in this sample were TBI, GCS < 10, ISS > 16. Mortality, length of hospital stay and the need for ICU care were significantly higher in patients who developed AKI.

Thus, we can state that the identification of these risk factors is of paramount importance for designing new care strategies for patients suffering from severe trauma, aiming at the prevention of acute renal failure and its associated high mortality rate.

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