

## ORIGINAL RESEARCH

# Epidemiology and Outcome of Patients with Acute Kidney Injury in Emergency Department; a Cross-Sectional Study

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**Abstract:** **Introduction:** Elimination of preventable deaths due to acute kidney injury (AKI) in low-income countries by 2025 is an important healthcare goal at the international level. The present study was designed with the aim of evaluating the prevalence and outcome of AKI in patients presenting to emergency department. **Methods:** The present cross-sectional, retrospective study was performed on patients that presented to the emergency departments of 3 major teaching hospitals, Tehran, Iran, between 2005 and 2015 and were diagnosed with AKI. Patient selection was done using consecutive sampling and required data for this study was extracted by referring to the medical profiles of the patients and filling out a checklist designed for the study. **Results:** 770 AKI patients with the mean age of  $62.72 \pm 19.79$  (1 – 99) years were evaluation (59.1% male). 690 (89.61%) cases of AKI causes were pre-renal or renal. Among the pre-renal causes, 74 (73.3%) cases were due to different types of shock ( $p < 0.001$ ). The most common etiologic causes of AKI in pre-renal group were hypotension (57.3%) and renal vascular insufficiency (31.6%). In addition, regarding the renal types, rhabdomyolysis (35.0%), medication (17.5%) and chemotherapy (15.3%) and in post-renal types, kidney stone (34.5%) were the most common etiologic causes. 327 (42.5%) patients needed dialysis and 169 (21.9%) patients died. Sex ( $p = 0.001$ ), age over 60 years ( $p = 0.001$ ), blood urea nitrogen level ( $p < 0.001$ ), hyperkalemia ( $p < 0.001$ ), metabolic acidosis ( $p < 0.001$ ), cause of failure ( $p = 0.001$ ), and type of failure ( $p = 0.009$ ) were independent risk factors of mortality. **Conclusion:** The total prevalence of AKI in emergency department was 315 for each 1000000 population and preventable mortality rate due to AKI was estimated to be 28.2 cases in each 1000000 population. The most important preventable AKI causes in the pre-renal group included shock, sepsis, and dehydration; in the renal group they included rhabdomyolysis and intoxication; and stones in the post-renal group.

**Keywords:** Acute kidney injury; outcome assessment (health care); prevalence; epidemiology; renal insufficiency

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## 1. Introduction

Acute kidney injury (AKI), which was called acute renal failure in the past, is defined as sudden failure and inefficiency of the kidney (1). This disease is one of the most important causes of mortality in hospitalized patients and with aging of the population and based on new definitions, the number of those affected with it has increased (2-5). Annual prevalence of patients with AKI in need of one of the replacement methods has been reported to be about 200

to 300 cases in 1 million population (6, 7). The causes of AKI are different based on various geographical regions and there is a significant difference in its prevalence between developing and developed countries (8). Most affected population is 60 – 79 year old men and common comorbidities in this group of patients include surgery, diabetes, pneumonia, cardiac failure, stroke, and history of chronic kidney disease (9). Currently, the universal policy and the International Society of Nephrology (ISN) policy are concentrated on elimination of preventable deaths due to AKI in low-income countries by 2025 (10).

For effective planning regarding reduction of preventable mortalities resulting from AKI there is a need for sufficient data regarding the epidemiologic pattern of this disease in each country. Various reports have been published in this

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regard until now but most studies have been restricted to cases after surgery or in the intensive care unit (ICU) and have somehow covered the AKI cases initiated in the hospital (11, 12). Therefore, the present study was done with the aim of evaluating the prevalence and outcome of AKI in patients presenting to emergency department as a sample of community acquired cases.

## 2. Methods

### 2.1. Study design and setting

The present cross-sectional retrospective study was performed on patients that presented to the emergency departments of teaching hospitals of Shahid Beheshti University of Medical Sciences (Imam Hossein, Loghmane Hakim and Shohadaye Tajrish), Tehran, Iran, between 2005 and 2015 and were diagnosed with AKI. These 3 hospitals are major hospitals and referral centers and bear the treatment burden of about one third of the patients in Tehran and its suburbs with a population of about 14 million people. Protocol of the study was approved by the ethics committee of Shahid Beheshti University of Medical Sciences and the researchers adhered to confidentiality of patients' data and the recommendations in the declaration of Helsinki throughout the study.

### 2.2. Participants

All the patients who were hospitalized in the emergency departments of the mentioned hospitals during the studied years were evaluated via consecutive sampling. Patients who had kidney transplants or were under treatment with one of the renal replacement therapy (RRT) methods including blood or peritoneal dialysis were excluded from the study. In addition, patients with a missing data regarding the confirmed diagnosis or the etiologic causes of AKI were also excluded from the study. No age or sex limitations were considered for the present study.

### 2.3. Data gathering

Data required for the present study was gathered by referring to the medical profiles of the patients and by filling out a checklist designed for the study. For this purpose, by referring to the medical document registry center of the mentioned hospitals, the list of patients who had been hospitalized via the emergency department with diagnosis of AKI alone or along with other diagnoses were extracted. Then, using the identification number of each patient, their clinical profile was extracted from the archive and a trained senior emergency medicine resident studied the profile and extracted the data by consulting an emergency medicine specialist.

The checklist used in the present study included demo-

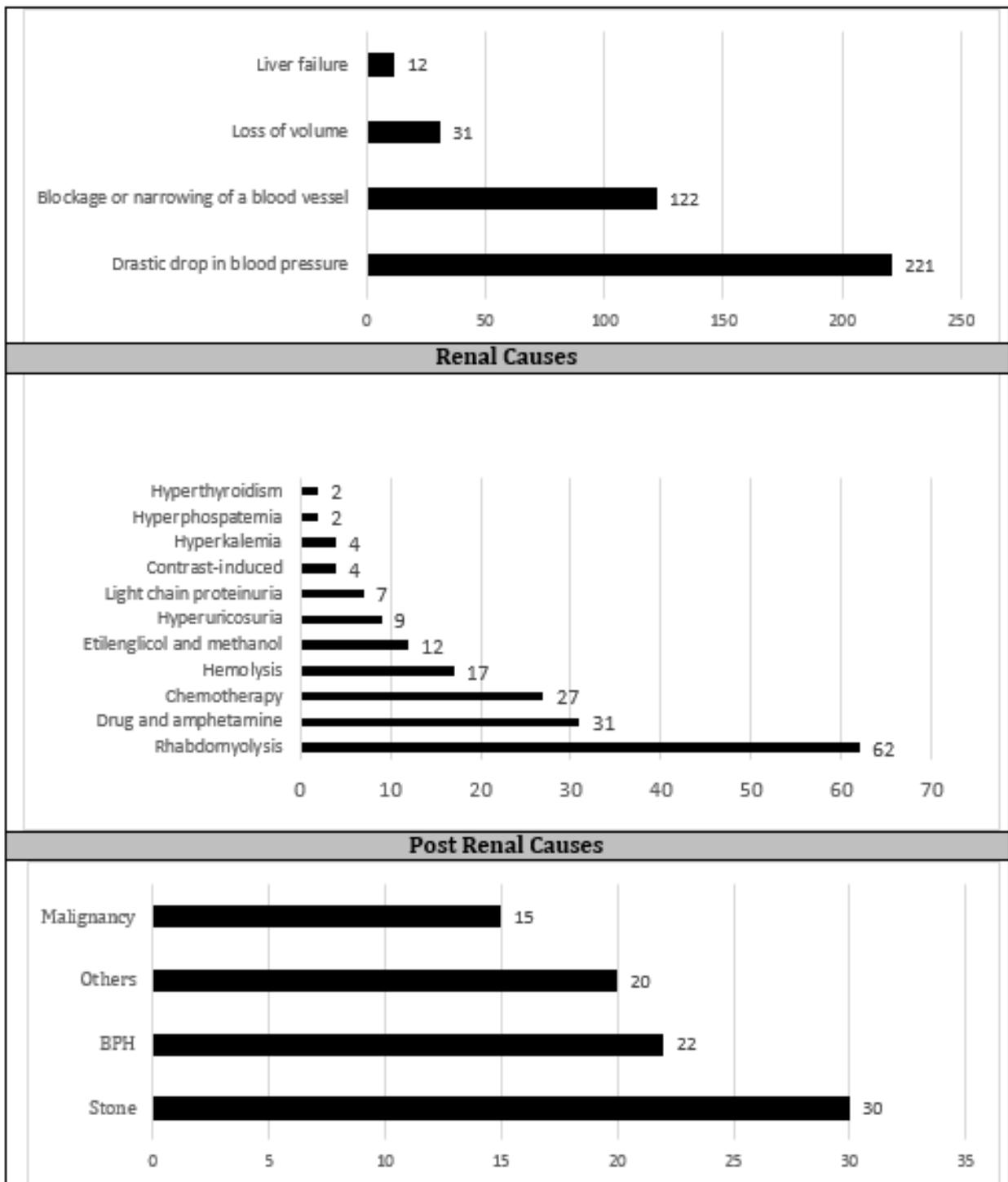
**Table 1:** Baseline characteristics of the studied patients

Variable	Frequency (%)
<b>Sex</b>	
Male	455 (59.1)
Female	315 (40.9)
<b>Age (year)</b>	
1 – 19.9	17 (2.2)
20 – 39.9	100 (13.0)
40 – 59.9	176 (22.9)
≤ 60	47 (61.9)
<b>Underlying illness</b>	
Hypertension	352 (45.7)
Diabetes	126 (16.4)
Cardiovascular disease	51 (6.6)
Malignancy	44 (5.7)
Other	197 (25.6)
<b>Cause of failure</b>	
Pre-renal	386 (40.1)
Renal	304 (39.5)
Post-renal	87 (11.3)
<b>Type of failure</b>	
Acute	640 (83.1)
Acute on top of chronic	130 (16.9)

graphic data (age, sex), underlying illnesses, laboratory findings (urea, creatinine, blood urea nitrogen, potassium, blood gas analyses, urinalysis), ultrasonography findings, causes of failure (pre-renal, renal, post renal), type of failure (acute, acute on chronic), etiologic cause of the failure, and the final outcome of the patients (mortality, need for dialysis). Diagnosis of AKI and its cause was made by a nephrologist in charge of the patient at the time of hospitalization and by considering the existing standard definitions. Etiologic causes that led to AKI via deficiencies in blood flow to the kidney (shock, vascular deficiencies, dehydration and ...) were classified in the pre-renal group, causes that acted via injury to the renal tissue (radio-contrast agents, medications, rhabdomyolysis and ...) were in the renal group and finally, causes that resulted in AKI via creating an obstacle to evacuation of urine (stone, tumor, ...) were placed in the post-renal group.

### 2.4. Statistical Analysis

Samples were gathered via census sampling. All analyses were done using SPSS 21.0 statistical software. To describe data, frequency and percentage or mean  $\pm$  standard deviation were used. For comparisons, chi square, or Fisher's exact statistical tests as well as student t-test were used. For multivariate analysis, logistic regression analysis was applied. In all comparisons, p less than 0.05 was considered as level of significance.



**Figure 1:** Frequency of acute kidney injury etiology based on pre-renal, renal, and post-renal causes. BPH: benign prostatic hyperplasia.

### 3. Results

#### 3.1. Baseline characteristics

770 AKI patients with the mean age of  $62.72 \pm 19.79$  (1 – 99) years were studied (59.1% male). Table 1 depicts the base-

line characteristics of the studied patients. 477 (61.9%) patients were in the age group of  $\geq 60$  years and hypertension was their most common underlying disease (45.7%). Considering the presentation of about 2,444,000 individuals to the



emergency departments of the studied hospitals during the mentioned period, prevalence of AKI was estimated as 315 in 1000000 population.

### 3.2. Laboratory data

Mean blood urea nitrogen and creatinine of the patients were  $81.57 \pm 57.75$  (20 – 590) mg/dl and  $3.50 \pm 2.20$  (1.5 – 20.1) mg/dl, respectively. Hyperkalemia was reported in 106 (13.8%) and metabolic acidosis in 233 (30.3%) patients. The results of urinalysis was available for 520 patients, which indicated 14 (1.8%) cases of > 50 red blood cells, 40 (5.2%) blood positive cases, 29 (3.8%) cases of high white blood cells, 59 (7.7%) protein positive cases, 27 (3.5%) cast positive cases, 40 (5.2%) ketone positive cases, and 23 (3.0%) bacteria positive cases.

### 3.3. Ultrasonography findings

Kidney ultrasonography findings were available for 664 of the studied patients. Regarding the size of the kidney, 472 (70.9%) cases were normal, 110 (16.5%) were atrophic, and 84 (12.6%) cases of hydronephrosis were reported. Other ultrasonography findings consisted of 60 (9.0%) cases of simple cysts, 41 (6.2%) cases of stone, and 28 (4.2%) calcification.

### 3.4. Etiologic causes

690 (89.61%) cases of AKI were pre-renal or renal (table 1). Figure 1 shows the frequency of etiologic causes of AKI based on types of pre-renal, renal, and post-renal. Among the pre-renal causes, 74 (73.3%) cases were due to different types of shock ( $p < 0.001$ ). the most common etiologic causes of AKI in pre-renal group were hypotension (57.3%) and failure of renal vessels (31.6%). In addition, regarding the renal types, rhabdomyolysis (35.0%), medication (17.5%) and chemotherapy (15.3%) and in post-renal types, kidney stone (34.5%) were the most common etiologic causes.

### 3.5. Patient outcome

In the end, 327 (42.5%) patients needed dialysis 167 (51.2%) of which underwent dialysis once, 79 (24.2%) twice, 44 (13.5%) 3 times, and 36 (11.1%) underwent dialysis 4 times or more.

169 (21.9%) patients died, in 69 (8.9%) cases the cause of death was diagnosed due to AKI. In other words, by preventing AKI, 8.9% of mortalities were preventable.

### 3.6. Factors related to mortality

Table 2 has evaluated the correlation of various factors with mortality. The rate of mortality in patients significantly correlated with sex ( $p = 0.001$ ), age over 60 years ( $p = 0.027$ ), hyperkalemia ( $p < 0.001$ ), metabolic acidosis ( $p < 0.001$ ), the cause of failure ( $p < 0.001$ ), need for dialysis ( $p = 0.031$ ), and type of failure ( $p = 0.014$ ). Dead patients had significantly higher

serum creatinine levels ( $4.14 \pm 2.60$  vs.  $3.32 \pm 2.03$  mg/dl;  $p < 0.001$ ) and blood urea nitrogen ( $99.56 \pm 74.30$  vs.  $76.51 \pm 51.11$  mg/dl;  $p < 0.001$ ).

The results of multivariate analysis was indicative of the significant and independent correlation of sex ( $p = 0.001$ ), age over 60 years ( $p = 0.001$ ), blood urea nitrogen level ( $p < 0.001$ ), hyperkalemia ( $p < 0.001$ ), metabolic acidosis ( $p < 0.001$ ), cause of failure ( $p = 0.001$ ), and finally, type of failure ( $p = 0.009$ ) with mortality.

## 4. Discussion

Based on the findings of the present study, the total prevalence of AKI in patients presenting to the emergency departments of the evaluated hospitals was 315 for each 1000000 population and preventable mortality rate due to AKI was estimated to be 28.2 cases in each 1000000 population. The most important preventable AKI cases in the pre-renal group included shock, sepsis, and dehydration; in the renal group they included rhabdomyolysis and intoxication; and stones in the post-renal group.

Hoste et al. in a study in 2006 emphasized that even little changes in renal functionality of the hospitalized patients can have adverse effects on their final outcome (13). The results of studies show that patients with AKI who need dialysis are in higher risk for chronic kidney failure and permanent need for dialysis (14, 15).

The prevalence of AKI is widely different among various studies and from 1811 to 3000 individuals in 1 million has been reported among hospitalized patients (2, 16). Of course, this rate has been reported much higher in critically ill patients. The results of the study by Hoste et al. are indicative of 67.2% prevalence of AKI in critically ill patients hospitalized in ICU (17). Additionally, Ralib et al. in addition to confirming the findings of the mentioned study showed that 60% of AKI cases in critically ill patients happen in the initial 48 hours of their hospitalization in ICU (18). The results of a study in Iran was indicative of the exceptionally high prevalence of 49.1% of AKI and 2.7% mortality due to it following open heart surgery (19).

The reason for the low prevalence found in this study might be the research environment. Because emergency department patients can be considered as a sample of community acquired AKI cases and not imposed by hospitalization and etc. Therefore, considering this point, the low prevalence obtained can be explained. Based on the results of the present study, more than 80% of AKI cases had happened in individuals over 50 years of age, which is in line with the findings of previous studies in this regard (2, 3). In the present study, hypertension and diabetes were the most common comorbidities of AKI (62.1%).

In addition, pre-renal types with 40.1% prevalence were the



**Table 2:** Correlation of different factors with mortality

Variable	Dead	Alive	P value
<b>Sex</b>			
Male	119 (26.2)	336 (73.8)	<0.001
Female	50 (15.8)	265 (84.2)	
<b>Age</b>			
< 60	52 (17.7)	241 (82.3)	0.027
≤ 60	117 (24.5)	360 (75.5)	
<b>Ultrasonographic size of kidney</b>			
Normal	98 (20.8)	374 (79.2)	0.051
Atrophic	23 (20.9)	87 (79.1)	
hypertrophic	8 (9.5)	76 (90.5)	
<b>Hyperkalemia</b>			
Yes	43 (40.6)	63 (59.4)	< 0.001
No	126 (19.0)	538 (81.0)	
<b>Metabolic acidosis</b>			
Yes	82 (35.2)	151 (64.8)	< 0.001
No	87 (16.2)	450 (83.8)	
<b>Cause of failure</b>			
Pre-renal	99 (26.1)	280 (73.9)	< 0.001
Renal	68 (22.4)	236 (77.6)	
Post-renal	2 (2.3)	85 (97.7)	
<b>Type of failure</b>			
Acute	151 (23.6)	489 (76.4)	0.014
Acute on top of chronic	18 (13.8)	112 (86.2)	
<b>Need for dialysis</b>			
Yes	84 (25.7)	243 (74.3)	0.031
No	85 (19.2)	387 (80.8)	
<b>Number of dialysis sessions</b>			
< 3 times	62 (25.2)	184 (74.8)	0.852
≥ 3 times	21 (26.2)	59 (73.8)	

most frequent and the most common cause of them was reported as various types of shock. Chertow et al. epidemiologically evaluated patients with AKI and introduced decreased blood flow to the kidney, major surgeries, and injection of radio-contrast as important factors related to different types of pre-renal failures (20).

Although many studies have been done on the epidemiology of AKI in different places all over the world, due to the differences present in the definitions of AKI as well as different environments we have seen dissimilar reports regarding the prevalence and outcome of these patients. Additionally, the etiologic causes of AKI vary in different countries. For these reasons, it seems that different countries should do their own studies on the burden of this disease in their country to be able to act towards preventing the disease by identifying the causes. Based on the results of this study and as might have been predicted before, the pre-renal and renal causes were at the top of the causes of failure. Modification of lifestyle and reducing the burden of non-communicable chronic diseases such as hypertension, diabetes, dyslipidemia and ... can result in reduction in the prevalence of a major part of pre-renal cases by decreasing the prevalence of vascular diseases. In addition, with aging of the population and increase in preva-

lence of diseases such as sepsis in these ages, more attention should be paid regarding dehydration and prevention of septic shock occurrence in these patients. More care should be taken regarding the use of nephrotoxic agents such as radio-contrasts as well as traumatic rhabdomyolysis, which is very important due to Iran being affected with many natural disasters and traffic accidents (21-25).

It seems that by performing a multi-center study around Iran and identifying preventable causes of AKI and increasing public awareness in this regard, we can take a big step towards improving public health and decreasing the burden of AKI.

## 5. Limitation

Missing data in some profiles and not being able to contact patients for follow-up of treatment process as well as limited sample size are among the limitations of this study. Definition of AKI and its causes were recorded based on the opinion of the nephrologist in charge of the patient and therefore, this can impair the results to some extent.



## 6. Conclusion

Based on the findings of the present study, the total prevalence of AKI in patients presenting to the emergency departments of the evaluated hospitals was 315 for each 1000000 population and preventable mortality rate due to AKI was estimated to be 28.2 cases in each 1000000 population. In addition, the most important preventable AKI cases in the pre-renal group included shock, sepsis, and dehydration; in the renal group they included rhabdomyolysis and intoxication; and stones in the post-renal group.

## 7. Appendix

### 7.1. Acknowledgements

The present article is derived from Dr. Meysam Heydari's thesis for receiving his specialist degree in emergency medicine, performed under supervision of Dr. Saeed Safari.

### 7.2. Author contribution

All the authors met the 4 criteria recommended by the international committee of medical journal editors for gaining authorship.

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None.

### 7.4. Conflict of interest

None.

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