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(CASE STUDY)

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Incidence and risk factors of acute kidney injury in ICU patients at Rasoul Akram hospital: Implications for mortality and outcomes

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Abstract

Background: Acute Kidney Injury (AKI) is a common complication in patients admitted to Intensive Care Units (ICUs), which can lead to increased length of stay, treatment costs, and patient mortality. Specific preventive and therapeutic methods, such as appropriate fluid therapy and reducing the use of nephrotoxic drugs, can help alleviate acute kidney injury. This study aims to investigate the incidence of acute kidney injury in ICU-admitted patients.

Methods and Material: This is a cross-sectional study conducted in the ICU of Rasoul Akram Hospital. Patients admitted to this unit were enrolled in the study after obtaining informed consent. Exclusion criteria included the presence of known kidney disease at admission (such as a history of dialysis, hematuria, kidney failure, etc.) and oliguria or creatinine levels above 1.5. Upon entering the study, a checklist was prepared for each patient, including demographic variables (age, gender, body mass index) and relevant medical history (history of kidney disease, hypertension, diabetes), as well as laboratory tests for kidney function.

Results: The collected data were analyzed to determine the incidence of acute kidney injury in these patients and to examine its association with demographic and clinical variables. The average age of the 100 participating patients was 65.8 years ± 13.8. Of these, 79% were discharged, and 21% died. The most common reasons for hospitalization included sepsis and decreased consciousness levels. Additionally, 50% of the patients had hypertension, and 40% were diabetic. In-hospital mortality was significantly higher in patients with AKI (p=0.002). The incidence of a history of colicky pain and underlying conditions such as diabetes and hypertension was also considerably higher in patients with AKI. However, no significant difference was observed in the incidence of organ failure. In the group with a history of diabetes, the incidence of AKI was 50%, while in patients without a history of diabetes, this rate was lower at 25%.

Conclusion: The study highlighted a high incidence of AKI in the ICU of Rasoul Akram Hospital (35%) and the increased mortality rate in these patients. Therefore, prevention, rapid diagnosis, and treatment methods for acute kidney injury are crucial. Identifying risk factors and implementing appropriate strategies can help reduce complications and improve clinical outcomes in patients hospitalized in the ICU.

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Keywords: Acute Kidney Injury; Intensive Care Unit; Mortality rate; Glomerular Filtration Rate

1. Introduction

Acute Kidney Injury (AKI) is a syndrome that can lead to a sudden decline in kidney function, occurring over hours or days, resulting in the accumulation of nitrogenous waste products (BUN) and disturbances in extracellular fluid volume and electrolyte, acid, and base balance in the body. This condition is determined based on serum creatinine measurements used to estimate the Glomerular Filtration Rate (GFR) (1).

Acute Kidney Injury may arise from various factors, including diseases that reduce renal blood flow (prerenal azotemia), diseases that directly affect the renal parenchyma (renal azotemia), and conditions associated with urinary flow obstruction (postrenal azotemia) (2). Acute kidney failure is associated with symptoms and signs such as decreased urine output, shortness of breath, fatigue, weakness, malaise, nausea, and confusion. In some cases, acute kidney failure may occur without any symptoms and can only be identified through diagnostic tests (1, 3).

The incidence of Acute Kidney Injury (AKI) is not well understood globally. AKI is more common in hospitalized patients, especially those with acute illnesses requiring intensive care. Various studies show variability in the incidence of AKI among intensive care unit patients. Two major factors contributing to these variations are the baseline characteristics of patients and the definitions used for AKI (4). AKI affects up to 30% of patients admitted to intensive care units. According to another study, AKI affects 25 to 50 percent of patients in intensive care, leading to an increase in mortality rates ranging from 15 to 60 percent, as well as increased treatment costs and length of hospital stay (5, 6).

In a study conducted by Uchino and colleagues on patients admitted to intensive care units in several countries, it was shown that out of 29,269 patients admitted to the ICU, 1,738 (5.7%) developed Acute Kidney Injury (AKI) (7). The primary cause of this condition was septic shock. The average age of those affected by AKI was 67 years. The reasons for ICU admission were primarily medical (58.9%), while 41.1% were related to surgical causes (7). The significance of factors influencing AKI varies based on underlying pathology and patient characteristics. Various risk factors for the development of AKI have been analyzed in different studies, including gastrointestinal bleeding, infections, shock, use of contrast agents, and drug toxicity (8-11).

Considering that AKI is a risk factor for increased mortality in critically ill patients, especially those admitted to intensive care units, this study aimed to investigate the incidence of AKI following admission to the ICU at Rasoul Akram Hospital in Tehran.

2. Materials and Methods

The present study is a cross-sectional study conducted in the intensive care unit of Rasoul Akram Hospital. Patients admitted to this unit were included in the study after obtaining informed consent. Exclusion criteria included known kidney disease at the time of admission (history of dialysis, hematuria, kidney failure, etc.), oliguria, and creatinine levels greater than 1.5.

Upon entering the study, a pre-prepared checklist was completed for each patient, which included demographic variables such as age, gender, body mass index, history of kidney disease, hypertension, and diabetes. Additionally, laboratory tests for kidney function were conducted.

To calculate the sample size, the formula for estimating a proportion and the formula for sample size calculation in analytical cross-sectional studies were used. Based on data obtained from previous studies, the total sample size was determined to be 70 individuals, considering a prevalence of kidney injury of 80% and a confidence interval of 0.08, resulting in a final sample size of 100 individuals.

Statistical analysis was conducted using SPSS version 20. Descriptive statistics included measures of central tendency such as mean, frequency percentage, and median, as well as measures of dispersion such as standard deviation (SD) and interquartile range (IQR). The t-test and chi-square test were employed for data analysis. The severity of changes was reported using mean differences and risk ratios. A significance level of less than 0.05 was considered for all tests.

3. Results

In this study, 100 patients admitted to the ICU were included. Of these, 55 were male (55%) and 45 were female (45%). The mean age of the patients was 65.8 ± 13.8 years (the age of patients ranged from 44 to 93 years). Other quantitative variables of the study are presented in Table 1.

Table 1 Quantitative Variables of the Study Participants

Variable	Minimum (Days)	Maximum (Days)	Mean	SD
Age	44	93	65.8	13.8
Admission time	4	20	11.7	3.6
GCS	5	15	10.1	2.4
T	36.5	38.9	37.49	0.67
HR	58	118	90.15	15.4
RR	11	90	24.3	16.6
BP systolic	90.0	170.0	124.1	22.5
BP diastolic	45.0	90.0	69.7	14.3
MAP	63.3	114.0	87.8	16.2
PaO2	25.80	236.00	75.2	52.2
PH	7.11	7.51	7.35	0.09
HCO3	12.40	32.00	21.08	4.28
Na	120	148	138.2	6.5
K	3.0	5.1	4.24	0.5
BUN	20	165	48.2	34.4
Cr (base)	0.6	1.5	1.17	0.24
Cr (end)	0.7	4.2	1.5	0.87
WBC	1100	37000	13600	7714.4
Hb	6.7	14.2	11.36	1.8
Hct	22.7	92.4	38.5	13.6
PLT	41000	412000	210000	108736.4
AST	6	75	28.9	17
ALT	8	87	24.5	21.2
APACHE2 score	2	34	16.4	8.58

The reasons for admission to the ICU are shown in Table 2.

Table 2 Reasons for admission of the studied individuals to the ICU

Variable	Percent
CVA	5
Toxicity	3
Loss of consciousness	20

GI Bleeding	9
Pneumonia	12
Sepsis	24
Septic shock	4
Aspiration pneumonia	10
Hepatic encephalopathy	2
Trauma	11

79% of the patients were discharged, and 21% died. The table shows the incidence of colicky pain, history of underlying diseases, occurrence of acute kidney injury (AKI) during hospitalization, and severe organ failure. According to the statistics in the table, 35% of the patients admitted to the ICU experienced AKI.

Table 3 Incidence of colicky pain, history of underlying diseases, occurrence of acute kidney failure during hospitalization, and severe organ failure

Variable	**Incidence**
Colic pain	25%
Diabetes	40%
Hypertension	50%
Organ failure	10%
Acute kidney injury	35%

In Table 4, gender, mortality, colicky pain, underlying diseases, and organ failure were compared between the two groups with and without AKI. It was found that in-hospital mortality was significantly higher in patients who developed AKI (p=0.002). The incidence of a history of colicky pain and underlying diseases such as diabetes and hypertension was also reported to be significantly higher in AKI patients. However, no significant difference was observed in the incidence of organ failure.

Table 4 Comparison of gender, mortality, colicky pain, underlying diseases, and organ failure in two groups with and without AKI

Variable	**AKI+ (n=35)**	**AKI- (n=65)**	**P value**
Male sex	20 (57.1%)	35 (53.8%)	0.7
death	15 (42.9%)	10 (16.7%)	0.002
Colic pain	20 (57.1%)	5 (7.7%)	<0.0001
Diabetes	20 (57.1%)	20 (30.8%)	0.01
Hypertension	30 (85.7%)	20 (30.8%)	<0.0001
Organ failure	5 (14.3%)	5 (7.7%)	0.2
age	79.4 ±11.6	58.5 ±8.5	<0.0001
Duration of admission	11.7 ±4.1	11.5 ±2.6	0.9
WBC	13000±11600	14000±5111	0.78
HB	10.1 ±1.3	12 ±1.8	0.029
Plt	140000±49142	247000±114948	0.03
Na	140.5 ±2.3	136.9 ±7.7	0.13

K	4.6 ±0.3	4 ±0.5	0.02
BUN	68.57 ±49.8	37.2 ±16.2	0.15
Cr (base)	1.24±0.3	1.14 ±0.2	0.37
GFR	56.9 ±32.8	61.4 ±19.5	0.7
GCS	9.4 ±2.5	10.4 ±2.47	0.38
APACHE II score	24 ±5	12.3 ±7.2	0.001
AST	40.3 ±19	22.1 ±11.8	0.03
ALT	18.5 ±8.5	28.2 ±25	0.3

The occurrence of acute kidney injury (AKI) is shown in Table 5, categorized by age group, gender, diabetes prevalence, and reason for hospitalization. Among individuals with a history of diabetes, the incidence of AKI was 50%, whereas it was lower (25%) in patients without a history of diabetes.

Table 5 Incidence of acute kidney injury by age group, gender, incidence of diabetes, and cause of hospitalization

Variable	**Type**	**AKI (n)**
Age group	40-49y	0
	50-59y	0
	60-69y	10
	70-79y	5
	80-89y	10
	90-99	10
Gender	Male	15 (33.3%)
	female	20 (36.4%)
Diabetes	DM+	20 (50%)
	DM-	15 (25%)
Cause	CVA	0
	Toxicity (opium overdose)	0
	Loss of consciousness	5 (25%)
	GI.Bleeding	5 (55.5%)
	Pneumonia	5 (41.6%)
	Sepsis	10 (41.6%)
	Septic shock	0
	Aspiration pneumonia	10 (100%)
	Hepatic encephalopathy	0
	Trauma	0

4. Discussion

This study aimed to investigate the incidence of acute kidney injury (AKI) following hospitalization in the intensive care unit (ICU). The results showed that the average age of the 100 participating patients was 65.8 ± 13.8 years. Seventy-nine percent of the patients were discharged, while 21% died. The most common reasons for hospitalization were sepsis and decreased level of consciousness. Fifty percent of the patients had hypertension, and 40% were diabetic. The in-

hospital mortality rate in patients who experienced AKI was significantly higher (p = 0.002). The incidence of colicky pain and underlying conditions such as diabetes and hypertension was also reported to be considerably higher in AKI patients. However, no significant difference was observed in the occurrence of organ failure. In the group with a history of diabetes, the incidence of AKI was 50%, whereas it was lower (25%) in patients without a history of diabetes.

In this study, it was observed that the incidence of acute kidney injury (AKI) reached 35%, which is reported to be higher compared to similar studies. This discrepancy may be due to differences in populations and risk factors such as age, reasons for ICU admission, underlying diseases, or varying criteria for defining AKI in different studies. In this study, AKI was defined based on a rapid increase (within 48 hours) in serum creatinine concentration by ≥ 0.3 mg/dl compared to baseline creatinine. The study by Şimşek also reported that 31.06% of patients experienced AKI during their hospitalization using a similar definition for AKI. This statistic is almost consistent with our results.

In the study by Uchino et al., among 29,269 patients hospitalized in the ICU, 1,738 (5.7%) experienced acute kidney failure during their stay. The occurrence of AKI was studied in 120,123 ICU patients in Australia from 2000 to 2005, where AKI was reported in 36.1% of patients. The study by Hoste et al. also showed that AKI occurred in two-thirds of ICU patients, while only 22% had AKI according to the RIFLE criteria. The study by Ali Tariq et al. examined the incidence of AKI in a population from northern Scotland, with a population size of 390,523, reporting an incidence of 2,147 cases of AKI per one million population. The incidence of AKI varied from 16% in the cardiac surgery ICU population to 35.8% in mixed ICUs (various patients).

This wide range of AKI incidence indicates how much the occurrence of this condition depends on the baseline characteristics of the studied patients. The present study was conducted in a medical ICU where internal medicine patients were hospitalized. The causes of hospitalization among patients, in order of prevalence, included sepsis (24%), decreased level of consciousness (20%), pneumonia (12%), trauma (11%), aspiration pneumonia (10%), gastrointestinal bleeding (9%), ischemic brain disease (5%), septic shock (4%), poisoning (3%), and hepatic encephalopathy (2%). Therefore, an important factor contributing to the difference in AKI incidence in our study was the patient population in the ICU.

In this study, 21% of patients hospitalized in the ICU died. The mortality rate in AKI patients was significantly higher (42.9% vs. 16.7%, p: 0.002). The study by Samimagham et al. also showed that the mortality rate for AKI patients (72.6%) was higher compared to patients without AKI (25.9%) (15-17). Other studies have also indicated that AKI is associated with increased hospital mortality (12-14).

Therefore, acute kidney injury in ICU patients is one of the main causes of morbidity and mortality, and strict monitoring of kidney function should be implemented in this patient group (5, 18). The mean age of AKI patients in our study was significantly higher (79.4 vs. 58.5, p<0.0001), which aligns with the results of the study by Samimagham et al. (17). With increasing age, renal reserve, and function decline, and comorbidities increase. Thus, older patients are at greater risk for the progression of AKI (19, 20).

The mean APACHE II score in AKI patients was significantly higher (24 vs. 12.3, p=0.001), which is consistent with the findings of Samimagham et al. (17,21). They also demonstrated that the average APACHE II score and the related mortality risk within the first 24 hours are independent risk factors for AKI.

Limitations of our study include the small sample size and the specific population studied, which was collected from a medical ICU. Additionally, incomplete information in patient records and inconsistent documentation of vital signs by different personnel were also limitations of the present study.

5. Conclusion

Given the high incidence of AKI in the ICU at Rasoul Akram Hospital (35%) and the increased mortality rate in these patients, it is essential to utilize prevention methods, ensure timely diagnosis, and provide rapid treatment for AKI.

Compliance with ethical standards

Disclosure of conflict of interest

The authors have declared that no competing interests exist.

Statement of ethical approval

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

Statement of informed consent

As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

Disclaimer (artificial intelligence)

The authors hereby declare that generative AI technologies were used for large language editing of manuscripts.

- Name: ChatGPT
- Version: 4
- Model: GPT-4
- Source: OpenAI

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