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Research Article

Epidemiology of acute kidney injury in surgical intensive care at University Hospital in Egypt. A prospective observational study

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KEYWORDS

Acute kidney injury;
Incidence;
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Abstract *Introduction:* The acute kidney injury (AKI) incidence in ICU patients varies widely from 3% to 30%, with mortality ranging from 36% to 90%, depending on the type of ICU, study population, the period during which the study is conducted, and the criteria used to define AKI. There have been many studies about the epidemiology and risk factors of AKI in critically ill patients in the different regions of the world. However, little data on the epidemiology of AKI in critically ill patients are available in Egypt.

Objectives: The aim of this study was to assess the incidence of AKI among critical ill patients using RIFEL [risk (R), injury (I), failure (F), loss (L), and end-stage kidney disease (E)] classification and to determine the risk factors and outcome of patients who developed AKI in our surgical ICU.

Methods: We conducted a 6-month prospective observational study in the surgical ICU. Patients were classified daily using the RIFLE criteria. Patients were considered as having new AKI if they did not have AKI on ICU admission and subsequently reached at least class risk during their follow-up. Deterioration of AKI was diagnosed if the patient had increased in RIFLE class compared to the initial classification.

Results: One hundred and twelve patients were studied. AKI occurred in 40 (35.7%) of patients. The most common risk factors for AKI are APACHE II score (acute physiology and chronic health evaluation score, version II.) and sepsis. APACHEII was lower in non-AKI group than AKI group

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(17.3 ± 7.5 versus 22.4 ± 7.4, $p = 0.001$), and sepsis was more common in AKI patients than non-AKI patients (77.5% versus 49% $p = 0.004$). Patients with AKI had a mortality rate of 67.5% which was more in patients with failure compared with risk patients. APACHEII, AKI, and needs for mechanical ventilation were independent risks for mortality.

1. Introduction

Acute kidney injury (AKI) is a complex disorder that occurs in a variety of settings, with clinical manifestations ranging from a minimal elevation in serum creatinine to anuric renal failure [1].

The Acute Dialysis Quality Initiative (ADQI) working group, comprised of experts in the fields of nephrology and critical care, has published the RIFLE classification, a new consensus and evidence-based definition for AKI. The RIFLE classification defines three grades of severity of AKI (risk, injury, and failure) based on changes to serum creatinine and urine output and two clinical outcomes (loss and end-stage) [2].

The AKI incidence in ICU patients varies widely from 3% to 30%, with mortality ranging from 36% to 90%, depending on the type of ICU, study population, the period during which the study is conducted, and the criteria used to define AKI [3].

There have been many studies about the epidemiology and risk factors of AKI in critically ill patients in the different regions of the world [4]. However, little data on the epidemiology of AKI in critically ill patients are available in Egypt.

The aim of this study was to assess the incidence of AKI among critical ill patients using RIFEL [risk (R), injury (I), failure (F), loss (L) and end-stage kidney disease (E)] classification, a new consensus and evidence-based definition for AKI and [4] to determine the risk factors and outcome of patients who developed AKI in our surgical ICU.

2. Patients and methods

2.1. Patient population

A prospective observational study was conducted in surgical intensive care in Cairo University Hospital (Kasr-Alaini), and the study included all adult patients admitted to surgical ICU over 6 months period with or without acute kidney injury defined by RIFLE criteria [4]. All patients were above 18 years old with no gender limitation. Patients with the following were not included in the study;

1. Patients remained in the ICU for less than 48 h.
2. Patients with preexisting end-stage kidney disease on chronic dialysis.
3. Patients with prior renal transplant.

2.2. Methods

A patient was considered to have AKI when he had an increase in serum creatinine of at least 50% from baseline or a reduction in urine output to <0.5 mL $<$ kg per hour for more than 6 h. As suggested by the Acute Dialysis Quality Initiative working group [4], for patients whose preexisting renal function was not known, a normal GFR before admission to ICU was assumed. Patients were classified daily using the RIFLE criteria. Patients were considered as having new AKI if they did not have AKI on ICU admission and subsequently reached at least class (risk) during their follow-up. Deterioration of AKI was diagnosed if the patient had increased in RIFLE class compared to the initial classification. The most severe degree of AKI was recorded, that is, patients with injury to the kidney at admission to ICU who later developed failure of kidney function were classified as having failure. Similarly, patients who had failure at one stage and later recovered remained classified as having failure.

2.3. Data collection

Data were collected including the following:

1. Co-morbidities.
2. Primary admission diagnostic categories.
3. Need for mechanical ventilation.
4. Presence of sepsis.
5. RIFLE categories of risk, injury, and failure.
6. Renal replacement therapy for AKI.
7. Emergency surgery; elective surgery; and nonsurgical admission.
8. Acute physiology and chronic health evaluation II (APACHE II) score on admission to ICU.
9. ICU stay.
10. Mortality.

2.4. Statistical analysis

Categorical variables were presented as number (frequency) and analyzed using chi-square or Fischer exact test where appropriate test. Student's t-test or the Mann–Whitney U-test is used for quantitative data. All variables significant in univariate analysis were analyzed by a multiple regression logistic model. The logistic regression forward method was used for multivariate analysis of the risk factors, and the results were tabulated as odds ratio and confidence interval. The level of significance was set at $p < 0.05$. The relationships between different factors and mortality were evaluated using a Cox Proportional Hazards model, and survival curves were constructed. Variables with $p < 0.05$ were included in the model. The software SPSS v15.0 for Windows (SPSS, Inc., Chicago, Il, United States) was used for statistical analysis.

3. Results

A total of 112 patients admitted to surgical ICU over 6 months met the inclusion criteria, and forty patients (35.7%) developed AKI. Thirty-one patients had AKI within 24 h of ICU

Table 1 Patient characteristics classified by AKI. Data are mean ± SD, Median (range) number (percentage).

	ALL	Non-AKI	AKI	*p* value
N	112	72	40	
Gender male/female	67/45	42/30	25/15	0.6
Age	42 ± 19	41 ± 20	44.4 ± 18	
Co-morbidity score	0 (0–8)	0 (0–6)	0 (0–8)	0.17
A APACHE II PACHE II	19 ± 7.8	17.3 ± 7.5	22.4 ± 7.4	0.001
Patients type				0.8
Medical	25 (21.9)	16 (22.2)	9 (22.5)	
Trauma	39 (34.2)	24 (33.3)	15 (37.5)	
Surgical	48 (42.1)	32 (44.4)	16 (40)	
Sepsis	66 (58.9)	35 (59)	31 (77.5)	0.004
Mechanical ventilation	74 (64.9)	44 (61)	10 (75)	0.13
Creatinine	2.7 ± 1.4 mg/dl	0.9 ± 0.2 mg/dl	2.3 ± 1.2 mg/dl	< 0.0001
BUN	39 ± 34 mg/dl	34 ± 24 mg/dl	27 ± 20 mg/dl	0.2
Na	139 + 7.6 meq/L	140 ± 4.9 meq/L	138 ± 8 meq/L	0.1
K	4.5 ± 0.8 meq/L	4.3 ± 0.7 meq/L	4.2 ± 0.5 meq/L	0.3
ICU length of stay	6 (2–78) days	6 (2–66) days	6 (2–78) days	0.7
Mortality	60 (52)	33 (45.8)	27 (67.5)	0.028

APACHE II (acute physiology and chronic health evaluation score, version II.).

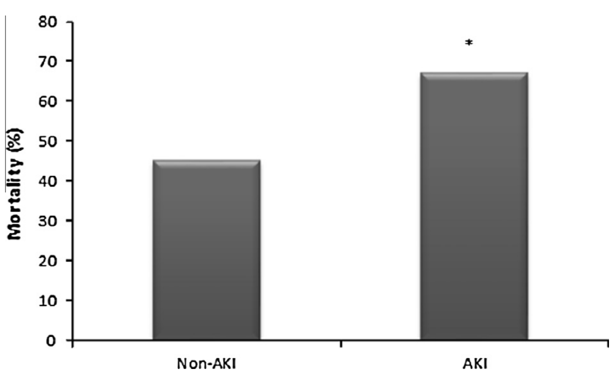

Figure 1 Mortality in the cohort study. *denotes significance < 0.05.

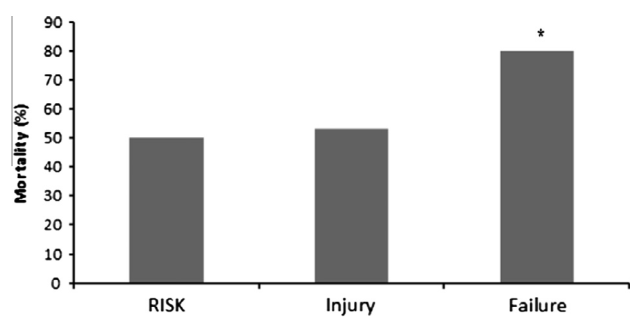

Figure 2 Mortality according to RIFLE classification in AKI. *denotes significance < 0.05.

admission, while 9 patients developed AKI after 48 h of ICU admission. The characteristics of patients with and without AKI are summarized in (Table 1) RIFLE score within 24 h of admission was risk in 7 (17.5%), injury 10 (25%), and failure in 14 (35%). Progression of AKI to a worse RIFLE class was seen in 9 patients (22.5% of AKI patients).

The most common factor contributed to AKI is APACHE II score and sepsis. APACHE II in non-AKI group versus AKI group (17.3 ± 7.5 versus 22.4 ± 7.4, $p = 0.001$), sepsis was the primary admission diagnosis (58.9%) in non-AKI group was 49% versus 77.5% in AKI group with $p = 0.004$.

The overall mortality among patients studied was 53.5% (60/112). The mortality in AKI group was significantly higher than in non-AKI group 67.5% versus 45.8%, respectively, p value = 0.028 (Fig. 1).

Crude hospital mortality stratified by RIFLE categories showed significantly higher mortality rate in failure stage 80% compared to risk 50% and injury stage 53% (Fig. 2).

Non-survivors showed a higher incidence of AKI than survivors (45% versus 25% $p < 0.028$). The APACHE II score was significantly higher in non-survivors than survivor (22 ± 7.7 versus 15.6 ± 6.4, $p < 0.0001$). Proportions of medical admission were significantly higher in non-survivors than survivors. Patients with sepsis and those mechanically ventilated had higher ICU mortality. Neither the age nor the gender was significantly different between survivors and non-survivors (Table 2).

Table 2 Univariate analysis of risk of mortality. Data are mean ± SD, Median (range) number (percentage).

	Survival	Non-survival	*p* value
Number	52	60	
Age	40.4 ± 17.8	44.7 ± 20.7	0.3
Gender male/female	30/22	37/23	0.6
APACHE II	15.6 ± 6.4	22 ± 7.7	< 0.0001
Co-morbidity score	0 (0–6)	0 (0–8)	0.5
AKI	13 (25)	27 (45)	0.028
Sepsis	24 (47)	42 (63.6)	0.01
Medical admission	7 (13.5)	18 (30)	0.02
Mechanical ventilation	19 (36.5)	55 (49.1)	< 0.0001

APACHE II (acute physiology and chronic health evaluation score, version II.), AKI (acute kidney injury).

Table 3 Multivariate analysis of risk of mortality.

	Odds ratio	Confidence Interval		*p* value
		Lower	Upper	
APACHE II	1.2	1.08	1.5	0.048
AKI	3.1	1.1	9.2	0.035
Sepsis	1.1	0.4	3.3	0.7
Medical admission	1.3	0.5	1.5	0.08‘
Mechanical ventilation	11.7	3.6	38	< 0.0001

APACHE II (acute physiology and chronic health evaluation score, version II.), AKI (acute kidney injury).

In multivariate analysis, APACHE II (with odds ratio 1.2 and 95% CI 1.08–1.5), AKI (with odds ratio 1.1 and 95% CI 1.1–9.2), and needs for mechanical ventilation (with odds ratio 11.7 and 95% CI 3.6–38) were independent risks for mortality of risk of mortality (Table 3).

4. Discussion

We conducted an epidemiological observational ICU study to assess the incidence of AKI among critical ill patients using consensus definitions and to determine the risk factors and outcome of patients who develop AKI in our surgical ICU over 6 months.

The main finding of the present study described herein was that 30% of patients displayed some form of AKI at ICU admission and 40% of patients developed AKI at any time during ICU stay.

Several studies have reported the incidence of AKI in critically ill patients. Park et al. reported that AKI occurred in 41% of ICU patients [5]. The incidence of AKI in the present study was somewhat lower than those in other studies using the same RIFLE classification [6]. The most likely explanations depending on the type of admission (i.e., medical versus surgical), study population, the period during which the study is conducted, and the criteria used to define AKI, and factors related to a single-center versus multicenter study [2].

Acute kidney injury has been associated with increased mortality, increased hospital length of stay, and increased healthcare resource use and costs in critically ill patients [7].

In the present study, greater severity of illness on admission (APACHE II) was associated with increased risk of occurrence of AKI However, unlike the previous reports [7], the patients with AKI and those without AKI did not differ in age and co-morbidities on admission.

In the current study, sepsis represent more than half of patients developed AKI about 77.5% and 58.9% of all admitted patients to ICU.

Acute kidney injury (AKI) is a frequent and serious complication of sepsis in intensive care unit (ICU) patients [8]. Ostermann have demonstrated that sepsis is a well-known risk factor for the development of AKI, in 35–50% of acute renal failure cases in the ICU [9].

In the study described herein, neither the age nor the type of patients' admission was associated with increased risk of AKI. Contrary to our findings, Hoste et al. suggested that both surgical admission and increasing age were with increased risk for occurrence of AKI [7].

Occurrence of AKI was reported to be associated with an increasing length of ICU stay and length of mechanical ventilation. In the current study, we could not find any significant association between the occurrence of AKI and need of mechanical ventilation or the length of ICU stay. In a recent study of Coca et al., data of 304 patients with severe burn injury were analyzed. The authors reported that AKI occurred in 26% of patients with major burn and the occurrence of AKI was associated with greater requirement of artificial ventilation and longer duration of ICU stay [10].

Previous studies demonstrated that any degree of AKI was associated with elevated mortality rate, compared with patients who maintained normal function [11]. In the present study, the overall hospital mortality rate of ICU patients was 53.5%, which was significantly higher for AKI patients versus non-AKI patients. We also found that ICU mortality in risk, injury, and failure patients were 50%, 53%, and 80%, respectively. In line with our result, Bagshaw et al. had shown a clear "dose-response" increase in crude and adjusted mortality with greater severity of AKI when stratified by RIFLE [12].

Factor associated with mortality in our critically ill patients included APACHE II, AKI, and needs for mechanical ventilation.

In conclusion, the study demonstrated the incidence of AKI in the surgical critically ill patients. Patients with RIFLE class F incur a significantly increased risk of hospital mortality, and development of acute kidney injury (AKI) during sepsis is one of the predictors of higher mortality rate among critically ill patients.

Our study had several limitations, First, it is an observational and is potentially susceptible to several forms of bias; nonetheless, the strength of our study, in our opinion, was that it is a prospective study. Second, no data on long-term follow-up were available beyond ICU discharge.

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