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Research Article

Predictors of Mortality in Acute Kidney Injury in Elderly Patients Admitted to Geriatrics Intensive Care Unit in Egypt: A Prospective Cross-Sectional Study

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Abstract

Background: Acute kidney injury (AKI) is a major problem in critically ill elderly patients in intensive care units (ICUs). It increases their morbidity, mortality, and length of ICU stay. ***Objective***: This study aims to determine the prevalence of AKI, the factors associated with increased mortality of AKI patients, and the impact of AKI on ICU outcomes. ***Methods***: This was a multistage cross-sectional study followed by a cohort study. Included 210 patients who were admitted to the geriatric ICU. We included the elderly aged 60 and more, and we excluded patients on regular dialysis, renal transplantation, and patients who died within the first 24 hours of admission. ***Results***: 210 elderly patients were included in the study. The prevalence of AKI was 53.8%. Overall, in-hospital mortality was 46.2%. Mortality was higher in the AKI group compared to the non-AKI group (61.9% *vs.* 27.8%, p=0.001). 22.1% of patients needed renal replacement therapy. Mortality for this RRT group was 84%. In multivariable analysis, chronic kidney disease (CKD), KDIGO staging III, Acute Physiology and Chronic Health Evaluation (APACHE) II, septic shock, and diabetes (DM) were independent predictors of mortality. ***Conclusions***: AKI is common in ICU patients. Most patients were having community-acquired AKI. Chronic kidney disease (CKD), serum creatinine at AKI diagnosis, KDIGO staging III, acute physiology and chronic health evaluation (APACHE) II, septic shock, and diabetes (DM) were independent predictors of mortality.

Keywords: Acute kidney injury, APACHE, Chronic kidney disease, Intensive care unit, Mortality.

التنبؤ بالوفيات الناجمة عن إصابات الكلى الحادة لدى المرضى المسنين الراقدين في وحدة العناية المركزة لطب الشيخوخة في مصر: دراسة مقطعية استشرافية

الخلاصة

الخلفية: تعد إصابة الكلى الحادة (AKI) مشكلة رئيسية لدى المرضى المسنين المصابين بأمراض خطيرة في وحدات العناية المركزة (ICUs) و يزيد من اعتلالهم ووفياتهم ومدة إقامتهم في وحدة العناية المركزة. **الهدف**: تهدف هذه الدراسة إلى تحديد انتشار AKI، والعوامل المرتبطة بزيادة معدل وفيات مرضى AKI، وتأثير AKI على نتائج وحدة العناية المركزة. **الأساليب**: هذه دراسة مقطعية متعددة المراحل تليها دراسة جماعية. وشملت 210 مرضى تم إدخالهم إلى وحدة العناية المركزة لكبار السن. وشملت كبار السن الذين تبلغ أعمارهم 60 عاما فما فوق، واستبعدنا المرضى الذين يخضعون لغسيل الكلى المنتظم وزراعة الكلى والمرضى الذين ماتوا خلال ال 24 ساعة الأولى من الدخول. **النتائج**: تم تضمين 210 مرضى مسنين في الدراسة. كان انتشار AKI 53.8٪. بشكل عام، كان معدل الوفيات في المستشفى 46.2٪. كانت الوفيات أعلى في مجموعة AKI مقارنة بالمجموعة غير AKI (61.9٪ مقابل 27.8٪ ، p = 0.001). 22.1٪ من المرضى يحتاجون إلى علاج باستبدال الكلى. وبلغت نسبة الوفيات في هذه الفئة من الاختبارات السريعة 84٪. في التحليل متعدد المتغيرات ، كانت أمراض الكلى المزمنة (CKD)، و KDIGO التدريج III، وقصور وظائف الأعضاء الحاد وتقييم الصحة المزمنة II (APACHE)، والصدمة الإنتانية، والسكري (DM) تنبؤات مستقلة بالوفيات. **الاستنتاجات**: AKI شائع في مرضى وحدة العناية المركزة. كان معظم المرضى يعانون من AKI المكتسب من المجتمع. كان مرض الكلى المزمن (CKD)، والكرياتينين في الدم عند تشخيص AKI، و KDIGO التدريج III ، وقصور وظائف الأعضاء الحاد وتقييم الصحة المزمنة II (APACHE)، والصدمة الإنتانية ، والسكري (DM) تنبؤات مستقلة بالوفيات.

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INTRODUCTION

Acute kidney damage (AKI) in the intensive care unit (ICU) is one of the most prevalent and significant global public health concerns [1]. AKI is the primary cause of organ failure in the ICU, and even mild AKI is associated with a 50% higher risk of hospital mortality [2]. Kidney Disease Improving Global Outcomes (KDIGO) clinical guidelines define acute kidney injury (AKI) as a subset of acute kidney diseases (AKD) and disorders. AKI is classified based on its severity (stages) and origin, which affects management and prognosis [3]. Clinical outcomes from AKI include mortality, morbidity (including end-stage renal disease [ESRD] and chronic kidney disease [CKD]), prolonged ICU stays, and significant costs to public health [4]. AKI is diagnosed in 20% or more of hospitalized patients and 30–60% of critically ill patients [5]. This difference is based on the mean age and clinical severity of the patients, as well as the diagnostic

criteria used [6]. It's becoming more and more crucial to predict in-hospital mortality of critically ill AKI patients. Four types of severity scoring systems have been assessed for their ability to predict hospital mortality among critically ill elderly patients. These systems include Acute Physiology and Chronic Health Evaluation (APACHE II, IV), Sepsis-related Organ Failure Assessment (SOFA), Simplified Acute Physiology Score III (SAPS III), and Mortality Probability Model III (MPM III) [7]. We also lack specific guidelines for the diagnosis of AKI and prediction of mortality in geriatric ICUs, especially in developing countries [8]. So, estimating the frequency and consequences of AKI might be challenging. In this study we describe the prevalence of AKI, the factors associated with increased mortality of AKI patients, and we find out the impact of AKI on ICU outcomes in critically ill elderly patients.

METHODS

Design, setting and population of the study

A multistage prospective cross-sectional study was performed in the geriatric ICU of a teaching hospital located in Egypt. This study was conducted on 210 patients aged 60 years or older. The following patients were excluded: those on regular dialysis, renal transplantation, and patients who died within the first 24 hours.

Data collection

The data of patients admitted to the ICU from February 2023 to August 2023 was gathered. At the time of ICU admission, all data were obtained, including the patients' baseline characteristics, comorbidities, and laboratory parameters examined. The Mortality Probability Model III (MPM III) [13], the Sequential Organ Failure Assessment (SOFA) score [12], the Simplified Acute Physiology Score (SAPS3) [11], and the prognostic Acute Physiology and Chronic Health Evaluation (APACHE II, IV) score [9,10] were each calculated.

Diagnostic criteria for AKI

The Kidney Disease: Improving Global Outcomes (KDIGO) guidelines were used to define and classify AKI, which is diagnosed using serum creatinine and urinary volume values [3]. The KDIGO definition is superior to the Acute Kidney Injury Network (AKIN) and Risk, Injury, Failure, Loss of kidney function, and End-stage kidney disease (RIFLE) criteria [14]. The baseline value was determined by utilizing the lowest sCr at ICU admission to implement the KDIGO criteria. The following phases are used to further classify AKI: *Stage* 1: An increase in sCr of 1.5–1.9 times compared to the baseline or an increase of ≥0.3 mg/dl and a urine output of less than 0.5 ml/kg/h for a period of 6–12 hours. *Stage 2*: A 2.0–2.9-fold increase in sCr compared to the baseline and a urine discharge of less than 0.5 ml/kg/h for a period of at least 12 hours. *Stage 3*: An increase in sCr of 3.0 times the baseline value, an increase in serum creatinine to ≥4.0 mg/dl, the initiation of renal replacement therapy, and urine output of less than 0.3 mL/kg/h for a minimum of 24 hours or anuria for a minimum of 12 hours.

Outcomes of the study

The outcomes included the prevalence of AKI, renal recovery, the need for renal replacement therapy (RRT), the length of ICU and hospital stays, and hospital mortality, as well as predictors of mortality in non-survivors and AKI patients.

Ethical approval

The study protocol was approved by the Research Review Board of the Geriatrics and Gerontology Department, Faculty of Medicine, Ain Shams University, and the ethical committee at the Faculty of Medicine, Ain Shams University (FMASU MD 32/2023).

Statistical analysis

Data was analyzed using the Statistical Program for Social Science (SPSS) (SPSS, version 26.0). Comparisons among qualitative variables were performed using the chi-square or Fisher's exact test, and those among the quantitative variables were performed using the Student's t-test or the Mann–Whitney U test, depending on which was appropriate. A *p*-value of less than 0.05 was considered statistically significant. Multivariable techniques, including logistic regression, are used to evaluate the independent factors of mortality in AKI.

RESULTS

Two hundred and ten patients were admitted to the ICU during the investigation period. The most prevalent underlying comorbidities among study participants were hypertension (HTN), diabetes mellitus (DM), chronic cardiovascular diseases, and preexisting CKD, with respective percentages of 66.5%, 53%, 46%, and 23%. APACHE II, IV, SAPS 3, SOFA, and MPM III scores were also higher in AKI patients than in those without AKI (Tables 1, 2, and 3). The prevalence of AKI is 54%, as illustrated in Figure 1. The prevalence of AKI acquired in a hospital is 17%, while that of AKI acquired in the community is 37%. The classifications of AKI patients according to KDIGO staging criteria are illustrated in Figure 2. Stage 1 AKI was present in 55% of the total AKI patients, while 25% had stage 2 AKI and 20% had stage 3 AKI. The length of ICU stay for AKI patients was 9.14±7, while that of non-AKI patients was 7.41±5.06. This information is presented in Table 4.

Table 1: Baseline characteristics of the study cohort

Characters		All Patients (n=210)	AKI (n=113)	Non- AKI (n= 97)	*p*-value
Age (year) (Range=60-98)		74.96 ±7.79	75.18±8.08	74.76±7.78	0.71
Sex	Male	86 (41)	47 (41.6)	39 (40.2)	
	Female	124 (59)	66 (58.4)	58 (59.8)	0.84
Smoking status	Non-Smokers	165 (78.6)	84 (74.3)	81 (83.5)	
	Smokers	24 (11.4)	15 (13.3)	9 (9.3)	0.26
	Ex-smoker	21 (10)	14 (12.4)	7 (7.2)	
Co-morbidities	Neurological diseases[1]	59 (28.1)	35 (31.0)	24 (24.7)	0.3
	Hypertension	135 (64.3)	75 (66.4)	60 (61.9)	0.5
	Pulmonary diseases[2]	34 (16.2)	22 (19.5)	12 (12.4)	0.1
	Diabetes mellitus	97 (46.2)	60 (53.1)	37 (38.1)	0.03
	Cardiac disease[3]	97 (46.2)	52 (46.0)	45 (46.4)	0.9
	Chronic kidney disease	38 (18.1)	26 (23)	12 (12.3)	0.04
	Hepatic diseases	40 (19)	18 (15.9)	22 (22.7)	0.2
	Dementia	73 (34.8)	36 (31.9)	37 (38.1)	0.3
	Previous ICU admission	48 (22.9)	29 (25.7)	19 (19.6)	0.3
	Charlson Comorbidity Index <7	137 (65.2)	67 (59.2)	70 (72.1)	0.1
	Charlson Comorbidity Index >7	73 (34.8)	46 (40.7)	27 (27.8)	

Values were expressed as frequency, percentage, and mean±SD. [1] This includes Stroke, Seizures. [2] This includes Chronic obstructive pulmonary disease, Bronchial asthma, Tuberculosis. [3] This includes heart failure, ischemic heart diseases, arrhythmia and valvular heart diseases.

Table 2: Drug therapy and disease severity scoring of the studied cohort

		All Patients (n=210)	AKI (n=113)	Non- AKI (n= 97)	*p*-value
Drugs	BB	87(41.4)	46(40.7)	41(42.3)	0.82
	CCB	36(17.1)	16(14.2)	20(20.6)	0.22
	ACEI	55(26.2)	30(26.5)	25(25.8)	0.9
	Diuretics	30(14.3)	7(6.2)	6(6.2)	0.26
	Antiplatelet	82(39)	48(42.5)	34(35.1)	0.27
	Statins	27(12.9)	17(15)	10(10.3)	0.31
Severity scoring	APACHE II	17.21±6.79	18.65±7.02	15.77±6.57	0.002
	APACHE IV	70.50±18.95	73.5±19.0	67.5±18.9	0.02
	SOFA	4.73±2.75	5.29±2.95	4.17±2.55	0.004
	MPM_0 III (%)	29.77±19.99	33.3±19.95	26.24±20.02	0.01
	MPM_{48}III (%)	35.25± 22.05	38.97±23.56	31.54±20.55	0.01
	MPM_{72}III (%)	37.73±22.41	41.37±24.05	34.09±20.77	0.02
	SAPS III	67.02±11.47	68.73±11.59	65.31±11.35	0.03

Values were expressed as frequency, percentage, and mean±SD. BB: Beta blockers, CCB: calcium channels blockers, ACEI: angiotensin converting enzyme inhibitors. APACHE II and IV: Acute Physiology and Chronic Health Evaluation II AND IV respectively, SOFA: Sequential Organ Failure Assessment, MPM III: Mortality Probability Model III, SAPS III: Simplified Acute Physiology Score III.

Table 3: Renal function and serum electrolytes of the studied cohort

		All Patients (n=210)	AKI (n=113)	Non- AKI (n= 97)	*p*-value
Renal Function	BUN (mg/dL)	41.06±29.55	46.19±33.06	35.93±26.04	0.001
	Cr (mg/dL)	1.68±0.96	2.44±1.31	0.92±0.62	0.001
	Na (mmol/L)	136.23±8.13	136.67±8.13	135.78±8.14	0.4
	K (mmol/L)	4.14±0.83	4.24±0.88	4.04±0.78	0.09
	PO_4 (mg/dL)	3.53±1.68	3.65±1.7	3.41±1.67	0.3
	Ca (mg/dL)	8.97±0.63	8.97±0.6	8.97±0.66	0.9
	eGFR (%)	57.93±34.27	38.29± 8.74	77.57±29.8	<0.001

Values were expressed as mean±SD. GFR: glomerular filtration rate, BUN: blood urea nitrogen, Cr: creatinine, Na: Sodium, K: Potassium, PO_4: Phosphate, Ca: Calcium.

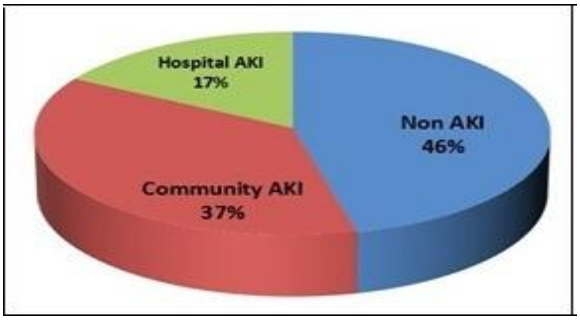

Figure 1: Prevalence of AKI. This figure shows the prevalence of AKI is 54%. The incidence of hospital acquired AKI is 17% while community acquired AKI is 37%.

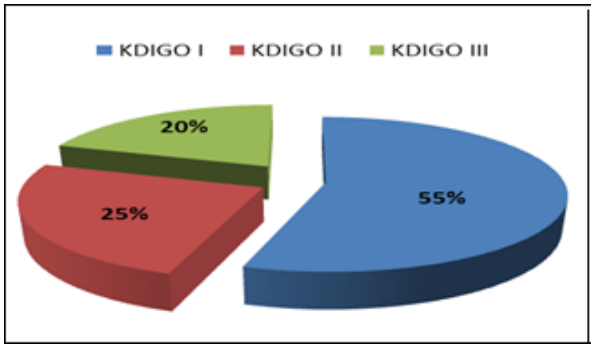

Figure 2: Classifications of AKI patients. According to KDIGO staging criteria, 55% of the total AKI patients had stage 1 AKI, 25% had stage 2 AKI, and 20% had stage 3 AKI.

Table 4: ICU outcomes and interventions

	All patients (n= 210)	AKI (n=113)	Non-AKI (n=97)	*p*-value
Length Of ICU Stay	8.28±6.03	9.14±7.0	7.41±5.06	0.04
Total hospital stays	12.91±8.3	12.31±8.54	13.52±8.05	0.3
In-hospital mortality	97(46.2)	70(61.9)	27(27.8)	0.001
Vasopressor	43(20.5)	30(26.5)	13(13.4)	0.02
Mechanical ventilation	31(14.8)	24(21.2)	7(7.21)	0.004

Values were expressed as frequency, percentage, and mean±SD.
ICU: Intensive care unit.

Mechanical ventilation was necessary for 21.5% of AKI patients, while 26.5% of AKI patients required vasopressor or ionotropic support. The mortality rate in AKI was 62%, which corresponds to an overall mortality rate of 46.2%. Table 5 shows the logistic regression analysis of factors predicting in-hospital mortality: DM (odds ratio [OR] - 1.008; 95% confidence interval [CI] - 0.756–1.361; p= 0.045]), CKD (OR - 4.786; 95% CI - 3.590–6.461; p= 0.017]), creatinine (OR - 3.496; 95% CI - 2.622-4.720; p= 0.019), KDIGO III (OR - 1.817; 95% CI - 1.363-2.453; p= 0.02), septic shock (OR - 1.580; 95% CI - 1.185-2.133; [p= 0.025]), and APACHE II (OR - 1.984; 95% CI - 1.488-2.678; p= 0.020).

Table 5: Logistic regression analysis of mortality predictors in AKI patients (n= 113)

Factors	OR (95% CI)	*p*-value
Diabetes	1.008 (0.756-1.361)	0.045
Hypertension	0.826 (0.619-1.115)	0.344
CKD	4.786 (3.590-6.461)	0.017
Creatinine	3.496 (2.622-4.720)	0.019
KDIGO III	1.817 (1.363-2.453)	0.020
Septic shock	1.580 (1.185-2.133)	0.025
RRT	0.862 (0.646-1.163)	0.063
APACHE II	1.984 (1.488-2.678)	0.020

CI: Confidence interval, CKD: chronic kidney disease, OR: odds ratio, KDIGO: Kidney Disease Improving Global Outcomes, APACHE II: Acute Physiology and Chronic Health Evaluation II, RRT: Renal replacement therapy.

The logistic regression analysis of mortality predictors in critically ill patients is illustrated in Table 6.

Table 6: Logistic regression analysis of mortality predictors in critically ill patients (n=210)

Factors	OR (95% CI)	*p*-value
Age (year)	1.585 (1.130-2.56)	0.313
Gender	0.610 (0.165-1.405)	0.562
AKI	1.955 (1.121-4.128)	0.001
Septic shock	1.849 (1.273-5.131)	0.003
Vasopressor	1.951 (1.282-3.188)	0.149
Mechanical ventilation	1.826 (1.203-4.869)	0.007
Charlson Comorbidity Index ≥7	1.232 (0.361-3.057)	0.027
Previous ICU admission	2.328 (1.376-5.697)	0.010
APACHE IV	1.094 (0.928-3.859)	0.040
SOFA	1.814 (1.047-6.005)	0.025

AKI: Acute kidney injury, CI: Confidence interval, OR: odds ratio, APACHE IV: Acute Physiology and Chronic Health Evaluation IV, SOFA: Sequential Organ Failure Assessment.

DISCUSSION

AKI in the ICU is emerging as a global health issue that has both clinical and economic repercussions in developed and developing nations. It increases in hospitalized patients, particularly those who are critically ill, which ultimately results in protracted hospital stays, RRT, the development of CKD, and increased short- and long-term morbidity and mortality or ESRD [15]. The mean age of AKI patients in the present study was 75.18±8.08 years. Male patients comprised 47 (41.6%), and female patients comprised 66 (58.4%). In accordance with Roberts' findings [16], which increased the prevalence of females to 56.7%. Variations in the severity of the underlying illness, the primary diagnosis (particularly sepsis), comorbidities, and the quality of the healthcare systems may be the cause of these variations. The elevated prevalence of AKI in our study is a cause for concern. It is essential to intensify efforts to promptly address modifiable risk factors and identify individuals who are at risk of disease. Comorbid conditions, such as hypertension and diabetes mellitus, are essential for the development of acute kidney injury (AKI) in the intensive care unit. HTN (65.8%) and DM (33%) were identified as risk factors for AKI, in accordance with the results of Levi *et al*. [17]. However, Eswarappa *et al*. [18] identified DM (30.6%) and HTN (29.2%) as the risk factors. AKI risk is elevated in patients with CKD because of their persistently low glomerular filtration rates (GFR) [19]. Our results suggest that AKI is present in 53.8% of patients. The multinational study results indicated that the prevalence of AKI was 57.3% [20]. Nevertheless, Hashemian *et al*. [21] reported that 33% of all ICU patients experienced acute kidney injury (AKI), while Koez *et al*. [22] reported that 20% of ICU patients experienced AKI. The incidence of hospital-acquired AKI was 16.7%, which was essentially identical to the findings of Ahmed *et al*. [23], who reported 16.1% of hospital-acquired AKI. Conversely, 32.8% of hospitals acquired AKI, as reported by Wonnacott *et al*. [24]. Most of our patients (55%) were in stage I, while 24.7% were in stage II and 20.3% were in stage III. Potter *et al*. [25] reported the same result, indicating that 50% of the patients were in stage I, 19% were in stage II, and 31% were in stage III. In a UK cohort conducted by Zhang *et al*. [26], it was discovered that approximately 41.2% of AKI patients in the ICU were in stage 1. In the ICU, the presence of AKI was independently correlated with SAPS 3 scores (> 18 points) and APACHE II scores (> 68 points). The prediction of mortality, in addition to acute kidney injury (AKI), may be facilitated by predictive mortality systems. It is crucial to promptly and meticulously monitor the clinical presentation of laboratory values in the ICU. When contrasted with baseline values, AKI patients exhibit elevated GFR, sCr, and blood urea nitrogen levels. In our investigation, dialysis was required by only 22.1% of individuals with AKI (n=25/113). The majority of RRT procedures were emergency dialysis through a temporary catheter for two hours, and these were hemodialysis sessions. This discovery is in stark contrast to a rate of 24% that was previously reported [27]. This may be due to a higher

proportion of low-stage AKI cases that did not necessitate dialysis. Another potential explanation for the low rate of dialysis is the treatment team's triage, which involves declining dialysis for patients with a poor prognosis. The aggregate mortality rate was 46% in total, with AKI affecting 62% of the population. In a tertiary care center in India, Kohli *et al*. [28] discovered a mortality rate of 61% in elderly patients with AKI. The mortality rate in a study conducted by Pedersen *et al*. [29] was 53.1%, which is nearly identical to our study. Hafez *et al*. [30] reported a mortality rate of 35%, while El-Badawy *et al*. [31] reported a mortality rate of 14%. These findings are lower than those of our study. The severity of the patients' underlying condition resulted in a mortality rate of 84% among those who underwent RRT. Nevertheless, the efficacy of RRT was not a predictor of mortality, even though it is known to reverse some of the life-threatening complications of AKI, including severe metabolic acidosis, severe hyperkalemia, and pulmonary edema. An ICU stay duration of 9.14±7 was observed in participants with developed AKI, while a stay duration of 7.41±5.06 was observed in non-AKI participants. Dos Santos *et al*. [32] discovered that ICU stays for AKI patients were longer than those of non-AKI patients (12 *vs*. 7 days), which is consistent with our research study. Between the AKI and the non-AKI, the mean duration of hospital stays (12.3 days) did not differ significantly (13.5 days). The shorter duration of hospital stays and increased in-hospital mortality may be attributed to the severity of the disease and the delay in hospital admission. As a component of respiratory support, mechanical ventilation was necessary for 21.2% of AKI patients in our study. Santos *et al*. [33] determined that it was 65.2%, whereas Anaele *et al*. [34] determined that it was 33.0%, a value that is comparable to our findings. 26.5% of patients with acute kidney injury required vasopressor support. However, Anaele *et al*. [34] discovered a higher percentage of 40.8% than we did. Using logistic regression analysis, this study determined that the Charlson Comorbidity Index 7, APACHE IV, SOFA, mechanical ventilation, septic shock, AKI, and previous ICU admission were all significant predictors of mortality. Sepsis is a common occurrence and has a strong correlation with AKI. It is imperative to prioritize the early diagnosis of infection and the timely implementation of appropriate antibiotics and fluid management. It is essential to comprehend the prognostic variables of any disease, as they may affect its prognosis. The study's mortality variables were identified as DM, CKD, sCr, KDIGO III, septic shock, vasopressor, mechanical ventilation, and APACHE II through a logistic regression analysis [35]. To prevent, monitor, diagnose, report, and follow up on AKI in the ICU, healthcare facilities must implement rigorous protocols. It is crucial to identify the initial symptoms of acute kidney injury (AKI) in the intensive care unit (ICU) to implement early management in accordance with established protocols and guidelines. To establish regulated procedures for the administration of pharmaceuticals, monitor sCr levels, and assist in the early detection of AKI, the clinical pharmacist must be a member of the multidisciplinary ICU team.

Strength of the study

Few studies used new criteria to assess the prevalence and risk of AKI in elderly patients admitted to ICUs in developing nations. A high frequency of AKI among older patients was discovered. Septic shock, greater APACHE II, diabetes mellitus, CKD, and AKI severity were identified as predictors of mortality.

Study limitations

The data presented from clinical records may have contained some bias. We were unable to investigate the effect of RRT on long-term clinical outcomes, RRT timing, AKI patients' quality of life, or the absence of data on long-term AKI repercussions. Furthermore, the sample was rather modest.

Conclusion

Our findings indicate a higher mortality rate among critically ill elderly patients with AKI in the ICU, particularly those who are septic. Moreover, the risk of mortality was greater for patients with more severe AKI. The study has revealed that the development of AKI in patients admitted to the ICU was associated with an increased length of stay.

Conflict of interests

No conflict of interest was declared by the authors.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

REFERENCES

1. Mo S, Bjelland TW, Nilsen TIL, Klepstad P. Acute kidney injury in intensive care patients: Incidence, time course, and risk factors. *Acta Anaesthesiol Scand*. 2022;66(8):961-968. doi: 10.1111/aas.14100.
2. Pickkers P, Darmon M, Hoste E, Joannidis M, Legrand M, Ostermann M, et al. Acute kidney injury in the critically ill: an updated review on pathophysiology and management. *Intensive Care Med*. 2021; 47(8):835-850. doi: 10.1007/s00134-021-06454-7.
3. Kellum JA, Lameire N, Aspelin P, Barsoum RS, Burdmann EA, Goldstein SL. Kidney disease: improving global outcomes (KDIGO) acute kidney injury workgroup. KDIGO clinical practice guideline for acute kidney injury. *Kidney Int Suppl*. 2012;2(1):1–138. doi: 10.1038/kisup.2012.1.
4. Mishra RC, Sinha S, Govil D, Chatterjee R, Gupta V, Singhal V, et al. Renal replacement therapy in adult intensive care unit: An ISCCM Expert Panel Practice Recommendation. *Indian J Crit Care Med*. 2022;26(Suppl 2):S3-S6. doi: 10.5005/jp-journals-10071-24278.

5. Kher V, Srisawat N, Noiri E, Benghanem Gharbi M, Shetty MS, Yang L et al. Prevention and therapy of acute kidney injury in the developing world. *Kidney Int Rep*. 2017;26;2(4):544–558. doi: 10.1016/j.ekir.2017.03.015.
6. Hoste EA, de Corte W. AKI patients have worse long-term outcomes especially in the immediate post-ICU period. *Crit Care*. 2012;16:148. doi: 10.1186/cc11470.
7. Cohen SD, Kimmel PL. Long-term sequelae of acute kidney injury in the ICU. *Curr Opin Crit Care*. 2012;18:623-628. doi: 10.1097/MCC.0b013e328358d3f5.
8. Mehta R, Bagga A, Patibandla R, Chakravarthi R. Detection and management of AKI in the developing world: The 18th Acute Disease Quality Initiative (ADQI) International Consensus Conference. *Kidney Int Rep*. 2017;2(4):515-518. doi: 10.1016/j.ekir.2017.03.013.
9. Zimmerman JE, Kramer AA, McNair DS, Malila FM. Acute physiology and chronic health evaluation (APACHE) IV: hospital mortality assessment for today's critically ill patients. *Crit Care Med*. 2006;34(5):1297-1310. doi: 10.1097/01.CCM.0000215112.84523.F0.
10. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: A severity of disease classification system. *Crit Care Med*. 1985;13:818–829.
11. Metnitz PG, Moreno RP, Almeida E, Jordan B, Bauer P, Campos RA, et al. SAPS3 Investigators. SAPS 3_From evaluation of the patient to evaluation of the intensive care unit. Part 1: objectives, methods and cohort description. *Intensive Care Med*. 2005;31(10):1336-1344. doi: 10.1007/s00134-005-2762-6.
12. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. *Intensive Care Med*. 1996;22(7):707-710. doi: 10.1007/BF01709751.
13. Nathanson BH, Higgins TL, Teres D, Copes WS, Kramer A, Stark M. A revised method to assess intensive care unit clinical performance and resource utilization. *Crit Care Med*. 2007;35(8):1853–1862. doi: 10.1097/01.CCM.0000275272.57237.53.
14. Li Z, Cai L, Liang X, Du Z, Chen Y, An S, Tan N, et al. Identification and predicting short-term prognosis of early cardiorenal syndrome type 1: KDIGO is superior to RIFLE or AKIN. *PLoS One*. 2014;9(12):e114369. doi: 10.1371/journal.pone.0114369.
15. Wang HE, Muntner P, Chertow GM, Warnock DG. Acute kidney injury and mortality in hospitalized patients. *Am J Nephrol*. 2012;35:349–355. doi: 10.1159/000337487.
16. Roberts G, Phillips D, McCarthy R, Bolusani H, Mizen P, Hassan M, et al. Acute kidney injury risk assessment at the hospital front door: what is the best measure of risk? *Clin Kidney J*. 2015;8(6):673-680. doi: 10.1093/ckj/sfv080.
17. Levi TM, de Souza SP, de Magalhães JG, de Carvalho MS, Cunha AL, Dantas JG, et al. Comparison of the RIFLE, AKIN and KDIGO criteria to predict mortality in critically ill patients. *Rev Bras Ter Intensiva*. 2013;25(4):290-296. doi: 10.5935/0103-507X.20130050.
18. Eswarappa M, Gireesh MS, Ravi V, Kumar D, Dev G. Spectrum of acute kidney injury in critically ill patients: A single center study from South India. *Indian J Nephrol*. 2014;24(5):280-285. doi: 10.4103/0971-4065.132991.
19. Gong Y, Zhang F, Ding F, Gu Y. Elderly patients with acute kidney injury (AKI): Clinical features and risk factors for mortality. *Arch Gerontol Geriatr*. 2012;54(2):47–51. doi: 10.1016/j.archger.2011.05.011.
20. Hoste EA, Bagshaw SM, Bellomo R, Cely CM, Colman R, Cruz DN, et al. Epidemiology of acute kidney injury in critically ill patients: the multinational AKI-EPI study. *Intensive Care Med*. 2015;41(8):1411-1423. doi: 10.1007/s00134-015-3934-7.
21. Hashemian SM, Jamaati H, Bidgoli B F, Farrokhi FR, Malekmohammad M, Roozdar S, et al. Outcome of acute kidney injury in critical care unit, based on AKI network. *Tanaffos*. 2016;15(2):89–95.
22. Koeze J, Keus F, Dieperink W, Van der Horst IC, Zijlstra JG, Van Meurs M. Incidence, timing and outcome of AKI in critically ill patients varies with the definition used and the addition of urine output criteria. *BMC Nephrol*. 2017;18(70):1–9. doi: 10.1186/s12882-017-0487-8.
23. Ahmed LI, Mansour HH, Hussen A, Zaki MS, Mohammed RR, Goda AT. Clinical evaluation of acute kidney injury in Al-Zahraa University Hospital, Cairo, Egypt. *Egypt J Intern Med*. 2017;29:16–23. doi: 10.4103/ejim.ejim_3_17.
24. Wonnacott A, Meran S, Amphlett B, Talabani B, Phillips A. Epidemiology and outcomes in community-acquired versus hospital-acquired AKI. *Clin J Am Soc Nephrol*. 2014;9(6):1007–1014. doi: 10.2215/CJN.07920713.
25. Potter DA, Wroe N, Redhead H, Lewington AJ. Outcomes in patients with acute kidney injury reviewed by critical care outreach: what is the role of the national early warning score? *J Intensive Care Soc*. 2017;18(4):300–309. doi: 10.1177/1751143717715968.
26. Zhang J, Crichton S, Dixon A, Seylanova N, Peng ZY, Ostermann M. Cumulative fluid accumulation is associated with the development of acute kidney injury and non-recovery of renal function: a retrospective analysis. *Crit Care*. 2019;23(1):392. doi: 10.1186/s13054-019-2673-5.
27. Kulkarni AP, Bhosale SJ. Epidemiology and pathogenesis of acute kidney injury in the critically ill patients. *Indian J Crit Care Med*. 2020;24(3):S84-S89. doi: 10.5005/jp-journals-10071-23394.
28. Kohli HS, Bhat A, Aravindan SudK, Jha V, Gupta KL, Sakhuja V. Spectrum of renal failure in elderly patients. *Int Urol Nephrol*. 2006;38(3–4):759–765. doi: 10.1007/s11255-006-0089-z.
29. Pedersen AB, Gammelager H, Kahlert J, Sørensen HT, Christiansen CF. Impact of body mass index on risk of acute kidney injury and mortality in elderly patients undergoing hip fracture surgery. *Osteoporos Int*. 2017;28:1087-1097. doi: 10.1007/s00198-016-3836-8.
30. Hafez MZE, Kassem SA, Saleh SA. Epidemiology of acute kidney injury in intensive care units in Aswan University Hospital. *Egypt J Hospital Med*. 2020;78(2):265−270. doi: 10.21608/ejhm.2020.70968.
31. El-Badawy AM, Mansour AE, Abdelmoniem RO. Acute kidney injury in intensive care unit patients in Benha University Hospitals. *J Egypt Soc Nephrol Transplant*. 2020;20(2):103−110. doi: 10.4103/jesnt.jesnt_33_19.
32. Dos Santos RP, Carvalho ARDS, Peres LAB. Incidence and risk factors of acute kidney injury in critically ill patients from a single centre in Brazil: a retrospective cohort analysis. *Sci Rep*. 2019;9(1):18141. doi: 10.1038/s41598-019-54674-1.
33. Santos PR, Monteiro DLS. Acute kidney injury in an intensive care unit of a general hospital with emergency room specializing in trauma: an observational prospective study. *BMC Nephrol*. 2015;16(1):1–6. doi: 10.1186/s12882-015-0026-4.
34. Anaele CU, Suarez G, prieto Sk, Bashir M, laski M, Yang S. Acute kidney injury patterns and outcomes in low-risk versus high-risk critically ill patients admitted to the medical intensive care unit. *Southwest Respir Crit Care Chronicles*. 2017;5(17):17–31.
35. Korula S, Balakrishnan S, Sundar V, Paul A, Balagopal A. Acute kidney injury-incidence, prognostic factors, and outcome of patients in an intensive care unit in a tertiary center: A prospective observational study. *Indian J Crit Care Med*. 2016;20(6):332–336. doi: 10.4103/0972-5229.183904.