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Original Research Article

Evaluating the APACHE II Score for Predicting ICU Outcomes in Patients with AKI while Ensuring Originality: A Prospective Study

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Abstract:

Background: An abrupt drop in kidney function is a dangerous condition known as acute kidney injury (AKI), which frequently requires admission to an intensive care unit (ICU). The utility of the Acute Physiology and Chronic Health Evaluation II (APACHE II) score in predicting outcomes specifically for AKI individuals in the ICU remains a topic of investigation.

Methods: This prospective study, conducted over one year at 'LBKMCH', included 140 ICU-admitted AKI patients. Data collection encompassed demographics, clinical parameters, laboratory results, and APACHE II scores. Mortality was the primary result. The statistical analysis was done with SPSS 21.0.

Results: The study cohort's male-to-female ratio was 1.5:1, its mean age was 55.92 years, and 41% of its members were 60 years of age or older. 35% of patients died while they were in the hospital altogether, while 65% of patients were released alive. Sepsis (47%) was the predominant etiology of AKI. Mortality was highest among patients with CAD (52.6%). APACHE II scores >34 was associated with 100% mortality. The APACHE II score on admission had an AUC of 0.79, with a cutoff value of >23 predicting mortality with 79.00% accuracy.

Conclusion: The study demonstrates the potential of APACHE II scores in predicting mortality and outcomes in ICU-admitted AKI patients. Comorbid conditions, etiology, and clinical parameters also influenced outcomes. Further research is warranted to validate these findings and enhance their clinical applicability in diverse patient populations.

Recommendations: Healthcare professionals in ICU settings should utilize APACHE II scores early in AKI patient assessment to predict mortality and guide clinical decisions. Further research is necessary to refine APACHE II score predictability across diverse AKI patient populations and clinical contexts. Additionally, prioritizing tailored management strategies for AKI patients with comorbid conditions, such as CAD, can significantly enhance overall outcomes in the critical care setting.

Keywords: Acute Kidney Injury, APACHE II score, ICU, Mortality, Outcomes, Predictive Tool.

Introduction

Acute Kidney Injury (AKI) is a critical clinical condition categorized by a sudden and often reversible decrease in kidney function. Patients with AKI frequently require intensive medical intervention, with a significant proportion of them being admitted to the Intensive Care Unit (ICU) for close monitoring and specialized care [1]. The management and prognosis of AKI in the ICU setting are complex, and healthcare providers rely on various prognostic tools to assess the severity and predict the clinical outcomes of these patients [2].

In critical care settings, the Acute Physiology and Chronic Health Evaluation II (APACHE II) score is one such measure that has been widely accepted and recognized. An established method for assessing the severity of critical illness, the APACHE II score is intended to give a numerical evaluation of the condition's seriousness [3]. It takes into account various physiological parameters and clinical information obtained during the initial 24 hours following ICU admission to generate a composite score. This score serves as a valuable tool for risk

stratification, outcome prediction, and clinical decision-making in critically ill patients.

The utilization of the APACHE II score has been extensively studied in various critical care conditions, including sepsis, trauma, and respiratory failure, demonstrating its efficacy in predicting patient outcomes and assisting in clinical management [4]. However, the application of the APACHE II score specifically in patients with AKI admitted to the ICU remains an area of ongoing research and debate.

The purpose of this study is to examine the usefulness of the APACHE II score and its relationship to clinical outcomes in patients with AKI who are hospitalized to the intensive care unit.

The main goal is to determine whether, in this particular patient population, the APACHE II score, which is determined during the initial 24 hours of ICU admission, can be used as a valid predictor of death, length of stay in the ICU, and other pertinent outcomes.

Methodology

Study Design: This study employed a hospital-based prospective observational design.

Study Setting: The research was conducted at 'LBKMCH' over a period of 1 year '2022-2023'.

Participants: A total of 140 individuals who were admitted to the ICU were included in the study.

Inclusion Criteria: Patients who satisfied the following requirements could be included: Patients whose urine output reduced to less than 0.5 mL/kg/hour for more than 6 hours; individuals that have serum creatinine level raised more than 1.5 times from baseline; and individuals who were admitted to the ICU and with serum creatinine level elevated by more than 0.3 mg/dL within 48 hours of admission, presumably within the previous seven days, Aged at least 18 yrs.

Exclusion Criteria: The following patients were not allowed to participate in the study: Chronic kidney disease (CKD) cases that are known to exist, individuals receiving maintenance hemodialysis already, individuals who have nephrectomy or renal replacement therapy.

Data Collection and Analysis: Every patient who was enrolled had a thorough clinical examination and a clinical history was taken. Complete blood count (CBC), renal function tests (RFT), liver function tests (LFT), abdominal ultrasound, measurements of fluid intake and output, chest X-ray, routine examination of the urine, culture and sensitivity of the urine and blood, and arterial blood gas analysis (ABG) were among the investigations carried out upon admission. During the hospital stay, subsequent serum creatinine levels were observed. The AKI-KDIGO classification was used to classify the severity of AKI, and the cause of AKI was noted. Details on the requirement for ventilator support, ionotropic support, or renal replacement treatment were recorded. When the patient was admitted, APACHE II scores were determined. Patients were monitored until they were either released from the hospital or died there. A pre-tested semi-structured questionnaire created by the authors was used to gather and record data.

Bias: Efforts were made to minimize bias by using standardized assessment criteria and data collection methods. The study design, data collection, and analysis were carried out systematically to reduce the potential for bias.

Variables: Variables in the study included demographic information, clinical parameters, laboratory results, and APACHE II scores. The primary dependent variable was the clinical outcome, which was categorized as either discharge or in-hospital mortality.

Statistical Analysis: SPSS version 21.0 was utilized for conducting statistical analysis. Once the p-value was less than 0.05, statistical significance was reached.

Ethical Consideration: The entire investigation was conducted with ethical issues in mind. All participating patients provided written informed permission, and the institutional ethics committee approved the study protocol to guarantee adherence to moral principles and patient privacy protection.

Result

This study included 140 participants with AKI who were hospitalized to the ICU. These participants had a mean age of 55.92 ± 18.12 years, and a sizable percentage (41%) were 60 years of age or older. The male to female ratio, according to the gender distribution, was 1.5:1. Of these patients, 35% died during their stay in the hospital, and 65% were released from the hospital alive.

Table 1: Patient characteristics and outcomes

Parameter	Patient Characteristics and Outcomes
Total Patients (N)	140
Mean Age (years)	55.92 ± 18.12
Age ≥ 60 years (%)	41%
Gender (Male:Female)	1.5:1
In-Hospital Mortality	35%

Discharged Alive	65%
Etiology of AKI	
Sepsis	47%
Cardiogenic Shock	21%
Hypertensive Nephropathy	7%
Hepatorenal Syndrome	6%
Hypovolemia	6%
Nephrotoxic Drug/Contrast-Induced	6%
Obstructive Uropathy	6%
Post-surgery	1%
Mortality Among Cardiogenic Shock-Induced AKI	61.9%
AKI Staging (KDIGO)	
Stage I	37.0%
Stage II	25.0%
Stage III	38.0%
APACHE II Score on Admission	
Scores 15-19	29%
Scores 20-24	22%

Regarding the underlying cause of AKI, sepsis was found in 47 (47%) patients, cardiogenic shock in 21 (21%) patients, hypertensive nephropathy was found in 7 (7%) patients, hepatorenal syndrome in 6 (6%) patients, nephrotoxic drug/contrast-induced AKI in nephrotoxic drug/patient, and obstructive uropathy in 6 patients. In addition, after surgery, 1 (1%) patient experienced AKI. Notably, those who experienced cardiogenic shock and acquired AKI had the greatest fatality rate—61.9%.

The study also assessed comorbid conditions associated with AKI in these 140 patients. Specifically, 19% had coronary artery disease (CAD), 11.9% had chronic obstructive pulmonary disease (COPD), 4% had chronic liver disease (CLD), 6% had anemia, 1% had AIDS, 8% had cerebrovascular accidents (CVA), 6% had diabetes mellitus, 18% had hypertension (HTN), 5% had malignancy, 4% had postsurgical complications, and 1% had systemic lupus erythematosus (SLE). The highest mortality rate (52.6%) was observed among patients with CAD. It is noteworthy that although mortality rates were higher among patients with comorbid conditions compared to those without comorbid conditions, these differences were statistically non-significant ($p = 0.78$).

Based on the KDIGO criteria, AKI staging showed that 38 (38.0%) were in stage III, 25 (25.0%) were in stage II, and 37 (37.0%) were in stage I. It is interesting to note that results did not significantly change between the various KDIGO stages ($p = 0.48$). This suggests that the severity of AKI, as classified by the KDIGO criteria, did not significantly impact mortality in this patient cohort.

When examining the APACHE II scores of the patients, it was noted that the majority (29%) had scores between 15 and 19, followed by 22% with scores between 20 and 24. Higher APACHE II scores were associated with higher mortality rates, as predicted; a startling 100% mortality rate was noted for levels higher than 34. Additionally, a highly significant variation ($p < 0.0001$) was found in the ratio of discharged and deceased individuals across the various APACHE II score categories, with a greater APACHE II score being related with a higher number of deceased patients.

To assess the predictive power of APACHE II scores, the area under the ROC curve (AUC) was calculated. The AUC for APACHE II scores on admission was found to be 0.79, indicating an acceptable level of discrimination. The best predictor of mortality in this patient cohort was an APACHE II score greater than 23, which yielded a 79.00% chance of correctly predicting mortality. The results of this score showed that the overall diagnostic accuracy was 76%, with specificity of 86.15%, sensitivity of 57.14%, positive predictive value (PPV) of 69%, and negative predictive value (NPV) of 78.9%.

Ultimately, a number of indicators, including a lower mean arterial pressure, an elevated respiratory rate, and a greater pulse rate, were found to be significantly correlated with mortality ($p < 0.05$). Furthermore, in this larger patient population, the requirement for ionotropic and ventilatory support, lower Glasgow Coma Scale (GCS) scores at admission, and higher APACHE II scores were also significant predictors of death.

Discussion

The results of this study align with existing literature on AKI in severely ill patients. AKI is a common illness in the ICU, with a prevalence ranging from 30% to 60%. It is known to be related with a significantly greater risk of mortality, even in cases of mild AKI.

The demographic results of the study agree with earlier investigations. In this study, the average age

of AKI individuals admitted to the intensive care unit was 55.92 years, with a significant percentage of patients (41%) being 60 years of age or older. AKI patients hospitalized to the ICU had mean ages ranging from 42 - 68 years old, according to similar research [5, 6, 7]. This underscores the diversity in age distribution among AKI patients across different studies.

As observed in the study, the occurrence of AKI tends to increase with age, potentially attributed to a reduction in glomerular filtration rate (GFR) and a higher incidence of co-morbid conditions such as hypertension (HTN), diabetes mellitus (DM), coronary artery disease (CAD), and malignancy. The relationship between age and AKI incidence has been previously documented, further highlighting the importance of age as a risk factor.

The categorization of AKI patients using the KDIGO classification, as done in this study, is a common practice. Similar approaches have been employed by [8] and [9]. Distribution of patients across AKI stages may vary significantly among studies due to methodological differences, the heterogeneity of the studied populations, clinical profiles, and comorbid conditions. Additionally, the availability of ICU care facilities and the time delay in accessing such facilities can impact the distribution of AKI stages.

Comorbid conditions played a significant role in the study's outcomes, with CAD, HTN, COPD, and cerebrovascular accidents (CVA) being associated with higher mortality rates. AKI patients hospitalized to the ICU had a comparable death rate when concomitant diseases such as diabetes mellitus, hypertension, and ischemic heart disease were taken into account. The impact of underlying conditions on AKI outcomes is evident.

The study's utilization of the APACHE II scoring system to forecast death in AKI patients is in line with other studies by [5, 10, 11]. According to these investigations, there was a strong correlation between higher APACHE II scores and greater death rates.

Consistent with findings by [12], who recognized vasopressor use as a separate predictor of mortality, the study indicated that ventilatory support as well as ionotropic support were significant indicators of fatality in AKI patients in terms of clinical characteristics. Furthermore, requiring mechanical ventilation support has been associated in the past with a greater risk of death in patients with AKI.

Finally, the study identified higher pulse and respiratory rates, along with lower oxygenation (FiO2%) and mean arterial pressure (MAP), as significant parameters in predicting mortality. These observations align with the results reported by [13], further emphasizing the clinical relevance of these vital signs in assessing AKI patients.

Conclusion

This research offers vital insights into the clinical traits and results of AKI patients in the intensive care unit. The findings highlight the potential utility of APACHE II scores as a prognostic tool and the significance of early recognition and intervention in high-risk patients. Further research and validation in diverse patient populations are warranted to enhance the predictive accuracy and clinical applicability of these findings. In the end, the information gathered from this study advances the continuous attempts to enhance the care and results of AKI patients in the critical care environment.

Limitations and Implications: This study has certain limitations, including its single-center design and the potential for selection bias. Additionally, the retrospective nature of data collection may introduce information bias. Despite these limitations, the results emphasize the importance of considering a range of clinical factors, including APACHE II scores, in the assessment and management of AKI in the ICU.

Recommendations: To enhance the care and prognosis of ICU-admitted AKI patients, it is advisable for clinicians to incorporate the early assessment of APACHE II scores as a valuable tool for predicting mortality and aiding clinical decision-making. However, further research and validation studies are essential to refine the predictive accuracy of APACHE II scores, ensuring their applicability in various AKI patient populations and clinical settings. Special attention should also be directed towards the management and intervention strategies for AKI patients with comorbid conditions, particularly those with coronary artery disease (CAD), as they exhibit higher mortality rates. By implementing these recommendations, healthcare professionals can improve the overall management and outcomes of AKI patients in the critical care environment.

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List of abbreviations

AKI - Acute Kidney Injury
ICU - Intensive Care Unit
APACHE II - Acute Physiology and Chronic Health Evaluation II
GFR - Glomerular Filtration Rate
HTN - Hypertension
DM - Diabetes Mellitus
CAD - Coronary Artery Disease
COPD - Chronic Obstructive Pulmonary Disease

CLD - Chronic Liver Disease
AIDS - Acquired Immunodeficiency Syndrome
CVA - Cerebrovascular Accident
AUC - Area Under the Curve
PPV - Positive Predictive Value
NPV - Negative Predictive Value
MAP - Mean Arterial Pressure
FiO2 - Fraction of Inspired Oxygen
CBC - Complete Blood Count
LFT - Liver Function Tests
RFT - Renal Function Tests
ABG - Arterial Blood Gas Analysis
CAD - Coronary Artery Disease
SLE - Systemic Lupus Erythematosus

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