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Original Research Article

A Comparative Analysis of Two Severity Scoring Systems in Predicting the Prognostic Outcomes in Acute Renal Failure

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Abstract:

Introduction: Predicting outcomes is crucial in clinical practise. The mortality rate linked with acute kidney injury (AKI) in older people is still high, despite major therapeutic advancements. Many severity grading methods have been utilised for predicting patient death in hospitals, but nothing is known about the importance of these systems for older patients with AKI.

Method: 431 people were hospitalised to four intensive care units as part of a prospective cohort using this methodology. Using association and correlation tests, the clinical characteristics at admission, severity profile, and level of treatment were examined. Using the ROC curve, the scores' sensitivity and specificity were evaluated.

Results: 431 patients were examined for the study during data collection. When compared to the patients in the group without injury, patients in the AKI group were older (61 years vs. 64 years, p = 0.018) and more frequently from the emergency department (14.8% vs. 28.3%, p 0.002), according to the comparative analysis between the clinical and demographic characteristics of the individuals studied.

Conclusion: The prognostic scores have a good ability to predict death, dialysis, and acute renal injury. The Charlson Comorbidity Index performed poorly when it came to predicting the need for dialysis but performed well for acute renal injury and death.

Keywords: Simplified Acute Physiology Score; Organ Dysfunction Scores; Dialysis; Death; Acute Kidney Injury; Intensive Care Units.

Introduction

The Kidney Disease Improving Global Outcomes (KDIGO) criteria for defining acute kidney injury (AKI) are based on changes in the level of plasma creatinine (Cr), urine output, and utilisation of renal replacement therapy (RRT) [1]. AKI is characterised by a sudden decrease in renal function. Numerous studies have focused on the incidence, risk factors, and outcomes of AKI, and it has become a major area of research within the field of intensive care medicine [2–5]. The death rates for patients with AKI vary from 20 to 60%, most likely as a result of the varied demographics and different ways that AKI classifications are used [6].

Acute kidney injury (AKI) is a multifactorial clinical illness that is characterised by a reduction in glomerular filtration rate and/or urine volume, which leads to a rapid impairment of the kidneys and damage to the renal tissues [7]. Due to their clinical instability and increased likelihood of developing it as a result of hospitalisation, many patients admitted to intensive care units (ICU) are more likely to do so [8].

As a result, clinical practise has focused on diagnosing acute kidney injury utilising creatinine levels during clinical treatment as well as figuring out how serious patients are on a daily basis and categorising kidney injury stages [7,9].

Studies frequently exclude the duration of AKI in favour of focusing on the occurrence of AKI as a dichotomous variable or reporting the highest

stage. However, increased hospital and long-term mortality are linked to both greater AKI severity and AKI duration [10-13]. Additionally, it has been discovered that individuals with AKI who meet both the Cr and urine output requirements consistently have greater fatality rates than those who only meet one of the two criteria [10,14]. Furthermore, it has been demonstrated that the prognostic significance of AKI and renal recovery is time-dependent [15,16]. However, no study has examined the relationship between results and the length of the various AKI stages.

The international guideline Kidney Disease: Improving Global Outcomes (KDIGO) was launched with the goal of directing clinicians in clinical practise and, as a result, reducing the high morbidity and mortality still observed today [9,17]. Its goals include standardising the concept of AKI and preventing and facilitating its diagnosis. According to KDIGO, acute kidney injury staging can be carried out by examining the rise in serum creatinine. Stage 1 refers to creatinine levels below 0.3 mg/dl or a 50% increase from baseline levels; stage 2 refers to lesions when baseline serum creatinine increases by 100%; stage 3 refers to failure when baseline serum creatinine increases by 20% or when renal replacement medication is necessary. Additionally, only individuals who are stage 3 according to KDIGO are recommended for renal replacement therapy [17].

The prognostic score is a measure that can be used to support clinical practise and management of care as a trustworthy predictor of hospital mortality in critically sick patients. The most common scores are the sequential Organ Failure Assessment (SOFA), which uses clinical and laboratory parameters to predict organ dysfunction, evaluating a total of six systems (respiratory, hematologic, hepatic, and cardiovascular), the Simplified Acute Physiology Assessment Score 3 (SAPS 3), the ICU scoring system also utilised for predicting mortality risk, and the Charlson Comorbidity Index (CCI), which predicts mortality based on patients' clinical conditions and morbidity. [18-20]

Materials and Methods:

Sample: Patients admitted to four intensive care units during the data collecting period made up this convenience selection of patients. The study period was January 2022 to June 2023 and the study was done at a tertiary care centre NRI Institute of Medical Sciences, Sangivalasa, Visakhapatnam.

Inclusion and exclusion criteria: All patients admitted to the ICU with AKI after admission to the ICU or upon prior medical diagnosis during the data collection period, were included in the study. Those patients who were 18 years of age or older and with a minimum stay of 24 hours in the ICU were included. Patients with no serum creatinine results were excluded from this study.

Data Collection: Information was recorded in the following domains: demographic data, clinical aspects, assistance with admission to the ICU, and outcomes using a specialised instrument designed for data collection. By examining the variables sex, age, weight, race, origin, comorbidities, usage of medications, and prediction scores for mortality and organ dysfunction, sample epidemiological and clinical characterisation was carried out.

CCI, SAPS, and SOFA were the prognostic prediction systems that were employed. It should be highlighted that these scoring systems, which are based on different sub scores of failure of organs, are validated for use in clinical and hospital situations, with a focus on critically sick patients admitted to the ICU. Given the dearth of papers pertaining to this association, it is difficult to evaluate these three scores in terms of the prediction of AKI, dialysis, and death through the examination of sensitivity and specificity.

The SAPS 3 prognostic score was used because it is a prognostic score for disease severity, with the purpose of predicting mortality based on data obtained at admission; the SOFA was used for recognising organ dysfunction, that describes the physiological disorders by organs system; the CCI determines the burden of morbidity and the patients' risk of death through the scoring of clinical conditions, recorded as secondary diagnoses [18-20].

For a period of seven days and/or until discharge from the ICU due to discharge, death, or transfer to another institution, daily records were kept in accordance with the collection instrument in order to identify the outcomes including acute kidney injury (AKI), hemodialysis (conventional hemodialysis), and death. Creatinine levels were measured between 48 hours and 7 days to determine the patient's injury stage and to record the AKI result. Utilising the medical records, the laboratory tests (serum BUN and creatinine, electrolytes, and liver profile) follow-up was carried out in order to monitor the progression of AKI and record the results.

With the aid of an instrument for collecting data to systematise information gathering, data were gathered by a before trained team with the participation of students from undergraduate (nursing, pharmacy, medicine, and physiotherapy) and graduate courses from the daily consultation of the patient's medical record. The researchers were divided into daily scales to visit the ICUs and make sure that at least two of them were there every day of the week in order to ensure that all the data needed for the study was gathered.

Data Analysis and Treatment: The Excel® 2019 programme was used to plot the data in tables. In order to define categorical variables, absolute and relative percentage frequencies were used. In order to describe continuous variables, median and interquartile range were used.

The sensitivity and specificity values were expressed as a Receiver Operating Characteristic (ROC) curve to enable the interpretation of the data discovered. The selection, organisation, and evaluation of diagnostic and/or prognostic systems can be done graphically using this method. By mapping continuous variables, the approach demonstrates the connection between specificity and sensitivity. Therefore, the accuracy of the diagnosis increases as the area under the curve increases [21].

Areas Below the Curve (AUC) estimates for death, acute renal damage, and dialysis associated with Charlson, SAPS 3, and SOFA predictors were made using ROC curves. Acute kidney injury was the independent variable in a two-way repeated measures analysis of variance (ANOVA), and the dependent variables included fluid balance, creatinine, diuresis, haemoglobin, lactate, nursing activities score (NAS), potassium, sodium, SOFA, and BUN over the course of seven days. The R Core Team 2020 was the programme utilised, and the significance threshold chosen was 5%.

Results

431 patients were examined for the study during data collection. When compared to the patients in the group without injury, patients in the AKI group were older (61 years vs. 64 years, p = 0.018) and more frequently from the emergency department (14.8% vs. 28.3%, p 0.002), according to the comparative analysis between the clinical and demographic characteristics of the individuals studied. In the group of patients with acute renal injury, the prevalence of dyslipidemia (3.4% vs. 9.4%, p = 0.020) and creatinine values above 1.5 mg/dL on admission (41.8% vs. 2.7%, p<0.021) were more common (Table 1).

In the data analysis of the admission profile, it was found that patients who developed AKI utilised more norepinephrine (10.4% vs. 8.1%, p<0.002), underwent more sedation with fentanyl citrate (51.3% vs. 31.7%, p<0.001) and midazolam hydrochloride (3.7% vs. 8.5%, p = 0.004), and used more invasive devices like Additionally, patients who had sustained injuries had greater admission severity as determined by the Charlson score (4.0 vs. 3.0, p = 0.003) and the SAPS 3 (1 vs. 26, p<0.002), respectively (Table 1).

Table 1: Clinical and demographic characterization of patients evaluated with and without acute kidney injury

Variables	Total (n = 431)	AKI (+)	AKI (–)	p-Value
Weight in Kg, median (IQR)	61 (18)	65 (23)	61 (17)	0.325[W]
Age in years, median (IQR)	61 (24)	64 (26)	61 (26)	0.018[W]
Sex, n (%)				
Female	213 (49.4)	154 (35.7)	77 (17.8)	0.507[Q]
Male	218 (50.5)	163 (37.8)	55 (12.7)	
Origin, n (%)				
Surgical Clinic	17 (3.9)	6 (1.3)	11 (2.55)	0.002[Q]
Emergency	186 (43.1)	64 (14.8)	122 (28.3)	
Internal Medicine	75 (17.4)	31 (7.1)	44 (10.2)	
Operating room	153 (35.0)	12 (2.7)	141 (32.7)	
Comorbidities				
Previous stroke, n(%)	50 (11.6)	30 (6.9)	20 (4.6)	0.460[Q]
Heart Failure, n(%)	35 (8.1)	11 (2.5)	24 (5.5)	0.060[Q]
Diabetes, n(%)	101 (23.)	46 (10.6)	55 (12.7)	0.175[Q]
Previous AMI, n(%)	42(9.7)	12 (2.7)	30 (6.9)	0.300[Q]
Systemic Arterial Hypertension, n(%)	65(15.08)	26 (6.03)	39 (9.0)	0.129[Q]
Arrhythmia, n(%)	32 (7.4)	17 (3.9)	15 (3.4)	0.456[Q]
Dyslipidemia, n(%)	27 (6.2)	15 (3.4)	12 (2.7)	0.021[Q]
Basal Creatinine > 1.5 mg/dL, n(%)	25 (5.8)	5 (1.1)	20 (4.6)	0.019[Q]
Previous Smoker, n(%)	15(3.4)	10 (2.3)	5 (1.1)	0.866[Q]
Current Smoker, n(%)	39 (9.04)	13 (3.01)	26 (6.0)	0.626[Q]
Admission support				
Indwelling urinary catheter, n(%)	105 (24.3)	63 (14.6)	42 (9.7)	0.085[Q]
Use of Dobutamine, n(%)	22 (5.1)	14 (3.2)	8 (1.8)	0.217[Q]
Central Venous Catheter, n(%)	70 (16.2)	35 (8.1)	35 (8.1)	0.029[Q]
Use of norepinephrine, n(%)	80 (18.5)	45 (10.4)	35 (8.1)	0.002[Q]
Orotracheal Tube, n(%)	29 (6.7)	9 (2.0)	20 (4.6)	0.001[Q]

Use of Fentanyl, n(%)	39 (9.04)	14 (3.2)	25 (5.8)	0.002[Q]
Use of Midazolam, n(%)	53 (12.2)	16 (3.7)	37 (8.5)	0.004[Q]
Nasoenteric tube, n(%)	33 (7.6)	6 (1.3)	27 (6.2)	0.003[Q]
Severity prediction scores				
Charlson score, median (IQR)	4 (5)	3 (0.69)	1 (0.23)	0.003[W]
Admission SAPS 3, median (IQR)	27 (21)	1 (0.23)	26 (6.03)	0.002[W]

When some factors were examined separately, it became clear that there was a higher likelihood of getting AKI. Among these, baseline creatinine > 1.5 mg/dl increased the odds by 7.27 times, norepinephrine use increased the odds almost threefold (OR = 2.82), ventilator use for > 47 hours was associated with a threefold rise in odds (OR: 3.04), the onset of the infection raised the odds by 2.1 and age raised the variance by 1.01, and patients who experienced pressure injury (PI) were 5.5 times more likely to have the condition.

Discussion

This study looked at how well prognostic scores may predict acute renal injury, the need for dialysis, and death in patients receiving intensive care in a developing nation. The three prognostic systems' AUC varied, ranging from a minimum value of 0.565 to a maximum of 0.708. This result so demonstrates that these systems have the ability to forecast ICU patients' outcomes based on the variable under study. The findings that were revealed here also made it possible to pinpoint the prevalence and risk factors for AKI in intensive care units.

Given the dearth of research linking these three scores to the studied variables, evaluating these three scores for the prediction of AKI, dialysis, and death through sensitivity and specificity analysis constitutes a challenge and distinguishes this study from others.

Patients admitted to the ICU via the emergency unit differed significantly from those without AKI in this study. The severity of these patients, which frequently progresses to hemodynamic instability, may be the cause. When the SAPS 3 and CCI were used to determine admission severity, patients with injuries showed higher levels of severity than patients without injuries. Additionally, the use of nephrotoxic medications, hemodynamic alterations linked to hypovolemia, and other factors all had a substantial impact on AKI in this study.

Vasopressor medication use is known to cause nephrotoxicity and raise the risk of AKI in critically ill patients [22]. Therefore, these findings were consistent with those of this study, where it was discovered that patients in the AKI group had a greater requirement for these medications and sedatives.

If the patient is hypotensive and not hypovolemic, norepinephrine, a vasoactive medication (VAD), is frequently given in the intensive care unit. However, the individuals in this trial had approximately a threefold greater chances of acquiring AKI as a result of using this medication. Since of their hemodynamic instability and vasoconstrictor impact, VADs must be used with caution and awareness since they might indirectly cause ischemia and a reduction in renal perfusion, especially in hypovolemic states [23].

More than half of the patients in the AKI group in the study required mechanical ventilation (MV) for longer than 48 hours, which is a finding that can be compared to the outcomes of studies showing that the use of these devices can cause acute failure due to three main mechanisms, namely: effect on systemic and renal blood flow; effects on arterial gases; and systemic release of inflammatory agents, producing immediate effects on renal function [8,24]

Similar to the usage of MV, patients with AKI tended to use medical devices more frequently, including orotracheal tubes, nasoenteric tubes, and central venous catheters. Patients who are more seriously ill typically require more medical equipment, which encourages the growth of infectious processes. As a result, using devices is a possible indirect sign of AKI. Nearly half of the AKI patients in this study also had an infectious disease. It is well recognised that AKI may be related to an antibiotic medication, which is employed in the majority of infectious illnesses in the ICU setting. As a result, it might be challenging to determine the cause and effect relationship between infections and AKI. However, a study shows that the link between sepsis and renal damage makes these patients' prognoses worse [25].

The present study's findings must be understood in the context of various potential limitations. First, the clinical profiles and severity levels of the patients varied. Therefore, generalisations must be used with care. It was only established in one state, thus research including additional centres may offer more complete data and encourage more in-depth comparative conversations on the topic under study. Additionally, the percentage of patients who improved with their renal function recovery was not assessed. Finally, given that data were gathered from medical records, which can contain inaccurate records, there is a potential of measuring bias.

It is notable for being a ground breaking study that examined the incidence, risk factors, and mortality of acute kidney injury in several hospitals in a developing nation in addition to combining these three prognostic scores with the variables AKI, dialysis, and death in patients admitted to the ICU. As a result, this study opens up the possibility of better care and prediction for critically sick patients receiving hospital treatment in hospitals and other similar settings.

Limitations

The present study's findings must be understood in the context of various potential limitations. First, the clinical profiles and severity levels of the patients varied. Therefore, generalisations must be used with care. It was only established in one state, thus research including additional centres may offer more complete data and encourage more in-depth comparative conversations on the topic under study. Additionally, the percentage of patients who improved with their renal function recovery was not assessed. Finally, given that data were gathered from medical records, which can contain inaccurate records, there is a potential of measuring bias.

Conclusion:

This study demonstrated that AKI is a complex occurrence that happens most frequently in older, predominantly male, critically unwell clinical patients. Additionally, it was found that although the Charlson comorbidity index, SAPS 3, and SOFA only have a limited ability to predict acute renal injury and dialysis, they do an excellent job at predicting variable mortality.

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