Original Research Article

Comparison of Two Severity Scoring System in Predicting the Prognosis in Acute Kidney Failure

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Received: 14-10-2021 / Revised: 19-11-2021 / Accepted: 12-12-2021

Abstract

Introduction: Acute kidney injury (AKI) is characterised by the sudden impairment in the kidney function resulting in retention of nitrogenous and other waste products and is associated with a high rate of mortality. One of the main problems of critically ill AKI patients is the lack of validated, well-established scoring systems to stratify the severity of patient disease states. The third generation ICU scoring systems i.e. SAPS 3 and APACHE IV are more updated. These models have been less assessed on non- dialysis acute kidney injury patients in ICU. The objective of this study is to compare between the two-scoring systems in predicting the outcome of patients with Acute kidney injury admitted in ICU. **Methods**: Sample size was calculated using the G* POWER 3.1 version software. Patients admitted in intensive care unit of Yenepoya Medical College Hospital with acute kidney injury were chosen for the study after informed consent. Detailed history was taken, and systemic examination was done. Relevant investigations were done which was required for the scoring. Data considered for the calculation of the SAPS 3 was collected and recorded within 1 hour of ICU admission and predicted mortality rates were calculated. APACHE IV scores were calculated using data during the first 24 hours of admission and predicted mortality rates were calculated as per the APACHE IV calculator by RNSH, Sydney. SPSS (Statistical Package for Social Sciences) version 20 [IBM SPSS statistics (IBM Corp., Armonk, NY, USA released 2011)] was used to perform the statistical analysis. **Results:** Out of total 75 AKI patients, 56(74.6%) patients survived, and 19(25.4%) patients died. Among these total 75 patients 46 patients were males and 29 patients were females. Most of the survivors were in the age group 56 to 65 years (33.9%). The sensitivity of both APACHE 4 and SAPS 3 scores were same at 78.9%, and specificity was higher for APACHE 4 score (67.9%) compared to 62.5% in SAPS 3. These changes were statistically significant.**Conclusion:** In this observational study conducted at intensive care unit in Yenepoya medical college, the collected data statistically demonstrates that APACHE IV score predicts mortality better than SAPS. However, the sensitivity of both scores remained similar, the specificity was higher for APACHE IV. SAPS 3 scoring system had the advantage of predicting the mortality rate prior to the ICU intervention.

Keywords: Acute Kidney Failure, Prognosis, Severity Scoring System, Survivor, Non-survivor.

Introduction

Acute kidney injury (AKI) is characterised by the sudden impairment in the kidney function resulting in retention of nitrogenous and other waste products.[1] It is associated with a high rate of adverse outcomes, mortality rates can range from 25 to 80 percent, depending on the clinical status and the cause[2]. Acute renal failure (ARF) was initially defined as abrupt and sustained decrease in renal function test. However later acute renal failure (ARF) was replaced by the term acute kidney injury (AKI) which had broader spectrum of severity. AKI was previously known as ARF, is associated with significantly increased mortality, length of hospital stays and costs across a broad spectrum of conditions.[3] Acute renal failure (ARF) is frequently observed in hospitalized patients and is increasingly prevalent in aging populations with multiple chronic comorbidities in subjects with severe underlying diseases such as neoplasia or AIDS, and in the intensive care unit (ICU) populations. Acute renal failure-specific prediction models developed in the past were usually derived from single institutions and more often have been validated in specific subsets of ARF patients, such as ARF in the ICU, ARF on haemodialysis or on continuous hemofiltration, ARF following aortic aneurysm or heart surgery, and ARF exclusively caused by acute

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tubular necrosis (ATN). Traditionally, ICU prediction of mortality was purely based on clinical experience[4].

One of the main problems concerning the design of clinical trials in critically ill AKI patients is the lack of validated, well-established scoring systems to stratify the severity of patient disease states. It remains speculated, which is the best models (general or specific scores) for AKI patients and the most appropriate time for scores application[5]. Research into acute kidney injury (AKI) took a significant step forward with the introduction of the Risk, Injury, Failure, Loss, End stage (RIFLE) AKI criteria in 2004 by the Acute Dialysis Quality Initiative Group. These consensus criteria for AKI replaced the more than 30 different definitions that had existed prior to this point[6].Most studies have assessed the second-generation scores that is acute physiology and chronic health evaluation (APACHE) II and**,** APACHE III, SAPS II. The recent development of third generation scores are APACHE IV, SAPS III and mortality probability model. They have been previously assessed and compared in critically ill patients but very handful of studies which assess their accuracy of predicting the mortality in patient with Acute kidney injury admitted in critical care setting.Acute Physiology and Chronic Health Evaluation (APACHE) was the first general severity scoring model applied to most of the critically ill patients. It was developed by William Knaus et al at the George Washington University Medical Centre in 1981[7]. The APACHE system demonstrated the ability to evaluate, in an accurate and reproducible form, the severity of disease in this population. The APACHE IV scoring system uses the worst physiological measurements on day 1 of ICU admission. It also provides ICU length of stay which can provide benchmarks for the assessment and comparison of ICU efficiency and resource use[8].The Simplified Acute physiological score (SAPS) was first released in 1984 as an alternative to APACHE scoring. The original score had data inputs collected within 24 hours of ICU admission which had assessment of 14 physiological variables and their degree of deviation was normal, but it lacked the inputs which addressed the pre-existing comorbid disease. It has been superseded by the SAPS II and SAPS III, both of which assess the 12 physiological variables in the first 24 h of ICU admission and include weightings for pre-admission health status and age**[7].**The third generation ICU scoring systems i.e. SAPS 3 and APACHE IV are more updated. These models have been less assessed on non- dialysis acute kidney injury patients in ICU. There are very few studies available among the latest scores which help in better prediction of outcome in AKI patients. The objective of this study is to compare between the two-scoring systems in predicting the outcome of patients with Acute kidney injury admitted in ICU.

Methods

Sample size was calculated using the G* POWER 3.1 VERSION software with prevalence of 20%, 5% level of significance, power 80% and 0.15 as effect size, sample size required will be 72 approximately 75.Patients admitted in intensive care unit of Yenepoya Medical College Hospital with acute kidney injury were chosen for the study after informed consent. If patient was not able to comprehend, surrogate was taken by the bystanders. Detailed history was taken and systemic examination was done. Laboratory tests like CBC, sodium, blood glucose levels, urea, creatinine, liver function tests, arterial blood gas analysis, Urine routine and other relevant investigations were done which was required for the scoring.

AKI is defined as an increase of 50% of baseline serum creatinine (SCr) measurement according to the R (risk) level criteria of RIFLE system. Data considered for the calculation of the SAPS 3 was collected and recorded within 1 hour of ICU admission and predicted mortality rates were calculated. APACHE IV scores were calculated using data during the first 24 hours of admission and predicted mortality rates were calculated as per the APACHE IV calculator by RNSH, Sydney. Patients were followed up until discharge from the hospital and outcomes of the patients were recorded. The two scores and the ability to predict the outcome was assessed using chi square test.SPSS (Statistical Package for Social Sciences) version 20 [IBM SPSS statistics (IBM Corp., Armonk, NY, USA released 2011)] was used to perform the statistical analysis. Descriptive statistics of the explanatory and outcome variables was calculated by mean, standard deviation for quantitative variables, frequency and proportions for qualitative variables. Inferential statistics like Chi square test was used to test the significance between qualitative variables. Unpaired t-test was used to test the significant difference for quantitative variables for two different groups. Receiver operating characteristic curve was drawn to calculate the area under curve. Sensitivity, specificity and cut off values for APACHE and SAPS scores were calculated. The level of significance was set at 5%.

Results

Out of total 75 AKI patients, 56(74.6%) patients survived, and 19(25.4%) patients died. Among these total 75 patients 46 patients were males and 29 patients were females. Out of 46 male patients 34(60.7%) patients survived and 12(63.2%) died. Out of 29 females 22(39.3%) survived and 7(36.8%) died.Most of the survivors were in the age group 56 to 65 years (33.9%), followed by 25% in 46 to 55 years; the lowest age group with survivors are in 76 to 85 years. The Non-survivors group the highest number was seen in 26 to 35 and 56 to 65 years (26.3%); the lowest number of non-survivors were in the age group less than 25 years. The gender distribution showed that in the survivors group majority were males (60.7%) and non-survivors' group also males were highest (63.2%).

The urine output of 500 to 2000 ml was highest in the survivors (55.4%) and the non-survivors were having very low urine output (<500 ml) in 14 patients (73.7%). This difference was statistically significant ($p < 0.005$)The readmission rate of survivors was just 8.9% and non-survivors rate is more with 26.3%. This difference was not statically significant.The temperature was on higher side in non-survivors, MAP was higher in survivors, FiO_2 was higher in non-survivors, PCO_2 was highest in survivors, Arterial PH was more alkaline in survivors, urine output was higher in survivors, creatinine was higher in non-survivors, urea was higher in non-survivors, albumin was highest in survivors and bilirubin higher in non-survivors; this difference was seen to statistically significant ($p<0.005$).The sensitivity of both the scores were same at 78.9%, and specificity was higher for APACHE 4 score (67.9%) compared to 62.5% in SAPS 3. These changes were statistically significant.

The ROC curve has the graphical representation of the ability of prediction of the two scores; in that it showed the APACHE 4 score to better than SAPS 3 score in both sensitivity and specificity.

Table 1: Age distribution in Survivors and Non-survivors

Age group	Survivor	Non survivor	Total	Chi square test	p-value
< 25	2(3.6%)	0(0%)	2(2.7%)	4.264	0.641
26-35	6(10.7%)	5(26.3%)	11(14.7%)		
36-45	5(8.9%)	1(5.3%)	6(8.0%)		
46-55	14(25%)	4(21.1%)	18(24%)		
56-65	19(33.9%)	5(26.3%)	24(32%)		
66-75	9(16.1%)	3(15.8%)	12(16%)		
76-85	1(1.8%)	1(5.3%)	2(2.7%)		
Total	56(100%)	19(100%)	75(100%)		

Table 2: Gender distribution in survivors and non-survivors

Gender	Survivor	Non survivor	Total	Chi square test	p value
Female	22(39.3%)	7(36.8%)	29(38.7%)	0.85	0.537
Male	34(60.7%)	12(63.2%)	46(61.3%)		
Total	56(100%)	19(100%)	75(100%)		

Table 3: Urine output in survivors and non-survivors

Urine output	Survivor	Non survivor	Total	Chi square test	p value
< 500	23(41.1%)	14(73.7%)	37(49.3%)	6.23	0.044
500-2000	31(55.4%)	5(26.3%)	36(48.0%)		
> 2000	2(3.6%)	0(0%)	2(2.7%)		
Total	56(100%)	19(100%)	75(100%)		

Table 4: Re-admission in survivors and non-survivors

Readmission	Survivor	Non survivor	Total	Chi square test	p value
No	51(91.1%)	14(73.7%)	65(86.7%)	3.712	0.054
Yes	5(8.9%)	5(26.3%)	10(13.3%)		
Total	56(100%)	19(100%)	75(100%)		

Table 5: Depicting all variables in survivors and non-survivors

Variables	Actual mortality	N	Mean	Std. Dev	Mean Diff	p-value
Age	Survivor	56	54.27	14.22	2.37	0.546
	Non survivor	19	51.89	16.20		
Temp	Survivor	56	37.07	0.76	-3.43	0.07
	Non survivor	19	40.51	14.09		
Heart rate	Survivor	56	96.48	16.51	-2.99	0.56
	Non survivor	19	99.47	26.01		
MAP	Survivor	56	93.13	19.20	3.65	0.48
	Non survivor	19	89.47	19.41		
Resp. rate	Survivor	56	25.45	6.71	0.97	0.61
	Non survivor	19	24.47	8.11		
FiO_2	Survivor	56	30.07	9.81	-5.61	0.04
	Non survivor	19	35.68	11.10		
PCO_2	Survivor	56	34.92	14.65	3.63	0.36
	Non survivor	19	31.28	14.98		
PO_2	Survivor	56	102.59	54.53	-3.09	0.83
	Non survivor	19	105.67	56.20		
Arterial pH	Survivor	56	7.35	0.11	0.03	0.31
	Non survivor	19	7.31	0.15		
Sodium	Survivor	56	132.52	9.10	0.31	0.89
	Non survivor	19	132.21	5.13		
Urine output	Survivor	56	778.21	661.78	327.32	0.05
	Non survivor	19	450.89	492.52		
Creatinine	Survivor	56	3.08	2.32	-0.82	0.26
	Non survivor	19	3.90	3.60		
Urea	Survivor	56	94.82	48.31	-14.28	0.29
	Non survivor	19	109.11	55.41		
BSL	Survivor	56	159.11	123.53	3.69	0.91
	Non survivor	19	155.42	122.33		
Albumin	Survivor	56	3.18	0.69	0.31	0.09
	Non survivor	19	2.87	0.68		
Bilirubin	Survivor	56	3.11	5.17	-4.02	0.03
	Non survivor	19	7.14	10.44		
HT%	Survivor	56	34.07	8.88	1.04	0.65
	Non survivor	19	33.04	7.05		
WBC (*1000/mm^3)	Survivor	56	12.86	5.86	-2.77	0.12
	Non survivor	19	15.63	8.71		
APACHE 4	Survivor	56	71.07	19.59	-21.40	0.00
	Non survivor	19	92.47	19.08		
Est mortality	Survivor	56	20.34	14.23	-17.29	0.00
	Non survivor	19	37.63	22.10		
Length of stay (days)	Survivor	56	4.63	1.46	-0.32	0.45
	Non survivor	19	4.95	1.84		

SAPS 3	Survivor	56	53.41	11.71	-11.69	0.00
	Non survivor	19	65.11	11.93		
Est Mortality	Survivor	56	26.48	18.93	-22.57	0.00
	Non survivor	19	49.05	22.15		

Table 6: Depicting the Sensitivity and Specificity

Scores	Cut off	Sensitivity (%)	Specificity (%)
APACHE 4	80	78.9	67.9
SAPS 3	56	78.9	62.5

Table 7: Depicting the Comparison of two severity scoring

Area Under the Curve				
Scores	Area	p value	Asymptotic 95% CI	
			Lower Bound	Upper Bound
APACHE 4	.791	.000	.687	.895
SAPS 3	.750	.001	.630	.870

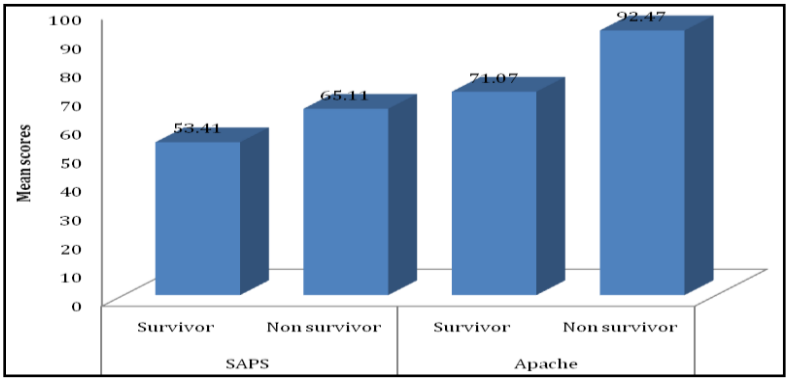

Fig 1: Mean scores by survivors and non survivors

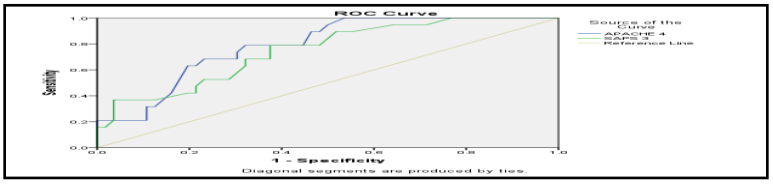

Fig 2: ROC Curve -depicting the Sensitivity and Specificity for APACHE 4 and SAPS 3 Score

Discussion

One of the main problems in the management of critically ill AKI patients is the lack of validated, well-established scoring systems to stratify the severity of patient disease states. It remains speculated, which is the best models (general or specific scores) for AKI patients and the most appropriate time for scores application. Presently the third generation ICU scoring systems i.e., SAPS 3 and APACHE IV are more updated. However, there are no studies available which considers which among the latest scores is better for predicting the outcome in AKI patients. Therefore, this study was attempted in comparing of these two-scoring system in predicting the prognosis in acute kidney failure.

Outcome of patients with AKI

In this study the mortality rate was 25.4%. In the reviewed studies by Bellomo R and Palevsky PM et al. showed that the mortality rate of critically ill patients with AKI was 40% to as high as 70%. Sara Nisula reported that mortality rate of 1141 cases of AKI inpatients was 25.6% and the mortality rate of 90-day-prognosis was 33.7%[3] Other scholars reported that the mortality rate of AKI patients was 32% in 28 days,[4] 44.7% and 52.5% in 90 days[9,11]and 57.5% in 2 years[12]. The reasons of different mortality rates might be related to diagnosis standard, patient's selection, the improvement of the treatment level, racial difference, basic disease, complication, cultural difference, individual economy and medical insurance difference. In previous studies, a mortality rate of 35.9%, 38.5%, and 58% was reported by Peres et al., Oluseyi et al., and Hamzić-Mehmedbašić et al., respectively[13-15].The variation in the mortality rate observed in these studies may be explained by the difference in the study populations, ICU settings, cause of ICU admission and underlying diseases, or by the nonuniform criteria used for defining AKI in different studies.

Age distribution in Survivors and Non-survivors

In this study the more than one third of the survivors were in the age group 56 to 65 years, in the non-survivor group more than two quarters were seen in 26 to 35 and 56 to 65 years group. The gender distribution showed that in the survivors and non-survivors were males. There is no statistical significance among them. This similar result was seen in the studies done by Luo M et al,[10] where most survivor and non-survivors were in the age group 40 to 60 years and males were highest in the survivor and non-survivors' groups. In contrast the findings reported by Hamzić-Mehmedbašić et al. reported that female gender was related to increased mortality[15]and Oluseyi et al., Poukkanen et al., Kohli et al., and Shiao et al., where older age was associated with an increased mortality[16-18].

Urine output in survivors and non-survivors

In our study the oliguria was seen among non-survivors and high to normal urine output in survivors and this difference was statistically significant. This results were similar to the oliguria seen among the AKI non survivors in the study by Luo M et al,[10] other studies showed that oliguria occurrence at AKI diagnosis, were independent significant prognostic indicators for the survivors[17-20]. The presence of oliguria was related to increased mortality in AKI patients in the previous studies reported by Kaul et al., Liaño and Pascual, Dela Cruz et al. and Obialo et al[21-24]. Similarly, oliguria was found to be an independent predictor of mortality or poor outcome in studies done by Teixeira C et al., and de Mendonca et al [25,26].

All Variables in survivors and non-survivors

In this study significantly higher variables were seen among the non-survivors of them the temperature was on the higher side in the non-survivors, MAP was higher in survivors, FiO_2 was higher in non-survivors, PCO_2 was highest in survivors, Arterial PH was more on alkaline side in survivors, Urine output was higher in the survivors, creatinine was higher in non-survivors, urea was higher in non-survivors, Albumin was highest in survivors and Bilirubin higher in non-survivors. Similarly study by Luo M et al[10] showed that there was no statistical difference between the two groups in baseline eGFR, KDIGO (kidney disease improving global outcomes) criteria, proteinuria, hematemesis, oliguria or anuria, CKD, diabetes mellitus, hypertension, sepsis, hepatic failure, Hb <90 g/L, hypoalbuminemia, hospital stay, creatinine peak value and replacement therapy between two groups. AKI types, causes of AKI, mechanical ventilation, hypotension, shock, heart failure, respiratory failure, digestive failure, central nervous system failure, BUN peak value, K^+ peak value and ATN-ISI (acute tubular necrosis-individual severity index) score had significant statistical difference. This was similar to other studies as well, which showed hyperkalemia and leucocytosis were related to in-hospital mortality in AKI patients, as in the study by A Saxena et al[27] It may be explained by the association of hyperkalemia and leucocytosis with an advanced AKI and sepsis, respectively in our patients. Hyperkalemia and the presence of sepsis were related to increased mortality in a study done by Dela Cruz et al[23]

The Comparison of two severity scoring

APACHE IV, the last version of APACHE score system, published in 2006, was prospectively developed in 131 988 patients admitted to 104 ICUs in USA, providing predictions of hospital mortality and ICU LOS. APACHE IV has never been evaluated for AKI patients. SAPS 3 score, the last version of the SAPS system published in 2005, was the largest prospective multinational study conducted so far, with enrolment of 19 577 patients in 307 ICUs from 35 countries of the five continents between October and December 2002. In our study the sensitivity of both the scores were the same at 78.9%, and specificity was higher for APACHE 4 score (67.9%) compared to 62.5% in SAPS 3, which was statistically significant. The ROC curve has the graphical representation of the ability of prediction of the two scores; in that it showed the APACHE 4 score to better than SAPS 3 score in both sensitivity and specificity. Three prospective studies, including the Maccariello et al.,[28] in which they have assessed a group of dialysis patients, presented similar results: adequate calibration and accurate prediction[29,30]. The results from our study have been seen similar to other reviewed studies[4,31]

Conclusion

Acute kidney injury is frequently observed in hospitalized patients in intensive care settings. More prevalent in age old patients with multiple comorbidities or chronic comorbidities. AKI has high mortality index despite improvements in the intervention and technological improvements. Most common in the studies related to AKI are the lack of ideal prognostic tools. Prognostication in AKI is important as it would guide in the objective risk stratification in interventional studies, evaluation of the critical care settings and relocation of health care resources.In this observational study conducted at intensive care unit in Yenepoya medical college, the collected data statistically demonstrates that APACHE IV score predicts mortality better than SAPS. However, the sensitivity of both scores remained similar, the specificity was higher for APACHE IV. All general outcome prediction models can only at their best predict the behaviour of a group of patients that exactly matches the patients in the development population. SAPS 3 scoring system had the advantage of predicting the mortality rate prior to the ICU intervention. This feature also had major setbacks such as decrease in the amount of data available and shorter the time available of collecting the data can eventually increase the risk of missing out physiological data and assuming the missed physiological data is within normal limits. This study showed APACHE IV making more accurate prediction in critically ill care in a single center. Further studies would be needed to accurate these two scoring systems in AKI patients in critically care setting. It should be equally stressed that the high degree of caution is needed in application of this prognostic score for clinical purpose. It should be kept in a clinician mind that the severity scores are solely for assessment of prediction of mortality and evaluation of critical care and not for routine clinical decision making or for decision at a triage setting.

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Conflict of Interest: Nil
Source of support:Nil