Afr. J. Med. Med. Sci. (2019) **48**, 379-387

Pattern and prognostic factors of acute kidney injury in an intensive care unit in Nigeria

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Abstract

Introduction; Acute kidney injury (AKI) is a clinical entity with significantly high morbidity and mortality rates especially in the intensive care setting. Few previous studies in this area have employed less sensitive criteria with limited results. Thus, application of newer criteria and prognostic scores will give a true picture of the magnitude of the problem in this particular setting.

Methodology; This study was carried out among 100 consecutive patients admitted to the intensive care unit (ICU) over an eighteen-month period to determine the occurrence, frequency, and outcomes, and to also seek a relationship between the diagnostic criteria of AKI such as the Risk, Injury, Failure, Loss and End stage (RIFLE) and the Acute Kidney Injury Network (AKIN) criteria respectively and the Acute Physiological and Chronic Health Evaluation, (APACHE) IV. The outcome measures in these patients were as follows; need for haemodialysis, survival without haemodialysis or death.

Results; The patients studied were aged between 18 and 70 years (Mean± SD ; 41.5±16.3) and the male to female ratio of 1.4:1. The incidence of AKI in patients admitted into the ICU was 54 (54%) . Using the RIFLE criteria, 37% were in the Injury stage while 46.3% were in stage 2 using the AKIN criteria. Surgical cases such as head injuries and advanced carcinomas constituted the major primary aetiology (72.2%). The presence of other organ system failure (apart from the kidney) was largely predictive of outcome among ICU patients ($p<0.001$). 47 patients had other organ system failure. Out of these, only 7 (14.9%) of them survived. There was a higher APACHE IV scores(61.1± 24.3) in patients that developed AKI compared to those that did not develop AKI (55.2 ± 19.9).

Conclusion; Acute kidney injury is a huge burden in the intensive care setting, early identification using newer diagnostic parameters and risk stratification with more sensitive diagnostic scores could help in identifying patients at risk

Keywords, *Acute, kidney, injury, intensive, care*

Résumé

Introduction : L'injurie rénale aiguë (IRA) est une entité clinique présentant des taux de morbidité et de mortalité significativement élevés, en particulier dans le contexte des soins intensifs. Peu d'études antérieures dans ce domaine ont utilisé des critères moins sensibles avec des résultats limités. Ainsi, l'application de critères et de scores pronostiques plus récents donnera une image fidèle de l'ampleur du problème dans ce contexte particulier.

Méthodologie : Cette étude a été réalisée sur 100 patients consécutifs admis en unité de soins intensifs (USI) sur une période de dix-huit mois afin de déterminer l'occurrence, la fréquence et les résultats ainsi que de rechercher une relation entre les critères de diagnostic de l'IRA tels que les critères de risque , blessures, échec, perte et étape ultime (RIFLE) et critères du réseau de lésions rénales aiguës (RIRA) respectivement et évaluation de l'état de santé aiguë physiologique et chronique (APACHE) IV. Les mesures de résultats chez ces patients étaient les suivantes : besoin d'hémodialyse, de survie sans hémodialyse ou mort.

Les résultats ; Les patients étudiés étaient âgés de 18 à 70 ans (moyenne ± ET ; 41,5 ± 16,3) et le ratio hommes / femmes de 1,4 : 1. L'incidence d'IRA chez les patients admis en USI était de 54 (54%). En utilisant les critères RIFLE, 37% se trouvaient à l'étape lésion alors que 46,3% étaient à l'étape 2 en utilisant les critères RIRA. Les cas chirurgicaux tels que les blessures à la tête et les carcinomes avancés constituaient la principale étiologie primaire (72,2%). La présence d'autres défaillances du système organique (hormis le rein) était largement prédictive du résultat chez

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Methods

This study was carried out at the intensive care unit of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Nigeria over an 18-month period. The institution provides specialist health services to over one million people in Osun State, South West Nigeria.

One hundred consecutive patients between the ages of 18 and 70 years, who fulfilled the criteria for ICU admission, were recruited for the study over the same period. The criteria included critically ill patients in a medically unstable state who require an intensive level of care for monitoring and treatment. Patients with hypertension, diabetes mellitus, clinical features of obstructive uropathy and those with previous history suggestive of chronic kidney disease were excluded from the study.

Presence of AKI in the ICU patients was determined using both the RIFLE and AKIN criteria which have been shown to be equally effective in defining AKI in this particular setting[16]. Within 24 hours of admission of these patients, their respective death risk and severity index score were determined using the APACHE IV scoring system. The APACHE foundation software generated a list of scores, which represented the actual versus the predicted hospital mortality, and ICU length of stay for the 100 patients recruited from the ICU. A standardized mortality ratio (SMR) was also generated for all the patients. This represented the ratio between the actual hospital mortality value and the patient's actual ICU length of stay compared to the predicted mortality value and predicted ICU length of stay. A SMR ratio of 1.0 indicated a match between actual and predicted values. Ratio above 1.0 represented actual mortality rates above predicted, and ratio below 1.0 represented rate below predicted. A ratio of 1.0 indicates a precise match between actual and predicted values.

The actual length of stay of patients in ICU and their outcome along each stages of RIFLE and AKIN criteria was noted and compared to other ICU patients who did not developed AKI. Major Burns was defined as thermal injury involving complete full thickness of the skin characterized by eschar formation and complete loss of sensation [19]

The presence of one or more organ failure (apart from kidneys) was determined using some clinicopathological parameters as defined by Knaus and Wagner [20]. Sepsis was defined as a microbiologically proven focus of infection (such as urine, blood, catheter, wound site and endotracheal tubes and others) and deterioration of the clinical state evidenced by at least one of the following: temperature >39°C on 2 or more occasions, leucocytes >10 x 10⁹/L, or positive blood culture[20].

Patients in RIFLE-F or Acute Kidney Network Stage 3 with indications requiring renal replacement support as per the following criteria were offered heamodialysis viz: symptomatic ureamia, severe hyperkaleamia (serum potassium>6.5 mmol/L) Ureamic pericarditis, acute pulmonary oedema especially in the setting of anuria or oliguria, intractable acidosis especially with serum bicarbonate <12mmol/L ; azotemia with serum creatinine > 600μ mol/L and serum urea > 25mmol/L.

Heamodialysis was done through femoral vein cannulation using a single lumen femoral catheter with indwelling life span of not more than 48hours. Such patients were treated as emergency cases and received some sessions of heamodialysis with one or two days interval. The conventional intermittent heamodialysis with low blood flow rate of 150ml/min, with heparin anticoagulation was used. Great attention was paid to their blood pressure during heamodialysis sessions and the use of low ultrafiltration and vasopressor support (low dose dopamine 2μg/kg/min) was administered when necessary

Conservative management was based on our unit protocol of practice which included attempts at reversing the underlying cause of the disease and corresponding fluid and electrolytes abnormalities. The fluid intake was restricted to 500ml to 1 litre in oliguric patients to match measurable plus insensible losses. The protein intake was restricted to 0.6g/kg/day of high biological value and calories of at least 35cal/kg/day. Energy supplementation for patients with severe vomiting included the administration of 50% glucose boluses. Mechanical ventilation was given by the ICU specialists to critically ill patients who required some form of assisted respiration.

Clinical outcomes of all patients were determined by the following: (i) mortality {death from ureamia, death not due to ureamia or other condition (but from the primary condition)}, (ii) need for commencement on RRT, (iii) patients survival (daily reduction of serum creatinine by 100μmol/lit/day), and other electrolytes to normal or near normal levels.

Data obtained was analyzed using the Statistical Package for Social Sciences (SPSS) for windows version 16 computing software. Variables were summarized in percentages, ratios, frequencies, proportions, means and standard deviation.

les patients en USI (p <0,001). 47 patients ont eu une autre défaillance du système d'organe. Parmi eux, seulement 7 (14,9%) ont survécu. Les scores APACHE IV étaient plus élevés (61,1 ± 24,3) chez les patients ayant développé une IRA par rapport à ceux qui ne présentaient pas d'IRA (55,2 ± 19,9).
Conclusion : Les lésions rénales aiguës représentent un fardeau énorme en soins intensifs. Une identification précoce à l'aide de nouveaux paramètres de diagnostic et une stratification du risque avec des scores de diagnostic plus sensibles pourraient aider à identifier les patients à risque.

Mots-clés : *Aiguë, rein, blessure, intensive, soins*

Introduction

Acute kidney injury (AKI) refers to an abrupt but often reversible decline in the glomerular filtration rate (GFR) occurring over a period of minutes to days with retention of blood urea nitrogen and serum creatinine. [1-2]. The kidney Disease Improving Global Outcomes (KDIGO) work group further defined AKI as any of the following (i) an increase in serum creatinine by ≥ 0.3mg/dl (≥ 26.5μmol/L) within 48hours, (ii) an increase in serum creatinine to ≥ 1.5 baseline, or (iii) urine volume < 0.5ml/kg/hr for 6 hours [3].

It occurs in different settings ranging from community-acquired to others seen in the general hospital wards and in the intensive care units (ICU) with very high mortality rates in the latter. [4-5]. Monitoring and support of threatened or failing vital functions in critically ill patients is done in this setting [6]. These categories of patients managed invariably have a higher incidence of AKI and a poorer outcome when compared to the general population [7].

There are several scoring systems used in the ICU to estimate the severity of illness and to predict outcomes, these includes, amongst others, the Mortality prediction model (MPM)[8], Multiple Organ dysfunction system (MODS)[9], LIANO scores [10] , and the APACHE scores [11] . The latter are used to assess the severity of illness estimation and estimates risk based on data on the first 24 hours of ICU stay using vital signs, co-morbid conditions, physiological and neurological variables.

The APACHE IV, which is a third generation of ICU scoring system, is based on the study of an advanced standard of care of a more recent patient population. Additional variables include mechanical ventilation, disease specific coefficient, rescaled Glasgow coma scale, need for thrombolysis, partial arterial oxygen and fraction of inspired oxygen [12]. Results from various studies have shown that APACHE IV is a better prognostic scoring system and it predicts mortality rate better than APACHE II scoring system as it provides the basis for the calculation of both the estimated mortality ratio or risk of death and the estimated length of stay [13]. It has 142 variables in 3 domains of vital signs/ laboratory data, chronic health conditions and admission information and diagnosis [10].

About a decade ago, studies on AKI in ICU from our environment, used generally older and less sensitive tools such as the APACHE II, and Liano severity scoring index, to assess the aetiological factors and outcomes. [5]

Furthermore, more specific criteria for defining AKI have been developed over the last fifteen years , these include the RIFLE (Risk, Injury, Failure, Loss of renal function and End stage renal disease) criteria which shows that increase in serum creatinine levels over 7 days correlates with disease severity in correlation with the urinary output and the glomerular filtration rates [14]. Also, the Acute kidney Injury network (AKIN) further proposed a modified version of RIFLE criteria i.e. an increase in serum creatinine over 48hour rather than 7days, using three different stages for acute kidney injury [15].

Outcome studies in the intensive care units using the above two definitions in other environments have not yielded any superior advantage of either in prognosticating [16].

The incidence and mortality of AKI in ICU patients were much lower when compared to what obtains in the developed world from a previous study in our environment and this may give a false sense of security [15]. This might have been due to the use of less sensitive and non-specific defining criteria.

We felt that a realistic and true picture of the magnitude of AKI in the ICU setting would be obtained using newer and more specific criteria in detecting the actual incidence and the mortality pattern in the patients. This will help to inform a strategy in the provision of acute renal care by the medical personnel in the ICU to prevent, recognize early, and assist in the management of AKI in these patients.

We therefore set out to study the occurrence, prognostic indicators and outcome of acute kidney injury in the intensive care unit by using the RIFLE and AKIN criteria, to assess the global illness severity in the ICU using the APACHE IV scoring systems and to seek a relationship between these AKI criteria and APACHE IV.

Table 2: Relationship between presence of AKI and outcome in ICU patients

Aetiology	Survived Presence of AKI n (%)			Dead Presence of AKI n (%)		
Sepsis	4(100)	0(0)		5(50)	4(50)	
Nephrotoxins	1(50)	1(50)		3(100)	0(0)	
Advanced Carcinoma	2(22.2)	7(77.8)	*LRx²*	8(80)	2(20)	*LRx²*
Head Injury	2(28.6)	5(71.4)		11(61.1)	7(38.9)	*=15.259*
Obstetrics	2(40)	3(60)	*=19.967*	3(60)	2(40)	
Vasculitidies	1(100)	0(0)		0(0)	1(100)	*(P<0.171*
Multiple Fracture	0(0)	5(100)	*(P<0.030)*	2(66.7)	1(33.3)	
Major burns	0(0)	1(100)		2(100)	0(0)	
Haem malignancy	1(100)	0(0)		0(0)	0(0)	
Major Surgeries* *(Abd/Cardiothoracic)	2(50)	2(50)		6(60)	4(5\40)	

* Significant

LRX^2 = Likelihood ratio chi-square test

Table 3: AKI staging and outcome in the icu using the rifle and the akin criteria.

ICU: RIFLE	n = 54 n(%)	Survived n(%)	Outcome n (%) Death n(%)	Total	Test Statistics	Df	p-value
R	17 (31.5)	6 (35.3)	11(64.7)	17			
I	13 (24.1)	5 (38.5)	8 (61.5)	13	**LRX^2** =3.360	4	0.339
F	20 (37.0)	4 (20)	16 (80)	20			
L	4(7.4)	0 (0)	4 (100)	4			
E	0 (0)	0 (0)	0 (0)	0			
AKIN							
Stage 1	17 (31.5)	7(41.2)	10 (58.8)	20			
Stage 2	25 (46.3)	7(28.0)	18(72.0)	17	LR $\chi2$=3.783	0.151 2	
Stage 3	12 (22.2)	1(8.3)	11(91.7)	12			

***LR $\chi2$** = Likelihood ratio Chi-square*
RIFLE (Risk, injury, loss, end stage renal failure)
***AKIN** (Acute Kidney Injury Network) criteria and outcome of patients in the ICU.*

(22.2%) at stage 3. In stage 1, 7 (41.2%) survived while 10 (58.8%) died and in stage 2, 7 (28.0%) survived while 18 (72.0%) died. Furthermore, only 1 (8.3%) survived in stage 3 while 11 (91.7%) died. As the severity of AKI progressed from one stage to another the outcome became poorer, (p<0.151) (Table 3). The mean actual length of stay among AKI patient was shorter (10.2 ± 9.4, Mean±SD) than those without AKI (11.1 ± 10.0, Mean±SD). (p = 0.721). (Figure 1)

The odds of an AKI patient in ICU dying increases with 3 units in the presence of organ system failure (p<0.001), while the odds of a non AKI patient dying in the presence of organ system failure increases by 1.6 (P<0.023). These findings were statistically significant. (Table 4)

Among the 23 (100%) AKI patients in ICU that developed organ system failure, 11 (47.8%) of them survived while 12 (52.2%) died. Furthermore,

Chi-square statistics was used for defining associations between categorical variables such as age, sex and duration of stay. While the Kaplan-Meier survival test was used to determine the outcome and the length of hospital stay across the different stages of AKI. . The correlation between quantitative variables was tested using the Pearson correlation analysis. Severity and prognosis of illness was determined by using APACHE IV scoring system while the Standardized Mortality Ratio (SMR) and the ICU/LOS ratio was determined using APACHE foundation software.

Results

One hundred critically ill patients admitted into the ICU constituted the study population. They were aged between 18 to 70 years with a mean age of 41.5±16.3 years (Mean±SD). Males constituted 59% of the total population with a male to female ratio of 1.4:1. The incidence of AKI in ICU patients is 54 (54%) by both RIFLE and AKIN criteria. The mean age of the patients with AKI was 42.7±15.4 years (Mean±SD), while that of the 46 non AKI patients was 40.0±17.4 years (Mean±SD). (Table 1)

Among all the ICU patients seen, surgical cases (78%) were the leading cause of admission. This was followed by medical (13%) and obstetrics (9%). Head injury was complicated by AKI in 24.1% (13) of cases. AKI was also found in 18.5% (10) cases of advanced carcinoma (carcinoma of breasts, stomach, pancreas and colon), 14.8% (8) cases of sepsis, 9.3% (5) cases of cardiothoracic surgery and obstetrics respectively (Table 1).

The pattern of outcome showed that patients with head injury had worst outcome with 28.2% deaths and 13.3% survival. This was followed by advanced carcinoma with 20.5% deaths and 13.3% survival. However, patients with vasculitidies and specifically, post maxillofacial surgery all survived. (Table 2)

Using the RIFLE criteria, 17 (31.5%) of AKI cases were at the Risk level, 13 (24.1%) at Injury, 20 (37.0%) at Failure and 4 (7.4%) cases were at the loss of renal function levels respectively. No patient was found with End Stage Renal Disease. At the Risk level ,6 (35.3%) survived while 11 (64.7%) died and at the injury level, 5 (38.5%) survived while 8 (61.5%) died. Furthermore, none of our AKI patients at Loss of renal function level survived. It was observed that as the severity of AKI progressed the outcome across each level of AKI according to RIFLE criteria became poorer ($p<0.339$).(Table 3).

Using the AKIN criteria, 17 (31.5%) of AKI cases were at stage l, 25 (46.3%) at stage 2 and 12

Table 1: Socio-demographics and clinical characteristics among patients with AKI/NON-AKI in the ICU

Age Range (years)	AKI Frequency (n) n=55(%)	Non AKI Frequency n=46(%)
Mean Age	*42.7±15.4*	40.0±17.4
≤19	-	2(4.3)
20-39	24(44.4)	25(54.3)
40-59	20(37.1)	9(18.5)
≥60	10(18.5)	10(21.7
Gender		
Male	30(55.6)	29(63)
Female	24(44.4)	17(37)
Aetiology (by specialty)		
Surgical	39(72.2)	39(84.8)
Medical	9(16.7)	4(8.7)
Obstetrics and Gynaecology	6(11.1)	3(6.5)
Primary Diagnosis		
Sepsis	8(14.8)	4(8.7)
Nephrotoxins	4(7.4)	1(2.2)
Advanced Carcinomas	10(18.5)	9(19.6)
Head Injury	13(24.1)	12(26.1)
Obstetrics	5(9.3)	5(10.9)
Vasculitidies	1(1.9)	1(2.2)
Multiple fractures	2(3.7)	6(13.0)
Haematological Malignancy	1(1.9)	0
Major burns	2(3.7)	1(2.2)
Post Major Surgeries	8(22.9)	7(17.4)

diagnostic criteria (RIFLE and AKIN) for patients across different stages of AKI was not statistically significant. The correlation result for RIFLE was r 0.054, p<0.698 and AKIN was r 0.116, p<0.0404.

Discussion

The magnitude of AKI worldwide is poorly defined due to under reporting, regional disparities, differences in definition, aetiological and environmental factors [21]. In this study, the incidence of 54% was higher than what was reported in this environment previously which was 19.6% [5]. This may be attributed to the use of more sensitive criteria in this study. It is also higher when compared to those from the developed world which ranged from 20-35% [22]. In our setting, apart from an increased acuity as well as increasing recognition of AKI, most cases needing further close monitoring and interventions are generally managed in the ICU with little triaging, while the comparatively lower incidence in developed countries might be due to active triaging, the use of early AKI diagnostic methods and prompt advance interventions.

The presence of AKI in critically ill patients also conferred on them a poor outcome, with a significant mortality rate of 65% compared to non-AKI patients with a mortality rate of 35 %. This mortality rate was similar to what has been reported from other local studies but lower than what obtains in the developed world which ranged from 75-80% [22]. This might be explained by the relatively large number of patients studied in such works and also the diverse number of cases managed in such ICUs.

The leading cause of admission among the AKI patients in the ICU was majorly surgical in this study as also reported elsewhere. Cases of head injury were the leading primary diagnosis in a quarter of patients and this portends a dismal prognosis especially in the setting of AKI. There have been some clinical and experimental evidence that the traumatized brain especially the cerebral frontal lobe can specifically affect the kidney causing renal cortical ischemia [5]. Jennet et al interpreted some clinical findings in a way that there exists a relationship between AKI and brain injury [5][24]. Furthermore, patients whose cases of head injury are complicated by AKI tends to have higher occurrence of organ system failure and death when compared to those with head injury without AKI in ICU.

The presence of AKI in critically ill patients confers 3 times higher risk of developing other organ system failure apart from kidney failure (OR 3.047, p<0.001) , acute injury often seen in the setting of multiple organ dysfunction is precipitated by a pro-inflammatory mechanism that involves neutrophil cell migration, cytokine expression and increased oxidative stress[25]. Survival after AKI is thus influenced by the severity of the underlying etiological factors and organ system failure in the ICU setting..

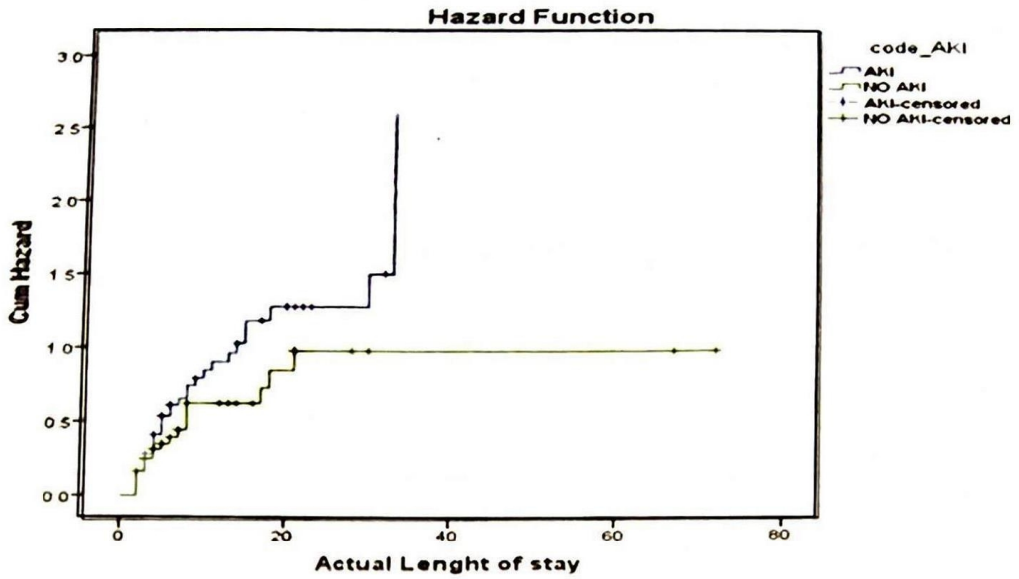
Using the RIFLE and AKIN criteria in this study, there were more patients in the early stage of AKI. However, as the severity of AKI progresses, the number of patients reduced, but the outcome in terms of survival and death worsened. This may be due to the severity of their illnesses and higher occurrence of multiple organ system failure in them. Abosaif et al reported that the patients in the failure stage showed the worst parameters with regards to the APACHE criteria as mortality was often increased in them[26].

The shorter duration of stay in ICU by patients with AKI compared with those that did not develop AKI may be due to their earlier exit from ICU as a result of death. This observation was also confirmed along the different stages of AKI. AKI patients in the early stages of AKI either by RIFLE or AKIN criteria had a longer duration of ICU stay compared to their counterparts with AKI at more severe stages of AKI .This might be due that the duration or length of stay of patients in ICU being shortened as as the severity of AKI progressed. A

Table 5: The mean APACHE IV general scores and outcome for AKI and Non AKI patients in the ICU

Variables	AKI (n =54)	Non AKI (n = 46)	Test statistics	df	p-value
Apache IV Score					
x ± SD	61.1 ± 24.3	55.2 ± 19.9	t = 1.315	98	0.192
Alive	54.87 ± 24.0	53.36 ± 20.44	t = 1.169	2	0.248
Dead	63.46±24.25	56.14±19.61	t= 0.300		0.765

df = degree of freedom



Cumulative hazard rate difference for non AKI versus AKI tested by log rank test.

Table 4: Relationship (including regression analysis) between organ system failure, AKI and outcome in ICU

Variables	Outcome			Chi Square	df	P-Value
	Survival n= 15	Dead n=39	Total n=54	X^2		
Organ System failure						
Present	11(47.8)	12(52.2)	23(100)	8.027	1	<0.005*
Absent	4(12.9)	27(85.1)	31(100)			
Variable	Outcome					
	B	S.E		CI		
OSF	2.130	0.056		3.118-22.696		<0.001*
AKI Status	-0.882	0.476		0.163-1.051		0.064

B= Regression coefficient, S.E= standard error, CI= confidence interval, OSF = organ system failure, AKI= acute kidney injury, df = degree of freedom.

** Significant*

among the 31 (100%) AKI patients who did not develop organ system failure, only 4 (12.9%) survived while 27 (87.1%) died. (Table 4)

The mean APACHE IV score of the 100 patients recruited for this study was 58.4±20.0. The range of their APACHE IV score was 14 to 119. The mean APACHE IV score for those patients that died was 66.0±23.2 (Mean±SD), with a median of 57.5 while that of those that survived was 48.2±16.9 , median of 55. This higher APACHE IV score in those patients that died was statistically significant with a p<0.0001, when compared to those patients that survived. There was no statistical difference in the APACHE IV score of patients with AKI, 61.1±24.3 (Mean±SD) when compared to that of those patients who did not develop AKI (55.2±19.9) during their admission in ICU.

The APACHE IV illness severity scores for those that died were high in both groups, i.e. 63.46±24.25 for AKI patients and 54.87±24.0 (Mean±SD) for non AKI patients (Table 5). This difference was not statistically significant (p<0.248 and p<0.765 respectively). This may imply that APACHE IV scoring system could not estimate and differentiate between AKI severity from that of the primary illness of the patients that necessitated their admission into ICU. Also the relationship that exist between APACHE IV illness severity score and AKI

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similar observation was reported by Hoste et al in which patients with RIFLE class F incur significantly increased length of stay and increased risk of in hospital mortality compared with those in early stages even after adjusting for baseline severity of illness, gender and age [27].

From this study, we could not determine the significance of dialysis therapy because most of our patients could not have adequate dialysis due to a number of factors ranging from delays in the referral to the nephrologist, the patient's heamodynamic status and financial constraints in accessing haemodialytic support. This observation was also reported a decade earlier in a similar work done in the same centre.

Furthermore, the mean APACHE IV of those AKI patients that died was higher than those non AKI patients that died though this difference did not reach a statistically significant level. This is probably because patients with AKI had high APACHE IV scores ab initio due to the severity of their illness.

The standard mortality ratio (SMR) for our patients in the ICU was greater than 1. This was because the actual mortality (60%) that was recorded in this study was higher than the predicted mortality of 40.12%. Furthermore the predicted mean length of stay of our patients in the ICU was shorter compared to the actual length of stay of our patients with SMR ratio greater than 1. This reflects a lower survival rate of our patients than what is expected of them. Similar finding was observed by Dahhan et al [28]

Preventive strategies in ensuring reduction in the high level of morbidity and mortality in critically ill patients generally must therefore be holistic and anticipatory. Those in developing countries must include the need to avoid nephrotoxic precipitants particularly in high risk patients, and aggressive fluid resuscitation of the traumatized patients.

This is one of the few studies that had specifically compared the APACHE IV scores with the newer diagnostic criteria for AKI. Preliminary results have suggested that the scores which measure the severity of illness in the critically ill patients is an important general predictor of outcome in our study population and might thus be routinely employed in the ICU. More studies with a larger number of patients are advocated for a more robust conclusion.

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