BANTAO Journal 2010; 8 (1): 35-39

BJ
BANTAO Journal

Original Article

Severity and Outcome of Acute Kidney Injury According to Rifle Criteria in the Intensive Care Unit

Albana Gjyzari[1], Elizana Petrela[2], Nestor Thereska[1], Myftar Barbullushi[1], Alketa Koroshi[1], Sulejman Kodra[1], Alma Idrizi[1] and Arjana Strakosha[1]

[1]Nephrology, University Hospital Center Nënë Tereza, [2]Epidemiology, University Hospital Center Nënë Tereza, Tirane, Albania

Abstract

Introductıon. The aim of this study was to evaluate severity and outcome in patients with acute kidney injury (AKI) in the intensive care unit (ICU) based on the RIFLE criteria.

Methods. Adult patients with AKI admitted in medical and surgical ICUs between January 2005 and December 2007 were reviewed retrospectively. The first three criteria of RIFLE were applied. Patients on chronic dialysis before admission to the ICU were excluded. Demographic, biochemical, clinical, APACHE II score and outcome data were studied and compared in the three classes.

Results. A total of 76 patients (32F/44M), mean age 55.1±18.75 were examined. 6 % of patients were in the risk class, 19% in the injury and 73 % in the failure class. The failure class showed higher APACHE II score compared to the risk one (24.6+7.6 Vs 28.12+6.4 p= 0.018). The overall in-hospital mortality was 52.6 % with the highest in the failure class (62 %), followed by the injury class (26 %) and the risk class (20 %), with a statistical significance (p=0.015). Renal replacement therapy was required in 32.8% of patients. At the time of death or ICU discharge 38.1% of patients with AKI recovered renal function.

Conclusion. AKI stratification based on RIFLE criteria correlated with APACHE II scores. In this study, the RIFLE criteria correlated well with the outcome.

Keywords: acute kidney injury, APACHE II score, intensive care unit, mortality, RIFLE criteria

Introduction

Acute kidney injury (AKI) affects 5 to 7% of all hospitalized patients, and it continues to be associated with poor outcomes and an increase in morbidity and mortality [1,2]. This syndrome is common in the intensive care unit (ICU), with a reported incidence of 1 to 25% depending on the population studied and the criteria used to define its presence [1,3]. AKI in this setting is associated with mortality rates of 50 to 70%, which have remained relatively constant over the past decades [2,4,5]. To define better AKI and its characteristics, the Acute Dialysis Quality Initiative (ADQI) developed a consensus and evidence-based definition for AKI [6].

The RIFLE classification defines three grades of severity of AKI (Risk, Injury and Failure) based on changes of serum creatinine and urine output and two clinical outcomes (Loss and End-stage) (Table 1).

Table 1. RIFLE classification for AKI

RIFLE Classification	Creatinine and GFR Criteria	UO Criteria
Risk	Increased creatinine ×1.5 or GFR decrease >25%	UO <0.5 ml/kg per h ×6 h
Injury	Increased creatinine ×2 or GFR decrease >50%	UO <0.5 ml/kg per h ×12 h
Failure	Increased creatinine ×3 or GFR decrease >75%	UO <0.3 ml/kg per h ×24 h or anuria ×12 h
Loss[a]	Persistent ARF = complete loss of kidney function >4 wk	
ESRD[a]	ESRD (need for dialysis >3 mo)	

AKI, acute kidney injury; ARF, acute renal failure; UO, urine output;
[a]"Outcome" categories

Recently, a number of clinical studies have evaluated the validity, clinical relevance and predictive ability for outcome of the RIFLE classification in critically ill patients with AKI [7-15].

Correspondence to: Albana Gjyzari, Department of Nephrology, University Hospital Center "Nene Tereza", L. 56, Bul. "Zhan D'Ark", Pallatet e Lanes Nr.4, Shk.7, Ap.39, Tirane, Albania; E-mail: albanavelaj@yahoo.com

Our study estimates the incidence of AKI in mixed ICU patients in a tertiary hospital center in Albania and describes the clinical characteristics of patients with AKI and their outcomes on the basis of their RIFLE class.

Patients and Methods

This study was conducted in five (medical, surgical and medico-surgical) adult ICUs in a single tertiary care hospital center in Tirana. Patients were reviewed retrospectively through computer database and medical records from January 2005 to December 2007.

Study Population

Adult patients (age≥18 years) who were admitted to one of the participating ICUs during the study period were considered for study inclusion. From this population, only incident patients who fulfilled criteria for the risk, injury, and failure categories of the RIFLE criteria for AKI were included in the study [6]. Either the serum creatinine or urine output criterion was used to diagnose AKI and to determine the RIFLE classification of each patient, using the criteria that led to the worst possible classification (Table 1). The RIFLE classification at the time of diagnosis of AKI was considered for analysis. For patients in whom baseline serum creatinine values were not known (22.4 %), the value was estimated using the Modification of Diet in Renal Disease equation (assuming average baseline GFR of 75 ml/min per 1.73 m2), as recommended by the ADQI workgroup [6,16]. Patients who had stage 5 chronic kidney disease and were undergoing long-term renal replacement therapy (RRT) were excluded from the study. One patient was admitted twice to the ICU during the study period for different reasons; in this case, the second admission was counted as a new case.

Data Collection

Multiple data elements were collected through computer database and medical records of each patient with AKI. Requested data included demographics, premorbid renal function, use of potentially nephrotoxic drugs, medical history, urine output, serum creatinine levels, and associated laboratory abnormalities at the time of AKI diagnosis.
The following preexisting co-morbidities were studied: hypertension, diabetes, chronic kidney disease (CKD) and heart failure (HF).
The overall severity of illness was based on the Acute Physiology and Chronic Health Evaluation (APACHE II) score [17] and SOFA score [18].
For patients who were treated with RRT, we collected data regarding the frequency, duration, and complications (mean arterial blood pressure <70 mmHg and cardiogenic shock) of treatment.
ICU mortality was the primary outcome of interest. We also collected data on cause of death and ICU length of stay, as well as recovery of renal function, defined as complete recovery of renal function: return of serum creatinine to <2 mg/dl, or return to baseline creatinine concentration for patients with acute or chronic renal disease.
Partial recovery: hospital discharge with a serum createnine >2 mg/dl, but the patient was no longer dialysis dependent. End-stage renal disease: need for dialysis therapy longer than 3 months.
For calculation of the incidence of AKI, summary data on all ICU admissions during the study period were obtained from each participating center. These included the total number of admissions and the overall ICU mortality for that time period. Individual patient data were not available for patients without AKI.

Statistical Analyses

Continuous variables are presented as the mean (standard deviation). Categorical variables are presented as percentages. Comparison between groups was done by using analysis of variance (ANOVA) test for numerical values and chi-square test for categorical data. The significance of differences between individual groups was assessed further by means of post-hoc tests using Bonferroni test. Values were considered statistically signifycant at $P<0.05$. Statistical analysis and calculations were performed using SPSS statistical package, version 15.0

Results

We evaluated a total of 4517 admissions in the five ICUs during the study period. The overall ICU mortality was 21.56% and ranged from 11.13 to 67.19% in the individual ICUs. The mean length of stay was 8±4.08 days.
During the study period, 76 (1.68%) patients completed criteria for risk injury and failure. The characteristics of the AKI cohort are shown in Table 2.
The reasons for admission of AKI patients were as following: 77 % medical, 15 % surgical and 8 % obstetrical. The medical reasons included: sepsis (21 %), followed by metabolic or renal (19 %), cardiovascular (17 %), gastrointestinal (7 %), neurological (3.9 %), respiretory (3.9 %), hematologic malignancy (2.6 %), hepatic (2.6 %) disorders. The type of AKI was prerenal in 29 %, ischemic ATN in 44.7 %, nephrotoxic ATN in 6.5 % of patients. Previous exposure to potentially nephrotoxic medications was reported in 39.4 % of AKI patients, the most common being ACEI or ARB, followed by NSAID and aminoglycosides. 7.9 % of patients were exposed to more than one of these agents. Preexisting co-morbidities were present in 50 % of AKI patients. Preexisting hypertension was found in 18.4 %. of AKI patients, diabetes in 7.9 %, CKD in 2.6 %, hypertension and diabetes in 10.5 %, hypertension and HF in 9.2 %, CKD and diabetes in 1.3 % of patients Among 76 patients with AKI, 6 % were classified as risk (R), 19 % as injury (I), and 73 % as failure (F) (Table 2).

Table 2. Characteristics of study population by RIFLE class*

Characteristic	All AKI	Risk	Injury	Failure	*P*
n	76	5(6%)	15(19%)	56(73%)	
Demographics					
age (yr; mean±SD)	55.1±18.7	64.4±6.0	43.2±20.4	57.4±17.8	0,015
male gender (%)	44 (57.9)	1 (20)	9 (60)	34 (60)	0.727
co-morbid condition¤ (%)	38 (50.0)	3 (60)	2 (13.3)	33 (58.9)	0.007
Scoring systems					
APACHE II score	26.9±6.6	24.6±7.6	23.0±7.03	28.1±6.4	0.018
SOFA score	10.9±3.2	7.6±1.5	9.6±2.9	11.5±3.2	0.007
Clinical characteristics					
MAP	(75.1+22.3)	(60.6+17.2)	(79.5+17.7)	(75.2+23.5)	0.262
sepsis (%)	35 (46.0)	1 (20)	6 (40)	28 (50)	0.379
respiratory support (%)	64 (84.2)	4 (80)	12 (80)	48 (85.7)	0.836
thrombocytopenia (%)	26 (34.2)	0 (0)	7 (46.7)	19 (33.9)	0.162
hepatic failure (%)	23 (30.3)	0 (0)	7 (46.7)	16 (28.6)	0.125
Type of AKI					
prerenal (%)	22 (28.9)	3 (60.0)	7 (46.7)	12 (21.4)	0.046
ischemic ATN (%)	34 (44.7)	1 (20.0)	3 (20.0)	30 (53.6)	0.068
nephrotoxic ATN (%)	5 (6.6)	1 (20.0)	1 (6.7)	3 (5.4)	
Renal function					
BUN at admission(mg/dl)	101.9+50.13	52.6+11.76	69.5+26.13	115.05+505	<0.001
sCr at admission (mg/dl)	6.5+3.63	1.78+0.04	3.21+0.31	7.84+3.33	<0.001
peak sCr (mg/dl)	9.52+4.91	4.57+4.0	6.06+3.02	10.88+4.68	<0.001
RRT (IHD)					
no. of patients (%)	25 (32,8)	0 (0)	1 (6.6)	24 (42.8)	0,008
Outcome					
ICU mortality (%)	40 (52.6)	1(20)	4 (26.6)	35 (62.5)	0.015
complete recovery (%)	29 (38,1)	3 (60)	10 (66.7)	16 (28.5)	0.06
length of stay (d; median [IQR])	9 (2 to 30)	8.2 (3 to 13)	9.2 (4 to 30)	10.2 (2 to 0)	0.60

*RIFLE class was determined at time of AKI diagnosis. MAP, mean arterial pressure; BUN, blood urea nitrogen; sCr, serum creatinine concentration; RRT, renal replacement therapy; IHD, intermittent hemodialysis; ATN, acute tubular necrosis;
¤Diabetes, hypertension, CKD and HF

As expected, on the basis of the RIFLE criteria, F patients had a significantly higher creatinine and lower urine output at the time of diagnosis of AKI. Compared with all ICU admissions, patients with AKI tended to be older (mean age 55.1±18.75) and male gender predominated (57.9 %). At the time of AKI diagnosis, severity scores of illness (APACHE II 26.93±6.6 and SOFA score 10.92±3.2) were higher than in the whole population, but significantly higher in F class compared to I and R (Table 2). More than one-half of the patients of class R and I progressed to more severe RIFLE classes.

RRT

32.8 % of patients with AKI were treated with RRT. There were 6.6 % of patients treated with RRT in I class and 42.8 % in class F (Table 2). Intermittent hemodialysis was performed daily with a total of 96 IHD sessions. These patients received an average of 4.36±4.45 dialysis treatments per patient. Three patients interrupted IHD sessions because of severe complications.

Outcomes

ICU mortality for all AKI patients was 52.6%. The most commonly reported causes of death were sepsis (26.3 %), cardiac causes (14.5%), vascular causes (6.5%), and neurological causes (3.9%). ICU mortality was the highest among class F (62 %), significantly higher (P <0.015) than that in class I (26%) and class R (20%).

At the time of death or ICU discharge, 38.1% of AKI patients had complete recovery of renal function. Recovery of renal function was seen more frequently among class R (60 %) and I (66.7 %) than class F patients (28.5 %; P = 0.06).

The mean ICU length of stay for AKI patients was 10.11±6.32 days, longer than that of the entire ICU cohort. ICU length of stay was not significantly different among the three RIFLE classes (Table 2).

Discussion

The RIFLE criteria were developed to standardize the diagnosis of acute renal failure and the term acute kidney injury has been proposed to encompass the entire spectrum of the syndrome from minor changes in renal function to requirement for renal replacement therapy. Since its introduction, the RIFLE criteria have been increasingly used in studies on AKI.

The RIFLE classification has proved to be a very sensitive classification for AKI, rendering a high incidence. All studies report a high occurrence rate for AKI [8,10,12].

The incidence of AKI in our study (1.68%) is lower, possibly because this is a retrospective study and the implementation of RIFLE criteria in our intensive care units needs to be improved.

It has been demonstrated that the incidence of nosocomial AKI is growing [19] and this is an important part of the rise in incidence of AKI, where sepsis-decreased renal perfusion and major surgery are the primary etiologies [2].

Our patients were more likely to be older, male and had co-morbid illnesses. AKI was more common in admissions for medical causes and with primary diagnoses of sepsis, following by metabolic, renal and cardiac complications. This is the common spectrum of AKI causes observed in developing countries except for the obstetrical cause, which remains still high (8%) in our country.

The use of diuretics and ACEI is independently associated with an increased risk for AKI and the risk is even greater with the concomitant use of NSAID [20]. In our study, previous exposure to potentially nephrotoxic medications was reported in 39.4% AKI patients, but the number of patients was too small to find any association.

A history of hypertension, diabetes, or heart failure, and use of cardiovascular drugs are risk factors for renal failure [20]. In our study a co-morbid condition, mostly hypertension, was present with high significance in F class patients (p=0.007).

Severity scores of illness (APACHE II and SOFA score) correlated with RIFLE classification. In class F, APACHE II score (28.12±6.4, *P*=0.018) and SOFA score (11.55±3.2, *P*=0.007) were significantly higher compared to I and R classes.

Intermittent hemodialysis performed daily was used as renal replacement therapy in 32% of our AKI patients, significantly higher in class F (42.8%, P=0,008). Initiation of RRT was more frequently guided by oliguria rather than by increases in creatinine and BUN (BUN at IHD start 117.6 ± 32.4 mg/dl).

All published studies on the RIFLE classification found that patients with AKI had a lower survival than patients without AKI and most of them found an increased mortality related to higher RIFLE class (7,8,10,14,21). Similarly, in our study the ICU mortality for all patients with AKI (52.6 %) was higher than the overall ICU mortality (21.56 %). Mortality increased significantly from class R to class F (*P* <0.015). Sepsis and septic shock have been associated with increased mortality risk in several studies [1,2]. Our results show that sepsis (26.3 %) was one of the most commonly reported causes of death. Multiple logistic regression analysis indicated that sepsis (OR: 0,048, 95 % CI: 0,008-0,283, *p*= 0,001) was independent risk factor for mortality.

We also examined the progression from the initial RIFLE category to the maximum or peak RIFLE class attained by patients. We found that more than one-half of the patients of classes R and I progressed to more severe RIFLE classes (Table 2). Since even small changes in kidney function in critically ill patients are important and are associated with significant changes in short and possibly long-term outcomes [8], this may be important for the time and type of intervention in these patients.

Recovery of renal function was other outcome to be assessed. In our cohort of patients, renal function of 38.1 % of patients with AKI (93.1 % survived and 6.9 % non-survived) recovered completely. As in other studies [12], we also found that the higher the RIFLE class the lower the recovery of renal function. In class F complete recovery was lower (28.5 %; *P* = 0.06) compared with classes I and R, but this was not statistically significant (Table 2).

Hoste and coworkers [8] found that higher RIFLE class was associated with longer length of stay in the ICU and in the hospital and, therefore, a greater use of hospital resources. In our study, AKI patients had longer length of stay than all ICU patients. There was no significant difference among the three RIFLE classes regarding the ICU length of stay, but it was significantly higher for hemodialysed patients (13.6±6.8, p=0.027).

Our study has several limitations. First, we assessed a small cohort of patients, and this was a retrospective evaluation. It would have been of greater interest if we compared the AKI group with a control non AKI group, but this would be an objective of future studies. We could not describe long-term outcomes such as long-term survival, relapse and complete remission because of the short-term follow-up. We had no data on baseline creatinine value for some patients (22.4%), using the Modification of Diet in Renal Disease (MDRD) equation to evaluate it and this can obviously lead to misclassification of some patients.

Conclusion

In our study AKI stratification based on RIFLE criteria correlated well with the severity of illness, as well as APACHE II and SOFA scoring systems. We found that increasing in stages of the RIFLE category was associated with an increase in mortality, and a decrease in recovery of renal functions. Prevention in progression from milder to more severe stages of AKI may have a positive impact on patient outcomes. The RIFLE criteria found to be a simple method providing us a well-balanced classification system to determine the severity of acute kidney injury.

Conflict of interest statement. None declared.

References

1. Lamiere N, Van Biesen W, Vanholder R. Acute renal failure. *Lancet* 365: 417–30, 2005.
2. Uchino S, Kellum JA, Bellomo R, *et al*. Acute renal failure in critically ill patients: a multinational, multicenter study. *JAMA* 2005; 294: 813–8.
3. De Mendonca A, Vincent JL, Suter PM, *et al*. Acute renal failure in the ICU: Risk factors and outcome evaluated by the SOFA score. *Intensive Care Med* 2000; 26: 915–21.
4. Liano F, Junco E, Pascual J, Madero R, Verde E. The spectrum of acute renal failure in the intensive care unit compared with that seen in other settings. The Madrid Acute Renal Failure Study Group. *Kidney Int Suppl* 1998; 66: S16–S24.

5. Brivet F, Kleinknecht D, Loirat P, Landals P. Acute renal failure in intensive care units-causes, outcome, and prognosis factors of hospital mortality: A prospective, multicenter study. French Study Group on Acute Renal Failure. *Crit Care Med* 1996; 24: 192–8.
6. Bellomo R, Ronco C, Kellum J, *et al*. The ADQI Workgroup. Acute renal failure-definition, outcome measures, animal models, fluid therapy and information technology needs: The Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. *Crit Care* 2004; 8: R204–R212.
7. Abosaif NY, Tolba YA, Heap M, *et al*. The outcome of acute renal failure in the intensive care unit according to RIFLE: model application, sensitivity, and predictability. *Am J Kidney Dis* 2005; 46: 1038–48.
8. Hoste EA, Clermont G, Kersten A, *et al*. RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis. *Crit Care* 2006; 10: R73.
9. Bell M, Liljestam E, Granath F, *et al*. Optimal follow-up time after continuous renal replacement therapy in actual renal failure patients stratified with the RIFLE criteria. *Nephrol Dial Transplant* 2005; 20: 354–60.
10. Uchino S, Bellomo R, Goldsmith D, *et al*. An assessment of the RIFLE criteria for acute renal failure in hospitalized patients. *Crit Care Med* 2006; 34: 1913–7.
11. Lin CY, Chen YC, Tsai FC, *et al*. RIFLE classification is predictive of short-term prognosis in critically ill patients with acute renal failure supported by extracorporeal membrane oxygenation. *Nephrol Dial Transplant* 2006; 21: 2867–73.
12. Ali T, Khan I, Simpson W, *et al*. Incidence and outcomes in acute kidney injury: a comprehensive population-based study. *J Am Soc Nephrol* 2007; 18: 1292–8.
13. Lopes JA, Jorge S, Neves FC, *et al*. An assessment of the rifle criteria for acute renal failure in severely burned patients. *Nephrol Dial Transplant* 2007; 22: 285.
14. Ostermann M, Chang RW. Acute kidney injury in the intensive care unit according to RIFLE. *Crit Care Med* 2007; 35: 1837–43.
15. Bagshaw SM, George C, Dinu I, Bellomo R. A multicentre evaluation of the RIFLE criteria for early acute kidney injury in critically ill patients. Nephrol Dial Transplant 2008; 23: 1203–10.
16. National Kidney Foundation: K/DOQI clinical practice guidelines for chronic kidney disease: Evaluation, classification and stratification. *Am J Kidney Dis* 2002; 39 [Suppl 1]: S76–S92.
17. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACH II score: A severity of disease classification system. *Crit Care Med* 1985; 13(10): 818-29.
18. Vincent JL, de Mendonça A, Cantraine F. Use of the SOFA scores to assess the incidence of organ dysfunction/failure in intensive care units: results of a multicenter, prospective study. *Crit Care Med* 1998; 26: 1793-800.
19. Wang Y, Cui Z, Fan M. Retrospective analysis on Chinese patients diagnosed with acute renal failure hospitallized during the last decade (1994-2003). *Am J Nephrol* 2005; 25: 514-9.
20. Huerta C, Castellsague J, Varas-Lorenzo C, Garcia Rodriguez LA. Nonsteroidal anti-inflammatory drugs and risk of ARF in the general population. *Am J Kidney Dis* 2005; 45: 531-539.
21. Bagshaw SM, George C, Bellomo R, *et al*: A comparison of the RIFLE and AKIN criteria for acute kidney injury in critically ill patients. *Nephrol Dial Transplant* 2008; 23: 1569-74.