Research Article

J Ped. Nephrology 2015;3(1):16-23
http://journals.sbmu.ac.ir/jpn

RIFLE Criteria in Critically Ill Neonates with Acute Renal Failure

How to Cite This Article: Mohkam M, Kompani F, Afjeii A, Golchin F, Abdollah Gorji F. RIFLE Criteria in Critically Ill Neonates with Acute Renal Failure. J Ped. Nephrology 2015;3(1):16-23.

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Received: Nov-2014
Revised: Nov-2014
Accepted: Dec-2014

Introduction: Diagnosis of neonatal acute renal failure (ARF) is a difficult dilemma. Traditionally neonatal ARF was defined as urine output of less than 1 ml/kg/hr together with a serum creatinine level of greater than 1.5 mg/dl for at least 24 hours. Early diagnosis and prompt treatment of ARF in NICUs can decrease the rate of mortality and morbidity in neonates. Based on RIFLE criteria the definition of ARF is changed lately in adult and pediatric groups. Studies to evaluate the RIFLE criteria in the definition of neonatal ARF have not been performed. The aim of this study was to compare the RIFLE criteria to the old definition of ARF in neonates in the diagnosis of neonatal acute kidney injury (AKI) and the prediction of mortality.
Materials and Methods: This cohort study was conducted on 904 critically ill neonates. The author determined the RIFLE score for each neonate based on serum creatinine and urine output at the second day of admission. Prevalence of AKI was determined based on old definition of ARF and RIFLE criteria separately.
Results: Based on RIFLE criteria, 22.5% of study group had normal renal function and 77.5% had AKI at the second day of admission. Among patients with AKI 43% met the risk, 51% the injury and about 6% the failure criterion. Based on old definition of ARF in neonates, the rate of ARF in our study group was 3.2%. There was a significant difference between AKI prevalence by RIFLE criteria and the former definition (P<0.001). The overall mortality rate in critically ill neonates was 14%. Of those who died, 81.9% had AKI. In patients with normal renal function there was no mortality and in patients with AKI based on RIFLE criteria the mortality rate was 21.7% (P<0.031, Odds Ratio=1.103, 95% CI=1.05-1.16) and in patients with ARF based on old definition the mortality rate was 61.5% (P<0.001, Odds Ratio=6.741).
A progressive and significant increase in the mortality was correlated with increasing severity of ARF as determined by RIFLE criteria in all neonates.
Conclusions: RIFLE criteria can detect neonatal AKI earlier and is a good predictor for mortality in critically ill neonates.

Keywords: Acute Kidney Injury; Newborn Intensive Care Units; Critically Ill.

Running Title: RIFLE Criteria in Neonates with AKI

Introduction

Acute renal failure (ARF) or acute kidney injury (AKI) is an acute reduction in the glomerular filtration rate (GFR) of kidneys with failure to remove solutes and water [1,2]. More than 30 ARF definitions exist in the published literature [3,4]. Diagnosis of neonatal ARF is a difficult dilemma and there is no consensus in this regard. Traditionally neonatal ARF was defined as decreased urinary output [5-9].

A former consensus about neonatal oliguric ARF defined it as a urine output less than 1 ml/kg/hr (with no response to fluid challenge) which is associated with a serum creatinine level of greater than 1.5 mg/dl for at least 24 hours while maternal renal function was in the normal range. But other investigators defined documented neonatal oliguria as urine output of less than 0.5 ml/kg/hr for more than 6 hours [3]. In this regard a rise of more than 0.3 mg/dl per day in the plasma creatinine concentration has been

proposed to improve the definition of ARF during the first days of life. In some studies, neonatal ARF was defined as doubling of baseline serum creatinine [3,10-14] or an increase of more than 1.5 fold from base line [5]. Some researchers defined neonatal ARF as increased blood urea nitrogen (BUN) concentration (BUN>20 mg/dl) [3,14-19]. Choker G. et al demonstrated that the assessment of daily changes in serum creatinine concentration in extremely premature neonates allows the diagnosis of ARF [20]. The definition of ARF is changed lately in adult and pediatric groups. The Acute Dialysis Quality initiative (ADQI) group has proposed the RIFLE criteria for AKI in adults and the susceptible cases to ARF can be distinguished earlier based on RIFLE criteria. The RIFLE acronym stands for risk, injury, failure, loss of kidney function and end stage renal disease [4]. Recently, Akcan-Arikan et al. have proposed a modified version of the RIFLE criteria for pediatric patients (pRIFLE) [21]. Studies to evaluate the accuracy of the rifle criteria in the diagnosis of AKI in neonatal group have not been validated [22,23]. It seems extremely important that acute renal failure of renal origin may be recognized as an indicator of poor prognosis in neonates and that early recognition of risk factors in conjunction with rapid effective treatment will reduce mortality in the neonatal period [24]. ARF is a significant factor of morbidity and mortality in critically ill children. Generally nonoliguric renal failure has a better prognosis when compared to oliguric renal failure [25]. The mortality of oliguric acute kidney injury in neonates may be as high as 60% and even higher in some neonatal disorders like congenital heart disease or of genitourinary tract anomalies [1]. According to other studies, mortality ranges from 10% to 78% in oligoanuric renal failure [14, 26]. In this regard Askenazi et al determined that a 1 mg/dl increase in serum creatinine was associated with almost two-times higher odds ratio of death (odds ratio =1.94) [22]. Based on these studies it seems that it's the time to define neonatal ARF again to find new more sensitive criteria for early diagnosis of acute renal failure. Recent studies hypothesized that critically ill neonates with ARF based on the former definition (serum creatinine more than 1.5 mg/dl) have decreased survival, independent of demographic characteristics, co-morbidities, clinical parameters, severity of illness and variables known to predict infant survival. According to this hypothesis we evaluated urine output, levels of serum creatinine and glomerular filtration rate in critically ill neonates and also determined the RIFLE criteria in each neonate. We also evaluated the CRIB, CRIB II, SNAP, SNAP II and SNAP-PE NICU scoring systems, which are neonatal scoring systems in neonatal intensive care units (NICUs) and compared them to RIFLE criteria for prediction of mortality. [CRIB (the Clinical Risk Index of Babies) [27], CRIB II (an update of the Clinical Risk Index for Babies score), SNAP (Score for Neonatal Acute Physiology) [28], SNAP II (Simplified newborn illness severity and mortality risk scores) and SNAP-PE (Score for Neonatal Acute Physiology - Perinatal Extension) [29]. The aim of this study was to compare the RIFLE scoring system with the former definition of ARF in neonates in the diagnosis of neonatal AKI to predict the mortality in critically ill neonates admitted to referral NICUs in Tehran – IRAN between September 2006 and October 2013.

Materials and Methods

This cohort study was conducted at Mahdieh and Mofid hospitals which have the largest referral NICUs in Tehran. Between September 2006 and October 2013 all neonates admitted to the NICUs were enrolled for the study in a prospective manner. We evaluated the variables which are listed in table 1 for each neonate and compared them between survived and non-survived neonates. We also determined the RIFLE criteria for each neonate based on serum creatinine and urine output on the second day of admission (to omit the mothers' creatinine effect, we continued the serum creatinine measurement on the following days). The author excluded the patients with abnormal serum creatinine on the first day of birth and normal creatinine after 72 hr of age and also all neonates with hyperbilirubinemia from the study. RIFLE criteria is defined as risk (R), injury (I), failure (F), loss of kidney function (L) and end stage renal disease (E) groups. In the risk group the patients show 25 - 50% loss of GFR and urine output is less than 0.5 cc/kg/hr for 6 hours and the level of creatinine is more than 1.5 times the baseline. In the injury group the patients show 50 - 75% loss of GFR and urine output is less than 0.5 cc/kg/hr for 12 hours and the level of creatinine is more than 2 times. In the failure group the patients show more than 75% loss of GFR and urine output is less than 0.3 cc/kg/hr for 24 hours and the level of creatinine is more than 3 times [4]. Then the authors determined the mortality rate of patients with and without ARF based on the old definition of ARF (serum creatinine greater than 1.5 mg/dl for at least 24 hours while maternal renal function was in

normal range) and the RIFLE criteria. The authors evaluated the neonatal scoring systems of NICUs (CRIB, CRIB II, SNAP, SNAP II and SNAP-PE) in all neonates and compared them to RIFLE criteria for prediction of mortality. All groups were statistically analyzed by the t test. This was done for both survivors and nonsurvivors separately to look for any statistically significant difference between the two groups. In the end with the hospital death as the dependant variable, Logistic model was used to analyze the prediction of mortality. The predictive accuracy of these receivers were expressed as area under the receiver operative characteristic (ROC) curve for each score and the results were compared. ROC curves helped to compare the performance of different tests, by plotting Sensitivity (or true positive rate) against 1-Specificity (or false positive rate). We also reported the PPV and NPV (positive and negative predictive values) for prediction of death in each group. Goodness-of-fit of predicted to observed probabilities of death was assessed with the Hosmer-Lemeshow goodness-of-fit test. All data were analyzed using SPSS software (Ver 15, IBM SPSS Inc., Chicago, IL). In this study, P<0.05 was considered to be statistically significant.

Ethical Considerations: The ethics committee of the Shahid Beheshti University of medical Sciences (Tehran) and Pediatric Infections Research Center approved this study. The neonates were only included in the study after their parents agreed and signed the informed consent form.

Results

We evaluated 904 critically ill neonates during 2006-2013. Mean and standard deviation for neonatal gestational age were 35.2 ± 3.2 weeks and ranged between 25 and 41 weeks. Male patients constituted 53% and female patients 47% of the study population. Primary diagnoses of our patients were respiratory distress syndrome (RDS) 56%, gastrointestinal obstruction 19%, sepsis 6%, prematurity 6%, convulsion 5% and others 8%. Based upon the RIFLE criteria, 22.5% (203 neonates) of study group had normal renal function and 77.5% (701 neonates) of them had abnormal renal function on the second day of admission. Therefore 77.5% (701 neonates) developed AKI by RIFLE criteria and among them 43% met the risk (R), 51% the injury (I) and about 6% the failure (F) criteria. Based on the previous definition of ARF in neonates, the rate of ARF in our study group was 3.2% (29 out of 904 neonates had serum creatinine more than 1.5 mg/dl). There was a significant difference between AKI prevalence by the RIFLE criteria and the previous definition (P<0.001). In this study we detected an overall in-hospital mortality of 14% in critically ill neonates. Of those who died, 81.9% had AKI. Demographic data of study group, clinical characteristics and the differences between survivors and nonsurvivors are shown in (Table 1). In patients with normal renal function there was no mortality and in patients with AKI based on RIFLE criteria the mortality rate was 21.7% (P<0.031, Odds Ratio=1.103, 95% CI=1.05-1.16). Regardless of 21.7% mortality rate in AKI based on RIFLE criteria, in patients with ARF based on the old definition the mortality rate was 61.5% (P<0.001, Odds Ratio=6.741) (Fig. 1 and Table2).

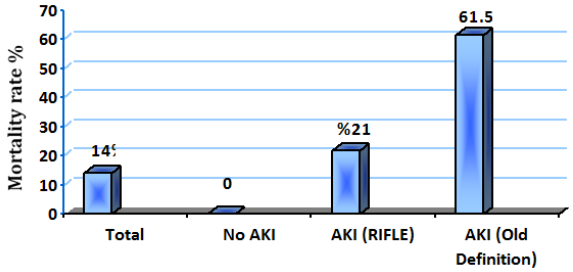

Figure 1. Mortality rate in study groups. In patients with AKI the mortality rate is higher than the patients with normal renal function. There is a significant difference in mortality rate between patients with AKI(RIFLE) and AKI(Old definition) (P<0.001, OR=6.741). AKI(RIFLE): Acute kidney injury based on RIFLE criteria, AKI (Old definition): Acute kidney injury based on old definition (serum Creatinine More than 1.5 mg/dl).

There was no difference in gender, height, APGAR score, temperature, blood pressure, heart rate, respiratory rate, serum electrolytes, blood sugar, bilirubin level and platelets between survived and nonsurvived neonates (Table 1). We evaluated the mortality rate in different groups of the RIFLE and demonstrated that in the R group the mortality rate was 4.3%, in the I group the mortality rate was 16.7% and in the F group the mortality rate was 50% (Fig.2). A progressive and significant elevation in mortality was correlated with increasing RIFLE severity among all patients. (Odds Ratio=1.406, P<0.002, CI=0.76-2.06) (Fig.3).

Neonates in the I group on admission showed a higher mortality rate than those in the R group

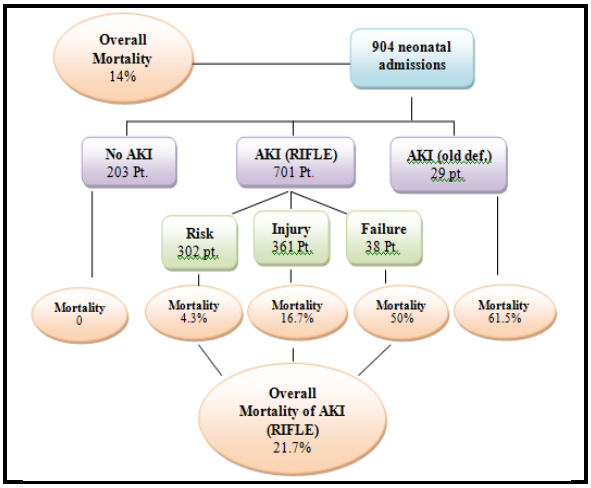

Figure 2. Diagram of mortality in admitted neonates during study period, with the incidence of acute kidney injury (AKI) according to RIFLE and the old definition. ⇧

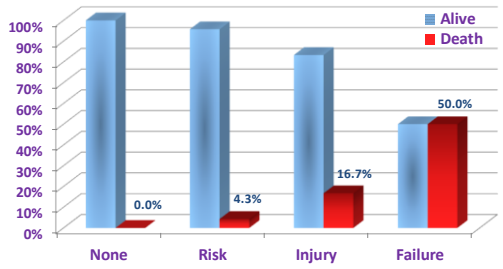

Figure 3 Mortality in different RIFLE groups. A progressive and significant increase in mortality was correlated with increasing RIFLE classification severity among all patients. (OR=1.406, CI=0.76-2.06, p<0.01). ⇧

(P< 0.001) and neonates who developed the F (failure) criteria during NICU staying had a higher mortality than those who developed the R or I criteria (Odds ratios : 3.17 and 1.84 respectively). The patients who had any evidence of AKI at the time of admission to the NICU showed statistically higher median scores at CRIB, CRIB II, SNAP, SNAP II and SNAP-PE NICU scoring systems (Table 3). The area under the curve for CRIB, CRIB II, SNAP, SNAP II, SNAP-PE and RIFLE for prediction of mortality was 0.817, 0.698, 0.931, 0.901, 0.918 and 0.552 respectively. In comparison to NICU scoring systems and the old definition of AKI, the

Table 1. Mean and standard deviation of demographic data, clinical characteristic and RIFLE scoring system in survivors and non-survivors ⇧

Patients' Data	Survivors	Non-survivors	P-value
Gestational age (weeks)	35.47±2.87	32.70±4.02	0.001
Birth weight (gram)	2579.2±800.8	2023.8±882.0	0.001
Height (cm)	47.26±3.96	45.89±4.72	0.066
Apgar score (1min)	8.44±1.05	8.04±1.65	0.61
Apgar score (5 min)	9.6±0.32	9.6±1.2	0.95
Systolic BP (mm/Hg)	67.96±10.0	66.40±10.94	0.228
Diastolic BP (mm/Hg)	39.27±7.4	37.80±8.6	0.144
Temperature °C	36.87±0.51	36.92±0.73	0.426
Maximum heart rate (/min)	143.32±13.20	141.82±18.25	0.386
Minimum heart rate (/min)	125.18±11.37	120.37±18.43	0.003
Respiratory rate (/min)	47.73±19.13	44.42±17.66	0.121
PH	7.32±0.08	7.19±0.16	0.001
PaO_2 (mmHg)	69.29±19.80	59.61±21.14	0.001
$PaCO_2$ (mmHg)	40.11±11.37	50.45±18.40	0.021
HCO_3 (mEq/L)	19.69±4.99	17.60±7.57	0.022
Fio_2 (02 Vol.%)	51.90±26.35	87.33±24.25	0.001
Maximum base excess (mmol/L)	-4.73±-9.30	-4.97±8.74	0.001
Sodium (mEq/L)	139.30±6.25	139.71±7.21	0.622
Potassium (mEq/L)	4.96±0.82	4.86±0.91	0.354
Blood Urea Nitrogen (mg/dl)	12.27±7.91	16.36±14.74	0.001
Blood sugar (mg/dl)	95.1±45.8	95.8±65.5	0.23
Direct bilirubin (mg/dl)	0.25±0.45	0.27±0.42	0.831
Indirect bilirubin (mg/dl)	1.50±0.88	1.72±1.16	0.097
Total calcium (mg/dl)	9.02±1.06	9.22±1.19	0.159
White blood cell	11638±4922	12910±7894	0.063
Platelet	287310±1479	253033±1670	0.081
Hematocrit (%)	42.8±8.30	42.9±8.7	0.04
Serum Creatinine (mg/dl)	0.31±0.31	0.73±0.33	0.007
Urine output (ml/24 hr)	88.78±23.80	67.74±27.95	0.001
GFR ($ml/min/1.73m^2$)	50.80±14.34	21.01±6.4	0.001
Acute kidney injury N (%)	152 (21.7%)	549 (78.3%)	0.030
Risk group (R) N (%)	49 (16.3%)	253 (83.7%)	0.001
Injury group (I) N (%)	87 (24.2%)	274 (75.8%)	0.006
Failure group (F) N (%)	16 (41.2%)	22 (58.8%)	0.007

Table 2. Clinical characteristic and outcome of patients with AKI (RIFLE) and AKI (old definition) ⇧

	AKI (RIFLE)*	ARF (old definition)**	P-value
Neonates **N (%)**	701 (77.5%)	29 (3.2%)	<0.0001
Age **(week)**	34.7±3.3	35.23±3.9	<0.5532
Birth weight **(gram)**	2397.1±834.1	2659.2±831.8	<0.2676
Urine output **(ml/24 hr)**	80.2±26.3	58.75±25.5	<0.0042
Serum creatinine **(mg/dl)**	0.81±0.33	1.96±0.33	<0.0001
GFR **(ml/min/1.73 m^2)**	23.94±7.22	11.63±1.72	<0.0001
Mortality %	21.7%	61.5%	<0.0029

*AKI(RIFLE): Acute kidney injury based on RIFLE criteria
**AKI (Old definition): Acute kidney injury based on old definition (serum Creatinine More than 1.5 mg/dl).

RIFLE criteria had sensitivity of 100%, specificity of 15.6%, negative predictive value (NPP) of 100 and a positive predictive value (PPV) of 9.3 for prediction of mortality (Table 4). Multivariate logistic regression modeling controlling for CRIB, CRIB II, SNAP, SNAP II and SNAP-PE NICU scoring systems and diagnostic category of admission confirmed the association between any AKI and the increase in the odds of NICU mortality. In addition, patients who developed failure criteria (F) during NICU stay were more likely to die than those who had risk criteria (R) after adjusting for the same high risk covariates (odds ratio, 2.94 [1.48, 5.75], p < 0.001). Each of the regression models had adequate goodness of fit according to the Hosmer-Lemeshow test. The measures of goodness of fit in this model for CRIB, CRIB II, SNAP, SNAP II and SNAP-PE and RIFLE are 0.767 (p< 0.001), 0.852 (P<0.003), 0.015 (P<0.001), 0.092 (P<0.001), 0.443 (P<0.001) and 0.356 (P<0.001) respectively.

Discussion

To describe the incidence of acute renal failure (ARF) in the neonatal intensive care unit (NICU) and to show the sensitivity and the precision of the RIFLE criteria in the identification of neonates with AKI. This study was carried out in the largest referral NICU of Tehran (IRAN). We have modified the criteria based on 904 critically ill neonates (neonatal RIFLE: nRIFLE) to assess acute kidney injury prevalence and its outcome in NICUs. The significant points of our study are listed below:

1. Of 904 admissions in the NICU, the rate of ARF was 3.2% by the old definition and 77.5% by the RIFLE criteria.
2. Among patients with AKI 43% met the risk, 51% the injury and about 6% the failure criteria.
3. We showed an overall in-hospital mortality of 14% in the critically ill neonates.
4. In patients with normal renal function there was no mortality.
5. In patients with AKI based on RIFLE criteria the mortality rate was 21.7%
6. In patients with abnormal renal function based on creatinine level (serum creatinine more than 1.5 mg/dl) the mortality rate was 61.5%.
7. A progressive and significant increase in mortality was correlated with increasing RIFLE severity among all patients. (Odds Ratio=1.406, P<0.002, CI=0.76-2.06).
8. The patients who had any degree of AKI at the time of admission to the NICU had statistically higher median values in median CRIB, CRIB II, SNAP, SNAP II and SNAP-PE NICU scoring systems.
9. The RIFLE criteria had 100% sensitivity and 15.6% specificity for the prediction of mortality.

The results of this study show that the AKI in neonates can be detected earlier based on RIFLE criteria compare to the old definition of renal failure. As a matter of fact we had lower mortality in the neonates with AKI based on RIFLE criteria (21.7%) compared to the neonates with ARF based on the old definition of renal failure (61.5%). Therefore, the earlier diagnosis of AKI as can be achieved with RIFLE criteria will improve the final outcome in neonates. In this study a progressive and significant elevation in mortality was correlated with increasing RIFLE classification severity among all patients. Several studies have been published in adult patients aiming to validate and apply it in clinical practice. They evaluated the outcome with progressive worsening and severity of AKI.

Perez Valdivieso et al analyzed the data gathered from a cohort of 956 adult patients admitted in a Spanish tertiary hospital between January 1998 and April 2006 and reported that the risk of in-hospital mortality during the AKI episode was positively associated with the increase in RIFLE severity. They showed that the RIFLE classification system had discriminative power in predicting hospital mortality within 60 days in

AKI patients [30]. In a large systematic review Ricci et al from Italy identified 24 studies in which the RIFLE classification was used to define AKI in adult patients. They included over 71000 patients in the analysis of published reports and showed that compared to non-AKI, there appeared to be a stepwise increase in RR for death going from Risk (RR=2.40) to Injury (RR=4.15) to Failure (6.37, P<0.0001 for all). They stated that the RIFLE classification is a simple, readily available clinical tool to classify AKI in different populations. It seems to be a good predictor for outcome, with a progressive increase in mortality rate with the worsening in the RIFLE classification. It also suggests that even mild degrees of kidney dysfunction may have a negative impact on outcome [31]. In 2007 for the first time Akcan-Arikan et al determined the modified pediatric RIFLE (pRIFLE) criteria and reported the pediatric patients with a maximum RIFLE score for R, I and F had an adjusted odds ratio for death of 2.9, 3 and 3 respectively [21].

Then Plotz et al observed a high incidence of significant acute kidney injury in a pediatric ICU population at risk, which was associated with a high mortality [32]. Hooman N. in a systematic review evaluated the epidemiology of AKI in hospitalized children in Iran and reported that the incidence of AKI declined from 36% to 15.4% in the PICUs. In this study the overall mortality rate was 18% [33]. Moghtaderi et al in a recent study in the emergency room of a tertiary center in Tehran demonstrated that 83% of children who presented with acute gastroenteritis had some degrees of acute kidney injury according to pRIFLE criteria. In their study 38% of AKI patients were in the failure category [34]. It seems that pediatric RIFLE criteria may guide in the early identification of patients at risk for acute kidney injury and in the initiation of therapy and prevention of mortality. Moreover Schneider et al reported that any extent of acute kidney injury on admission and also development or worsening of acute kidney injury during the pediatric intensive care unit stay were independently associated with increased mortality, and the odds of mortality increased with each grade increase in the RIFLE score ($P < 0.01$) [35]. As far as we know the scoring systems to define AKI in neonatal group has not been defined [23]. Recently Ferraz et al evaluated the rate of AKI in 19 neonates based on RIFLE criteria and reported a rate of 10% for ARF in NICU [36]. In this small sample size study the incidence of mortality was not reported. All the reports of increased mortality rate of neonates due to ARF are based on the old definition of ARF. As we highlighted before, based on the previous studies the mortality rate ranged between 10 to 78% in neonates with oligoanuric renal failure [14,26]. In this regard Askenazi et al determined that a 1 mg/dl increase in serum creatinine was associated with almost two-times higher odds of death [22]. Furthermore Mathur et al showed that the mortality rate is three times higher in neonates with sepsis and ARF compared to those without ARF and they concluded that the high mortality among septic neonates with ARF stresses the need for septic neonates to be screened for renal failure [37]. Advancement in neonatal medicine has improved the survival rates of critically ill neonates; yet residual mortality rate is significant. To date observational studies suggest high rates of AKI and poor outcome in critically ill neonates [23]. In our point of view, detection of neonatal AKI based on the old definitions is associated with a high mortality rate in NICUs. Therefore it is very important to have a more precise and sensitive definition for the identification of ARF at the earlier stages in the neonatal age group. Based on our study and the study by Akan-Arikan et al we propose using the RIFLE criteria in neonatal age group (nRIFLE) as well. By this means we can detect neonates with AKI in the earlier stages of involvement by nRIFLE. According to the previous studies, NICU scoring systems (CRIB, CRIB II, SNAP, SNAP II and SNAP-PE) have been introduced as useful indices of neonatal risk, to predict mortality in newborns [27, 38]. In our previous study, we concluded that the neonatal scoring systems could be a useful tool for prediction of mortality in NICUs and that SNAP can predict the mortality better than the others [39]. In this study, we concluded that the patients who had any degree of AKI at the time of admission to the NICU Had statistically higher median values in CRIB, CRIB II, SNAP, SNAP II and SNAP-PE NICU scoring systems. As far as we know the correlation between the RIFLE criteria and NICU scoring systems has not been made before. The results of this study showed that the neonates with AKI had higher median CRIB, CRIB II, SNAP, SNAP II and SNAP-PE NICU scoring systems compared to those neonates with normal renal function. It seems that renal function plays an important role in the prediction of NICU mortality and morbidity.

Conclusions

The authors concluded that RIFLE criteria can detect AKI earlier in neonatal age group and would be a good predictor for mortality in critically ill neonates.

Acknowledgement

The authors would like to thank the skilful technical assistance of Mahdieh hospital's nurses and Pediatric Infectious Research Center's staff.

Conflict of Interest

None declared

Financial Support

None declared

Table 3. Mean and standard deviation of demographic data, NICU scoring systems and rate of mortality in Risk, Injury and failure groups ⇧

	No AKI	Risk group	Injury group	Failure group	P value
Age (day)					
Gestational age (weeks)	36.85±2.13	35.73±2.60	33.96±3.47	33.0±4.37	<0.001
Birth weight (gram)	2854.2±722.6	2645.2±755.7	2212.2±832.6	2177.6±968.1	<0.001
Height (cm)	48.59±3.82	48.11±3.25	45.35±4.22	44.12±5.45	<0.001
Male (%)	56	46.7	54.7	64.7	0.307
Serum Creatinine (mg/dl)	0.43±0.22	0.62±0.14	0.89±0.22	1.61±0.63	<0.001
Urine output (ml/24 hr)	97.5±21.29	89.55±23.13	74.91±26.13	56.05±21.65	<0.001
GFR (ml/min/1.73m^2)	51.94±11.27	30.80±3.73	19.54±3.70	11.21±1.11	<0.001
CRIB	3.13±4.38	2.95±4.15	4.83±4.88	5.76±4.16	<0.001
CRIB II	4.80±3.03	3.52±2.27	6.33±3.03	8.50±2.88	<0.001
SNAP	7.26±5.28	7.50±5.61	8.58±6.41	11.47±6.96	0.086
SNAP-PE	14.29±14.46	12.84±13.80	15.27±15.70	26.47±20.58	0.008
SNAP II	11.89±11.02	11.04±11.05	12.05±11.058	20.59±15.34	0.006
Mortality (%)	0	4.3	16.7	50%	0.004

Table 4. Calibration and discrimination of RIFLE and old definition of acute renal failure in predicting of mortality in NICU ⇧

	Calibration			Discrimination		
	Goodness of fit (Chi^2)*	df**	P-value	Area under the curve	95% CI	P-value
RIFLE	9.198	8	0.326	0.528	0.460-0.596	0.431
Old definition of ARF	6.315	7	0.503	0.540	0.468-0.613	0.256

* Chi-square **Degree of freedom

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