

The Prognostic Value of AKIN and RIFLE Classifications in Acute Renal Failure Developing After Cardiac Surgery

Baloş S¹, Baloş Monica², Suciu H³, Deac R³, Kovács Judit⁴

¹ Cardiovascular Surgery, County Emergency Clinical Hospital, Târgu Mureş, Romania

² Department of Prosthetic Dentistry and Oral Rehabilitation, Faculty of Dental Medicine, University of Medicine and Pharmacy, Târgu Mureş, Romania

³ Department of Cardiovascular Surgery, University of Medicine and Pharmacy, Târgu Mureş, Romania

⁴ Department of Anesthesia, Intensive Care and Emergency Medicine, University of Medicine and Pharmacy, Târgu Mureş, Romania

Background: Renal dysfunction is common after cardiac surgery, ranging from minor changes in serum creatinine without clinical manifestations to frank anuria and severe metabolic dysfunction. In recent years two scores were developed to diagnose renal dysfunction. The aim of our study was to compare the prognostic value of these scores in acute renal failure associated with cardiac surgery.

Materials and methods: In our prospective clinical observational study we calculated and compared the AKIN (Acute Kidney Injury Network) and RIFLE (Risk, Injury, Failure, Loss, Endstage kidney disease) scores in 178 patients undergoing open heart surgery at the Clinic of Cardiovascular Surgery in Târgu Mureş, Romania, between October 1, 2010 and March 31, 2011, and studied the morbidity and mortality in patients with renal dysfunction in terms of these scores.

Results: According to AKI criteria, we identified 39 patients having high risk for developing renal injury (stage I) (with 16 cases more than with RIFLE criteria, class R), but we observed no differences in the number of renal dysfunction (28 patients) or renal failure (18 patients). The patients enrolled in high risk group according to AKI score, but not with RIFLE criteria, had a good outcome with diuretics and avoidance of nephrotoxic agents. Two patients needed renal replacement therapy, both of them were classified in the renal failure group. Mortality was higher in renal failure according to both RIFLE and AKI criteria.

Conclusions: AKI criteria are more sensitive in identifying patients at risk for renal injury, but the RIFLE criteria are more accurate in the estimation of postoperative morbidity and mortality.

Keywords: acute renal failure, cardiac surgery, prognostic value, diagnostic criteria

Received: 25 April 2012 / Accepted: 4 July 2012

Introduction

Renal injury is one of the most common complications following cardiac surgical procedures in which cardiopulmonary bypass is used, and the development of renal failure is associated with increased morbidity and mortality. These data highlight the importance of early diagnosis for implementing specific therapy and preventing the aggravation of renal dysfunction.

In the last years, two diagnostic and classification criteria were developed. The RIFLE (Risk, Injury, Failure, Loss of function, End-stage kidney disease) criteria is based on the changes over a one-week period of serum creatinine level, estimated glomerular filtration rate (eGFR) and urinary output, while the AKIN (Acute Kidney Injury Network) criteria follow the 48-hour changes on serum creatinine, urinary output, and include also the patients who need renal replacement therapy.

The aim of our study was to evaluate the diagnostic and prognostic value of these criteria in renal injury following open heart surgery.

Material and method

In our prospective clinical observational study we included patients undergoing elective cardiac surgical repair in car-

diopulmonary bypass between October 1, 2010 and March 31, 2011 at the Clinic of Cardiovascular Surgery in Târgu Mureş, Romania. We calculated and compared the scores obtained from RIFLE and AKIN criteria (Table I), the morbidity and mortality in patients with renal injury in terms of these scores. Serum creatinine level was measured preoperatively and in the 1st, 3rd, and 5th day postoperatively.

Renal injury was defined using the changes of serum creatinine level, and patients were included in the highest stage attained in the RIFLE or AKIN categories, according to their serum creatinine level. We did not use urinary output criteria to diagnose or to stage patients in our study,

Table I. Classification of renal injury according to RIFLE and AKIN criteria

RIFLE criteria			AKIN criteria		
Class R	s.cr. ≥ 1.5 x or GFR $< 25\%$	UO ≤ 0.5 ml/kg/h x 6 h	Stage I	s.cr. ≥ 1.5 x or s.cr. ≥ 0.3 mg/dl	UO ≤ 0.5 ml/kg/h x 6 h
Class I	s.cr. ≥ 2 x or GFR $< 50\%$	UO ≤ 0.5 ml/kg/h x 12 h	Stage II	s.cr. ≥ 2 x	UO ≤ 0.5 ml/kg/h x 12 h
Class F	s.cr. ≥ 3 x or s.cr. ≥ 4 mg/dl or GFR $< 75\%$	UO ≤ 0.3 ml/kg/h x 24 h or anuria x 12 h	Stage III	s.cr. ≥ 3 x or s.cr. ≥ 4 mg/dl or RRT	UO ≤ 0.3 ml/kg/h x 24 h or anuria x 12 h

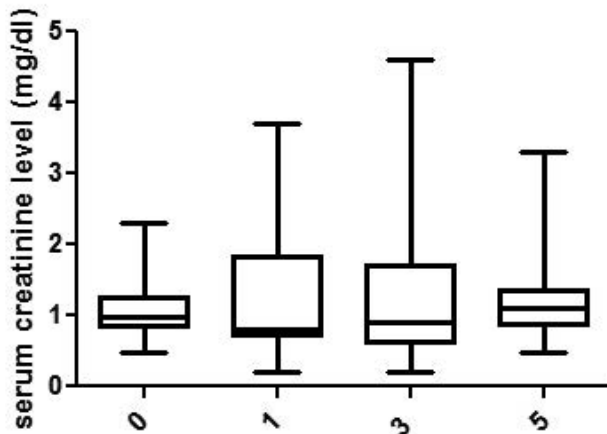


Fig. 1. The mean serum creatinine level in the preoperative (0) and in postoperative period (on the 1st, 3rd and 5th day)

because we used diuretics in all patients to treat hemodilution in the first postoperative day and then to maintain urinary output, which could have influenced the data. The urinary criteria were identical in these two classifications, so it would not influence our comparative study.

Statistical analysis was made using GraphPadPrism 5.0 software. Data were reported as mean \pm standard deviation. Variables were compared with Fisher exact test. We considered statistical significance when $p < 0.05$.

Results

One-hundred seventy-eight elective open heart surgeries were performed in the studied period. The mean age of the patients was 58.4 ± 11.4 years (17–75 years), 46 women (25.8%) and 132 men (74.2%). Ninety-eight patients underwent coronary revascularization, 68 valvular replacement or valvuloplasty, in 4 patients congenital defects were corrected and in 8 cases combined surgery was performed (coronary revascularization with valve replacement or vascular surgery). Four patients had mild elevation of serum creatinine level before surgery (1.69 ± 0.06 mg/dl), all of

Table II. Patient outcome according to RIFLE and AKIN criteria

	No. of pts. n (%)	s.cr. level day 1	s.cr. level day 3	s.cr. level day 5	Need for RRT in AKI pts. n (%)	Mortality in AKI pts. n (%)
RIFLE stage						
Without renal injury	109 (61.2%)	0.7	0.8	1.0	0	0
Class R	23 (12.9%)	1.15	1.2	0.8	0	0
Class I	28 (15.7%)	1.9	2.3	1.6	1 (1.4%)	1 (1.4%)
Class F	18 (10.1%)	3.1	3.3	2.9	2 (2.9%)	2 (2.9%)
AKIN stage						
Without renal injury	93 (52.2%)	0.6	0.8	0.9	0	0
Stage I	39 (21.9%)	1.1	1.1	0.9	0	0
Stage II	28 (15.7%)	1.9	2.3	1.6	0	0
Stage III	18 (10.1%)	3.1	3.5	3.1	3 (3.5%)	3 (3.5%)

s.cr. – serum creatinine, AKI – acute kidney injury

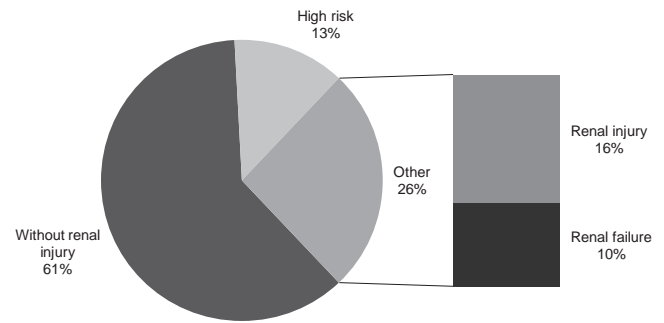


Fig. 2. Distribution of patients according to the RIFLE criteria

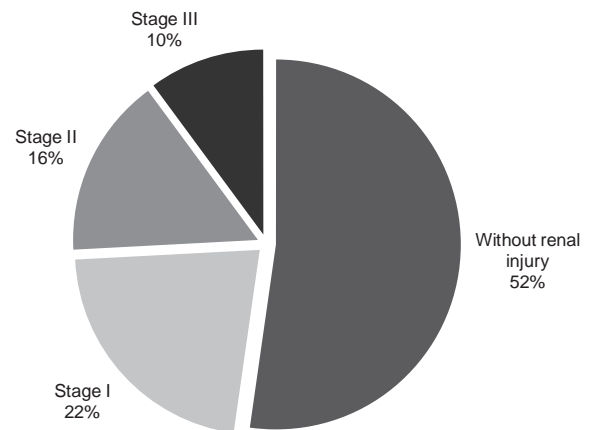


Fig. 3. Distribution of patients according to the AKIN criteria

them being diagnosed with coronary heart disease. The early postoperative mortality was 1.7% (3 patients).

The median serum creatinine level was slightly elevated in the third day after surgery in all patients, then showed a decrease till the 5th day (Figure 1).

According to the RIFLE criteria, we found 23 patients in class R (high risk), 28 in class I (renal injury) and 18 with renal failure ($n=69$ patients, 38.8%) (Figure 2).

Calculating the AKIN score, we found 85 patients with renal injury, 16 cases more than with RIFLE criteria (Figure 3), but this difference was not statistically significant ($p=0.1084$). These patients, diagnosed with renal injury by AKIN, but not with RIFLE, had an increase of creatinine level with 0.3–0.6 mg/dl in the first postoperative day, compared with the preoperative baseline level. There were no patients with renal injury diagnosed with RIFLE criteria, but not with AKIN criteria.

The clinical evolution and outcome of the patients with renal injury is presented in Table II.

Patients in class R (RIFLE) and stage I (AKIN) showed only minor differences in serum creatinine level (were lower

Table III. The mean hourly urinary output of the patients

RIFLE	Urinary output/hour	AKIN	Urinary output/hour
Class R	85 ± 30 ml	Stage I	85 ± 45 ml
Class I	70 ± 54 ml	Stage II	75 ± 35 ml
Class F	65 ± 30 ml	Stage III	55 ± 25 ml

in the AKIN group), but all these patients had a favourable outcome, without postoperative complications.

There were only mild differences between patients in class I and F (RIFLE), and stage I and II (AKIN) respectively in serum creatinine level, need for renal replacement therapy and postoperative morbidity and mortality (all patients with RRT were enrolled in stage III by the AKIN definition). Mortality was higher in patients with renal failure (class F or stage III) and in those needing continuous veno-venous hemodialysis. In our study, all patients who were on renal replacement therapy, died (100% mortality).

Urinary output was maintained in all patients in class R/RIFLE or class I/AKIN, only 2 patients had oliguria in class I/ stage II and we recorded 8 oliguric patients among cases included in class F/ stage III. In Table III we present the mean hourly urinary output of the patients with renal injury according to both classification systems.

Other complications, associated with renal injury were low cardiac output syndrome (in 40 patients in the RIFLE group and 47 patients in the AKIN group), liver dysfunction in 4 cases, cardiac tamponade and cerebral hemorrhage in 1 patient. Twelve patients needed prolonged mechanical ventilation, 8 were included in class F/stage III and 4 in class I/stage II. Infections were more common in patients with renal injury: there were 6 cases with ventilator associated pneumonia and in one patients sepsis was developed, compared with patients without renal dysfunction, where we did not find any infections.

Discussion

Renal dysfunction/failure is one of the most common complication occurring after cardiac surgery, its incidence is between 1–30%, depending on the diagnostic criteria used, severe cases requiring renal replacement therapy, which occurs with a frequency of 1% [1]. The problem is, that despite the development of cardiopulmonary bypass techniques, surgical procedures, intensive care and the new methods in renal replacement therapy, mortality in patients with renal injury remains high, between 24–70% [2,3].

All this data emphasizes the importance of understanding the etiology and physiopathology of renal failure in cardiac surgery patients, and the importance of early diagnosis, in order to implement effective preventive and therapeutically strategies.

The introduction of RIFLE and AKIN definition systems for the diagnosis acute kidney injury was the first step in identifying patients at high risk for developing renal dysfunction, and they both showed excellent association with mortality, need for prolonged intubation and hospital stay [4].

Hoste et al. showed in a retrospective cohort study [5], that the RIFLE score can be used successfully to determine the prognosis of patients with different degrees of renal injury. According to this study, patients classified in the high risk group (R) might have an evolution toward renal

dysfunction/failure, and those included in the I or F class (dysfunction or failure) will need a longer period of intensive care and have a higher mortality, than those at risk or patients without renal injury. Ostermann et al. demonstrated that the AKIN score correlates well with outcome, but not with early postoperative mortality [6].

Our aim was to compare the utility of these two criteria to predict outcome in patients undergoing open heart surgery. Our data demonstrate that the AKIN score is more sensitive in detecting patients with renal injury. We could diagnose 16 patients more with renal dysfunction than with the RIFLE classification, but all these patients could be included in stage I, and the serum creatinine level was only slightly higher than the preoperative baseline level. However, patients diagnosed as renal dysfunction with the AKIN score, but not with the RIFLE criteria, had a good evolution, all these patients showing a decrease in serum creatinine level until 5th postoperative level.

Among patients diagnosed with renal dysfunction or failure, there was only limited disagreement in staging the severity grade: one patient with renal replacement therapy, enrolled in class I by RIFLE was included in stage III/AKIN by definition. This led to a higher mortality rate in stage III/AKIN vs. class F/RIFLE, which shows a better prognostic value of AKIN classification.

Englberger et al. [4] reached the same conclusion regarding the utility of the AKIN score in cardiac surgery. Following a retrospective study, which calculated RIFLE and AKIN scores, they concluded that the AKIN criteria overestimate renal risk, but placing all patients on renal replacement therapy (whether the indication was for remove toxins or water) in the group of renal failure (F), its prognostic value is better. Other authors consider that AKIN has a good sensitivity, but is not able to predict intrahospital mortality in critically ill patients [7].

To diagnose renal injury, we used only serum creatinine level for both classification system. Given that most of our patients with renal dysfunction had preserved diuresis/or diuresis was stimulated efficiently with diuretics (furosemide), oliguria was somewhat "hidden", so we emphasize the importance of determining routine serum creatinine to detect renal damage as early as possible, to establish effective preventive measures and prevention of acute postoperative renal complications.

Conclusions

In summary, our results suggest that the AKIN criteria are more sensitive detecting renal injury following cardiac surgery and they can predict mortality better than the RIFLE classification. Because urinary output is maintained in almost all patients, we consider that it is important to monitor serum creatinine level, in order to detect renal injury in early stage.

Acknowledgement

This paper is partially supported by the Sectoral Op-

erational Programme Human Resources Development, financed from the European Social Fund and by the Romanian Government under the contract number POSDRU/89/1.5/S/60782.

References

1. Rosner MH, Okusa MD. Acute kidney injury associated with cardiac surgery. In-depth review. Clin J Am Soc Nephrol 2006;1:19-32.
2. Khilji SA, Khan AH. Acute renal failure after cardiopulmonary bypass surgery. J Ayub Med Coll Abbottabad 2004;16:25-8.
3. McCullough PA. Acute kidney injury with iodinated contrast. Critical Care Med, 2008;36(4):204-211.
4. Englberger L, Suri MR, Li Z, Casey TE, Daly RC, Dearani JA, Schaff HV. Clinical accuracy of RIFLE and Acute Kidney Injury Network (AKIN) criteria for acute kidney injury in patients undergoing cardiac surgery. Critical Care 2011;15:R16.
5. Hoste EA, Clermont G, Kersten A, Venkataraman R, Angus DC, DeBacquer D, Kellum JA. RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis. Critical Care 2006;10(3):R73.
6. Ostermann M, Chang R. Correlation between the AKI classification and outcome. Critical Care 2008;12:R144.
7. Lopes JA, Fernandes P, Jorge S, Goncalves S, Alvarez A, eSilva ZC, Franca C, Prata MM. Acute kidney injury in intensive care unit patients: a comparison between the RIFLE and the Acute Kidney Injury Network classifications. Critical Care 2008;12:R110.