

RIFLE classification of acute kidney failure in intensive care

The wide range of incidence of acute renal failure is partly the result of the lack of a reliable definition. The RIFLE classification allows acute renal failure to be stratified for severity, and different outcomes depend on the degree of severity. This review discusses how the RIFLE criteria fit into the whole picture.

Acute renal failure (ARF) has been the focus of extensive clinical and basic research efforts over the last decades. The lack of a universally recognized definition of ARF has posed a significant limitation. Despite the significant progress made in understanding the biology and mechanism of ARF in animal models, translation of this knowledge into improved management and outcomes for patients has been limited (Levy et al, 1996). The RIFLE classification is outlined in *Table 1*.

A consensus among different nephrological and critical care societies has proposed the term acute kidney injury (AKI) to reflect the entire spectrum of ARF, recognizing that an acute decline in kidney function is often secondary to an injury that causes functional or structural changes in the kidneys. Also a new group has been established which is called the Acute Kidney Injury Network (AKIN) as an independent collaborative network comprised of experts selected by the participating societies to represent both their area of expertise and their sponsoring organization. AKIN is intended to

facilitate international, interdisciplinary and intersocietal collaborations to ensure progress in the field of AKI and obtain the best outcomes for patients with or at risk for AKI (Levy et al, 1996).

The most approved definition for AKI is an abrupt (within 48 hours) reduction in kidney function currently defined as an absolute increase in serum creatinine of ≥ 26.4 mmol/litre, a percentage increase in serum creatinine of more than or equal to 50% (1.5-fold from baseline), or a reduction in urine output (documented oliguria of less than 0.5 ml/kg per hour for more than 6 hours).

The above criteria include both an absolute and a percentage change in creatinine to accommodate variations related to age, gender, and body mass index and to reduce the need for a baseline creatinine but do require at least two creatinine values within 48 hours. The urine output criterion was included based on the predictive importance of this measure but with the awareness that urine outputs may not be measured routinely in non-intensive care unit (ICU) settings. The above criteria should be used in the context of the clinical presentation and following adequate fluid resuscitation when applicable.

Table 1. Risk, Injury, Failure, Loss, and End-stage kidney disease (RIFLE) classification

Class	GFR criteria	UO criteria
Risk	Serum creatinine x 1.5	<0.5 ml/kg/h x 6 h
Injury	Serum creatinine x 2	<0.5 ml/kg/h x 12 h
Failure	Serum creatinine x 3 or serum creatinine ≥ 4 mg/dl with an acute rise >0.5 mg/dl	<0.3 ml/kg/h x 24 h Anuria x 12 h
Loss	Persistent acute renal failure = complete loss of kidney function >4 weeks	
End-stage kidney disease	End-stage kidney disease >3 months	

For conversion of creatinine expressed in conventional units to SI units, multiply by 88.4. Patients are categorized on serum creatinine or urinary output (UO), or both, and the criteria that lead to the worst classification are used. Glomerular filtration rate (GFR) criteria are calculated as an increase of serum creatinine above the baseline serum creatinine level. When the baseline serum creatinine is unknown and there is no past history of chronic kidney disease, serum creatinine is calculated using the Modification of Diet in Renal Disease formula for assessment of kidney function, assuming a glomerular filtration rate of 75 ml/min/1.73 m². From Bellomo et al (2004)

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RIFLE criteria and AKI

Because the most powerful tool to improve outcome of AKI is prevention, the definition should have a high sensitivity, be multifaceted, and allow detection of patients who are at risk of developing kidney injury, as well as those with already established AKI and those with established ARF. This distinction in different stages can be valuable to guide therapeutic recommendations and to allow reasonable comparisons of outcome between various treatment strategies in equivalent patient groups (Lameire et al, 2006).

The acronym RIFLE defines three grades of increasing severity of ARF (risk, injury, and failure, respectively, R, I, and F) and two outcome variables (loss and end-stage kidney disease, respectively, L and E). It was published 3 years ago (Bellomo et al, 2004).

A unique feature of the RIFLE classification is that it provides for three grades of severity of renal dysfunction on the basis of a change in serum creatinine, reflecting changes in glomerular filtration rate (GFR) or duration and severity of decline in urine output from the baseline.

The RIFLE criteria have the advantage of providing diagnostic definitions for the stage at which kidney injury still can be prevented (risk), the one when the kidney has already been damaged (injury) and the one when renal failure is established (failure) (Bellomo et al, 2004).

Validation of any classification and staging system of AKI is required which can improve the design of clinical trials. Also appropriate end points for clinical trials in AKI need to be defined (Schrier et al, 2004). The end points can range from the need for dialysis at a specified time point to development of renal recovery or mortality at a specified end point.

RIFLE has been studied and prospectively validated in a higher number of patients and in more heterogeneous groups of patients and cohorts than any other widely accepted and applied definitions and classifications of either ARF or other syndromes used particularly in ICU patients (Table 2) and seem to be at least coherent with regard to outcome of the patient with AKI (Abosaif et al, 2005; Bell et al, 2005; Hoste et al, 2006; Kuitunen et al, 2006; Uchino et al, 2006).

Advantages of the RIFLE classification

The use of a common language between different centres, the relative ease of clinical application, the idea of severity stratification of ARF and the emphasis on prevention and early detection and management are the major advantages of RIFLE.

Application of the RIFLE classification has enabled clinicians to establish the severity of AKI and provide short-term prognosis for the majority of patients.

Studies have suggested that even minimal increases in serum creatinine are associated with substantial increases in mortality, hospital length of stay and cost. In a sample

of nearly 20 000 consecutive patients who were admitted to a single academic medical centre, Chertow et al (2005) observed that increases in serum creatinine of ≥ 0.5 mg/dl, which were present in 13% of patients, were associated (after multivariate adjustment for demographic factors and co-morbid disease) with 6.5-fold increased odds of death. Even lesser elevations in serum creatinine were associated with increased mortality risk, with a 70% increase in adjusted mortality risk associated with increases in serum creatinine of only 0.3–0.4 mg/dl.

Controversial aspects of RIFLE classification The need for renal replacement therapy

Although the study of Maccariello and coworkers (2007) tried to test the applicability of RIFLE criteria as a prospective trial to determine patients in need of renal replacement therapy (RRT), the choice of RRT was not prescribed according to RIFLE classification but to other clinical and laboratory criteria. These criteria included; presence of one or more of the following characteristics: metabolic acidosis, urea above 100 mg/dl, hyperkalaemia above 6.0 mmol/litre, evidence of water overload, severe hyperphosphataemia or dysnatraemia, oligouria or anuria, and uraemic signs or symptoms. So RIFLE was not really tested as a setup for allocating patients to certain types of RRT or when to start it.

Sensitivity and specificity

An analysis (Hoste et al, 2006) of the RIFLE criteria in 5383 critically ill patients revealed that of the 1510 (28%) patients who were admitted in the risk stage, 840 (56%) progressed further to more severe RIFLE strata, suggesting that these criteria have a reasonable specificity to detect the difference between functional (vasocon-

Table 2. Summary of the studies that evaluated the RIFLE criteria

Reference	Patient group	n	Mortality %	6-month mortality	Hazard ratio	Need for renal replacement therapy
Abosaif et al (2005)	General ICU	183	ICU mortality R: 38.3% I: 50.0% F: 74.5%	R: 43.3% I: 53.6% F: 86.0%		R: 28.3% I: 50.0% F: 58.0% CRRT: 100%
Bell et al (2005)	General ICU Need for CRRT	207			30-day hospital mortality R: 1.0 I: 0.9 (0.3–2.7) F: 3.4 (1.2–9.3)	
Hoste et al (2006)	General ICU	5383	Hospital mortality R: 8.80% I: 11.4% F: 26.9%		Hospital mortality 1.0 (0.68–1.56) 1.4 (1.02–1.88) 2.7 (2.03–3.55)	
Uchino et al (2006)	General ICU	20 126			Hospital mortality Control group (no kidney injury): 1.0 R: 2.54 (2.15–2.99) I: 5.41 (4.55–6.44) F: 10.12 (8.32–12.32)	

Adapted from Biesen et al (2006). CRRT = continuous renal replacement therapy; F = failure; I = injury; ICU = intensive care unit; R = risk.

Table 3. Controversial aspects of RIFLE classification

Criteria for RIFLE classification	Controversial issue
Increase in serum creatinine	Dependency on baseline creatinine values of patients Reliability of calculated baseline creatinine by Modified Diet in Renal Disease formula
Reduced urinary output	Fluctuations in urine output depending on volume status, antidiuretic hormone, etc
Renal replacement therapy (RRT)	Influence of requirement of RRT on RIFLE stage Applicability of RIFLE as prognostic tool in patients with severe sepsis requiring RRT Applicability of RIFLE stage for initiation of RRT

Adapted from Joannidis (2007).

striction because of renal hypoperfusion) and structural (acute tubular necrosis) alterations.

Serum creatinine is the most widely used parameter for everyday assessment of GFR, but it has poor sensitivity and specificity in AKI because serum creatinine lags behind both renal injury and renal recovery (Lameire and Hoste, 2004) (Table 3). The knowledge of baseline creatinine is considered one of the major disadvantages in RIFLE. If unavailable, it is suggested that the initial serum creatinine be calculated based on an assumed GFR of 75 ml/min/1.73 m².

Another alternative for 'early' detection of a fall in GFR is the monitoring of serum levels of cystatin C. This compound is produced at a constant rate by all nucleated cells and is filtered freely at the glomeruli and reabsorbed and catabolized but not secreted by the tubules. Cystatin C detects the development of AKI 1–2 days earlier than graded changes in serum creatinine as based on the RIFLE criteria and increases more rapidly than serum creatinine after administration of radiocontrast media (Herget-Rosenthal et al, 2004). However, cystatin C is not widely used, is expensive, and cutoff values for detection of AKI are lacking.

In the new definition of AKI, urine output criterion was included based on the predictive importance of this measure but with the awareness that urine outputs may not be measured routinely in non-ICU settings. It is assumed that the diagnosis based on the urine output criterion alone will require exclusion of urinary tract obstructions that reduce urine output or of other easily

reversible causes of reduced urine output. The above criteria should be used in the context of the clinical presentation and following adequate fluid resuscitation when applicable (Mehta et al, 2007).

Conclusions

The introduction of the RIFLE system into the clinical arena represents a useful step in the field of critical care nephrology (Bellomo et al, 2007). Whereas the RIFLE criteria already allow diversification in the definition of AKI, making it possible to identify more exactly than before the degree of renal injury, other important variables (such as estimated GFR measurement, urine output criterion and RRT choice) were not included. For patients admitted directly to the ICU, the RIFLE score still provides the best way to identify these patients' severity in the first 24 hours of admission and helps further predict their outcome and prognosis. **BJHM**

Conflict of interest: none.

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KEY POINTS

- The RIFLE classification in the intensive care unit has been evaluated in many studies and found to be effective in categorizing patients with acute renal failure in the intensive care unit setting.
- It helps determine the severity, outcome and prognosis of this important and lethal disease in the intensive care unit.
- Standardization of the definition and classification will allow us to establish the best available treatment and renal replacement therapy.