



## Estimated Preoperative Renal Function as A Reliable Risk Factor That Predicts for Acute Kidney Dysfunction After Cardiac Surgery

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### ABSTRACT

Acute kidney dysfunction (AKD) is a common and serious postoperative complication after cardiac surgery. Different risk factors are identified for post cardiac surgery AKD. It is associated with a dramatic rise in mortality rate. We stratified patients into two levels of estimated preoperative creatinine clearance in order to analyze the effect of a number of pre-, intra-, and postoperative variables on post-operative renal function. In patients with  $eGFR \geq 60$  mL/min ( $n = 15$ ), advanced age, obesity, diabetes were independently associated with the onset of AKD (see Table 3). In patients  $eGFR < 60$  mL/min ( $n = 54$ ), baseline SCr and obesity were predictors of AKD. The reduction well-known risk factors for AKD, the graft number, total operational time and hemodilution during CBP, appear as very important risk factors though they are potentially modifiable.

**KEYWORDS:** acute kidney dysfunction, cardiac surgery, risk factors, serum creatinine

### INTRODUCTION

Acute kidney dysfunction (AKD) is a frequent and severe complication after cardiac surgery. Its frequency is variable, ranging from 1–5% for severe forms requiring renal replacement therapy, to up to 30% in less severe forms<sup>1</sup> that increases the length of stay and hospital charges<sup>2</sup>. Numerous variables were identified as risk factors for the development of AKD as well as the influence of previous renal function<sup>3</sup>. As a result, preventive strategies could be tailored according to baseline renal function. To test this hypothesis, we stratified patients into two levels of estimated preoperative creatinine clearance in order to analyze the effect of a number of pre-, intra-, and postoperative variables on post-operative renal function.

### PATIENTS AND METHODS

We collected retrospectively data from all adult patients submitted to cardiac surgery of the Hygeia Hospital Tirana from October 2011 and may 2012. Patients under dialysis or patients who died in the first 24 hours after surgery were excluded. Patient's data were collected from their medical charts and electronic records. According to the outlined inclusion criteria, 69 patients were studied. All patients had at least two measurements of serum creatinine (SCr): at baseline and in the post-operative period during hospitalization. AKD is defined by an increase in SCr equal to or greater than 0.3 mg/dL after cardiac surgery during hospitalization<sup>4</sup>. Baseline creatinine clearance (eGFR) was estimated by the Cockcroft-Gault equation. Advanced age were considered all patients above 65 years old<sup>5</sup> and obesity evaluation was considered according to BMI. Patients were stratified for the analysis into two groups according to estimated eGFR: group 1,  $eGFR \geq 60$  mL/min; group 2,  $eGFR < 60$  mL/min. This cutoff point was selected considering the National Kidney Foundation definition of chronic kidney disease. Variables described considered as risk factors for AKD, were selected to be tested in the present series of patients. These included age, gender, EuroSCORE, diabetes, prior myocardial infarction, cardiopulmonary bypass time, aortic cross-clamping time, arterial pressure under on-pump perfusion and aortic cross-clamping time and hematocrit.

### Statistical Analysis

Univariate analysis was performed using  $\chi^2$  test for categorical variables and the Student *t*- test, or Mann-Whitney test, for continuous variables. A separate multiple logistic regression model using the forward stepwise elimination method was performed in each group, with postoperative AKD being the dependant variable (yes/no). The large number of patients included in the analysis allows exploring for confounding factors and multivariate adjust for confounding, including age and serum creatinine, within each strata. This stratified analysis made it possible to explore for the residual contribution of the baseline renal function to the variance of AKD incidence within each group. The variables that reached a 10% probability of random association to onset of post-operative AKD in the univariate analysis were included in the model. The exit criterion was set at level 0.05. The statistical package SPSS 16.0 (Chicago, Illinois, USA) was used for statistical analysis.

### RESULTS

Demographic data of the general population are shown in Table 1. In

all, 15 patients (21.4%) developed acute kidney dysfunction according to the above adopted definition. In patients of group 1, which corresponds to  $eGFR \geq 60$  mL/min, the frequency of AKD was 11.1% (6/54). In patients of group 2, with  $eGFR < 60$  mL/min corresponding to chronic kidney disease the frequency of AKD was 60 % (9/15).

**Table 1. Demographic data in the general population**

Number of patients	69
Age (years)	61.6 ± 9.6
Male gender	52 (74.3)
Diabetes (%)	16 (23%)
Baseline Scrs (mg/dl)	1.03 ± 0.33
eGFR (mL/min)	85.08 ± 29.5
AKD	15 (21.4%)
EuroSCORE (median, range)	6 (0-22)
Obesity (%)	19 (27%)

Scr and eGFR are expressed as mean ± SD. Scr=serum creatinine, eGFR=estimated glomerular filtration rate, AKD=acute kidney dysfunction

**Table 2. Univariate analysis for AKD risk factors in the general population**

	AKD (n=15)	Non AKD (n=54)	P
Age (years old)	64.4 ± 9.6	60.87 ± 9.5	0.2084
Obesity (%)	13.3	31.5	0.90448
Diabetes (%)	27%	22.7	0.32218
Baseline Scrs (mg/dl)	1.4 ± 0.24	0.9 ± 0.24	0.0001***
eGFR (mL/min)	57.86 ± 16.14	92.93 ± 27.85	0.0001***
EuroSCORE (median, range)	6(0-21)	5 (0-22)	0***
M	86.7	72.2	0.25014
F	13.3	27.8	0.25014
Total operation time (min)	7.06 ± 2.2	6.1 ± 1.5	0.0531***
Graft number	2.4 ± 1.2	2.3 ± 1.35	0.0001***
Acute myocardial infarction (%)	93.30%	83.30%	0.33204
Non-coronary surgery	6.70%	14.90%	0.40654

HCT (%)	40.05± 3.9	37.71±4.1	0.0524***
Aortic clamp time (min)	63.27± 19.6	72.08±26.0	0.2278
Hct before surgery	27.73±4.3	28.49±3.9	0.5159
On pump	100	100	
Hct day 1	29.4 ± 2.31	30.19 ± 3.3	0.3886

eGFR=estimated glomerular filtration rate, Hct=hematocrit.

Risk factors for AKD in the general population were identified in the univariate analysis (see Table 2). When patients were stratified according to baseline eGFR, the risk factors profile was different between groups. In patients of group 1 (n = 15), advanced age, obesity, diabetes were independently associated with the onset of AKD (see Table 3). In patients of group 2 (n = 54), baseline Scr and obesity were predictors of AKD (see Table 3).

**Table 3. Adjusted risk factors for AKD in patients with baseline preoperative eGFR ≥ 60 mL/min and eGFR < 60 mL/min**

	Risk factors for AKD in patients with eGFR ≥ 60 mL/min			Risk factors for AKD in patients with eGFR < 60 mL/min		
	OR	CI 95%	p	OR	CI 95%	p
Advanced age (yrs)	2.5	0.45-14.23	0.001	1.8	1.1-3.7	0.2
Obesity	1.03	0.17-6.2	0.03	0.3	0.1-0.6	0.06
Diabetes (%)	1.5	0.25-9.8	0.0001	1.4	0.1-20.4	0.7
Baseline Scr (mg/dl)	6.2	3.6-5.4	0.13	3.5	0.9-1.2	0.05***
Total operation time	1.1	0.7-1.85	0.5	0.9	0.8-1.09	0.4
Lowest mean blood pressure	1.16	0.97-1.38	0.1	1.3	0.7-2.4	0.3

Scr=serum creatinine

## DISCUSSION

A growing number of patients submitted to cardiac surgery worldwide as a result of the rise in the incidence of coronary artery disease and the inclusion of older and sicker patients for surgery. Comparing data of our own study, mean age of patients in a series published in 1997<sup>6</sup> was 58 ± 0.9 years, while in the current series the mean age of patients is 61.6 ± 9.6 years (p = 0.001). Several risk factors for renal failure have been identified and algorithms to accurately predict the occurrence of AKD in this setting have been designed with the aim of preventing this complication, or at least for advising patients on a more accurate decision-making to improve the outcome. Thakar et al.<sup>7</sup> also developed a clinical score to predict AKD after open-heart surgery. CKD is one of the most important predictors of AKD, and it was demonstrated that even modest changes in serum creatinine are strongly associated with AKD and mortality after cardiac surgery<sup>8</sup>. This finding is in accordance with other studies that demonstrated a higher risk for postoperative AKD when eGFR is lower than 60 mL/min<sup>8</sup>. Interestingly, although the incidence of AKD in both groups was similar, variables associated with the onset of AKD were different between the two groups. In addition to baseline renal reserve, other variables, such as, hemodilution, age, EuroSCORE and the type of surgery, were also associated with AKD in this group of patients. In patients of group 1, AKD was independently associated with some underlying conditions (older age, diabetes), CPB time and hemodilution. Hemodilution during CPB has been identified recently as a risk factor for AKD<sup>10</sup>. In a comprehensive and elegant study, Habib and colleagues established a detrimental threshold of hemodilution when the nadir hematocrit was <24%. They also demonstrated that prolonged CPB, intraoperative transfusion of red cells, and preoperative impaired renal function exacerbated the probability of AKD.

## CONCLUSIONS

According to the present study, the risk factor for AKD varies according to the estimated preoperative renal function. Only in patients with preoperative renal dysfunction, high baseline creatinine level, long operation time were strong predictors of AKD. This fact highlights the weight of the reduction of renal reserve as a risk factor in patients with advanced stages of chronic kidney disease. In addition to other well-known risk factors for AKD in this setting, the graft number, total operational time and hemodilution during CPB, appear as very important risk factors though they are potentially modifiable.

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