Mortality risk factors in critical post-surgical patients treated using continuous renal replacement techniques

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KEYWORDS
Post-operative care; Acute renal failure; Renal replacement therapy; Mortality; Post-operative complications; Critically ill

Abstract
Objective: To determine the influence of demographics, medical, and surgical variables on 30-day mortality in patients who need continuous renal replacement therapy (CRRT).

Materials and methods: A retrospectively-followed study was conducted using the data of 112 patients admitted to the postoperative intensive care unit who required CRRT, between August 2006 and August 2011, and followed-up for 30 days. The following information was collected: age, gender, history of HBP, DM, cardiovascular disease, CKD, urgent surgery, surgical speciality, organic dysfunction according to the SOFA scale, the number of organs with dysfunction, use of mechanical ventilation, diagnostic and origin of sepsis, type of CRRT, and 30-day mortality. General linear models were used for estimating the strength of association (relative risk [RR], and 95% confidence interval [CI]) between variables and 30-day mortality.

Results: In the univariate analysis, the following variables were identified as risk factors for 30-day mortality: age (RR 1.04; 95% CI 1.01–1.06; p = .0005), and history of cardiovascular disease (RR 1.57; 95% CI 1.02–2.41; p = .039). Among the variables included in the multivariable analysis (age, history of cardiovascular disease, sepsis, and number of organs with dysfunction), only age was identified as an independent risk factor for 30-day mortality (RR 1.03; 95% CI 1.00–1.05; p = .007).

Conclusion: Thirty-day mortality in postoperative, critically ill patients who require CRRT is high (41.07%). Age has been identified as an independent risk factor, with renal failure as the most common indication for the use of these therapies.

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Introduction

Critical postoperative patients present multiple risk factors for mortality. Acute kidney injury (AKI) and decompensated chronic renal failure requiring continuous renal replacement therapy (CRRT) are among the principle risk factors, and the need for some kind of continuous renal replacement therapy has already been shown to be, in itself, an independent mortality risk factor.1

The aim of CRRTs is to replace the lost glomerular filtration function of the kidneys, but not their endocrine, metabolic and tubular functions, and to dialyse patients over a 24 h period, 7 days a week. There are several different types of CRRT, the most commonly used in our setting being slow continuous ultrafiltration (SCUF), continuous venovenous hemofiltration (CVVH) and continuous venovenous haemodialysis. SCUF removes fluids without the need for replacement fluids by pumping the blood through a highly permeable filter (convection mechanism). The most widely used treatment type in Spain is CVVH, which removes fluids and electrolytes using a convection mechanism. Unlike SCUF, CVVH uses a substitution solution to replace part of the fluids and electrolytes, removed before (pre-filter) or after (post-filter) the blood is pumped through the filter. Excess solutes are not replaced, thereby reducing blood fluid levels. CVVH combines convection and diffusion to eliminate both high and low molecular weight solutes.

CRRTs are widely used in critical care units because they allow for better haemodynamic tolerance. These therapies are not only used in AKI, but are also extremely useful in treating fluid overload refractory to diuretics, ionic changes, intoxications, etc.

Postoperative patients have typically undergone an aggressive procedure, and depending on a variety of factors such as their baseline situation, the severity of the surgical disease, the surgical procedure, and the degree of emergency, they are at risk of requiring CRRT.

In the literature, CRRT is usually described in the context of studies that include patients with medical and surgical diseases. In view of this, we believe it will be of interest to exclusively analyse and present our experience with postoperative patients.

The main aim of this study has been to determine the risk factors associated with 30-day mortality in critical postoperative patients requiring CRRT. The secondary aims were to describe the clinical characteristics, main indications for CRRT, and the type of CRRT used.

Patients and methods

This is a retrospective chart review of postoperative patients requiring some type of CRRT between August 2006 and August 2011.

Inclusion criteria were: aged over 18 years, undergoing any type of surgery except heart surgery, and admitted to the Postoperative Intensive Care Unit for more than 24h.

Exclusion criteria were: chronic need for haemodialysis, and receiving iatrogenic CRRT (for example, due to

Factores de riesgo para mortalidad en pacientes críticos posquirúrgicos tratados con técnicas continuas de reemplazo renal

Resumen

Objetivo: Determinar la influencia de las variables demográficas, médicas y quirúrgicas sobre la mortalidad a 30 días en pacientes que requieren la aplicación de técnicas continuas de reemplazo renal (TCRR) en la Unidad de Cuidados Intensivos Posquirúrgicos.

Materiales y métodos: Estudio de seguimiento retrospectivo. Datos de 112 pacientes admitidos en la Unidad de Cuidados Intensivos que requirieron TCRR, entre agosto de 2006 y agosto de 2011 y seguidos durante 30 días. Se recogió la siguiente información: edad, género, historia de HTA, DM, enfermedad cardiovascular e IRC, cirugía urgente, especialidad quirúrgica, disfunción orgánica de acuerdo con la escala SOFA, número de órganos con disfunción, uso de ventilación mecánica, diagnóstico y origen de la sepsis, modalidad de TCRR y mortalidad a 30 días. Se utilizaron modelos lineales generales para estimar la fuerza de la asociación (riesgo relativo [RR] e intervalo de confianza [IC] al 95%) entre las diferentes variables y la mortalidad a 30 días.

Resultados: En el análisis univariante se identificaron como factores de riesgo para la mortalidad a 30 días la edad (RR 1,04; IC 95% 1,01-1,06; p = 0,005) y la presencia de enfermedad cardiovascular previa (RR 1,57; IC 95% 1,02-2,41; p = 0,039). Entre las variables incluidas en el análisis multivariante (edad, historia de enfermedad cardiovascular previa, presencia de sepsis y número de órganos con disfunción), solo la edad se identificó como factor de riesgo independiente para mortalidad a 30 días (RR 1,03; IC 95% 1,00-1,05; p = 0,007).

Conclusión: La mortalidad a 30 días en los pacientes críticos posquirúrgicos que necesitan TCRR es alta (41,07%), identificándose la edad como factor de riesgo independiente, siendo la insuficiencia renal aguda la principal indicación para el uso de estas terapias.
upper gastrointestinal bleeding not requiring surgery). Pediatric, obstetric and gynaecological surgery patients were not included because they were assigned to other units.

We reviewed the patients’ discharge reports and medical records to collect demographic data, comorbidities, ASA classification at the time of surgery, type of surgery (elective/emergency), number of dysfunctional organs according to the Sequential Organ Failure Assessment score (Appendix 1), diagnosis of sepsis and the use of invasive mechanical ventilation, type of CRRT, length of stay in the Intensive Care Unit and the hospital, and 30-day mortality.

The study was approved by the Independent Ethics Committee of the Hospital Universitario 12 de Octubre in Madrid (number CEIC 11/282).

Prior cardiovascular disease was defined as a history of acute myocardial infarction, stroke, congestive heart failure or peripheral arterial disease.

History of chronic kidney disease was taken into consideration if it was already known or noted in the medical record, regardless of the cause and duration of the disease. Baseline creatinine was the last measurement taken prior to surgery, and clearance was calculated using the CKD-EPI equation.

Organ dysfunction was defined in accordance with the criteria listed in the Sequential Organ Failure Assessment, used for sepsis and non-sepsis patients.

CRRT was started in accordance with the protocol used in the ICU: AKI (oliguria [urine output <200 ml/12 h], anuria [urine output <50 ml/12 h], azaemia [urea >177 mg/dl or 30 mmol/l; creatinine >4 mg/dl or 300 μmol/l]), hyperkalaemia (K+ >6.5 mmol/l), severe acidemia (pH <7.1), heart failure refractory to diuretics, and pulmonary oedema.

Since this is a retrospective study, during our review of medical records we found that AKI was diagnosed following the criteria established in the protocol used in the unit, following generalisation of the Risk Injury Failure Loss End-stage kidney disease–RIFLE™–and then the Acute Kidney Injury–AKI™–criteria; these were taken into consideration when making the diagnosis.

Data analysis

Continuous variables are expressed as mean and SD, and categorical variables as absolute and relative frequencies. Comparison of the number of survivors and non-survivors at 30 days vs categorical variables was performed using the chi-square test, while the Student’s t-test, or a nonparametric test in the case of non-normal distribution, was used to compare the same vs continuous variables.

Generalised linear, log link, and binomial distribution models were used to determine relative risk (RR) as the measure of the strength of association between 30-day mortality and the different variables studied. Multivariate models were analysed. All results are presented together with a 95% confidence interval (CI).

Statistical analysis was performed using SAS analysis software, version 9.

Results

Of 123 patients undergoing CRRT, 112 met the inclusion criteria.

A total of 11 patients were excluded: 8 due to chronic haemodialysis, 2 due to non-surgical disease (upper gastrointestinal bleeding), and 1 due to age under 18.

The demographic and clinical characteristics are described in Table 1.

Mean age was 69.86 ± 12.86 years, 71 were men (63.39%), and most patients were classed ASA III (63 patients; 56.25%). The most common comorbidities were hypertension (62 patients; 55.36%) and history of cardiovascular disease (39 patients; 34.82%). Of the total number of patients, 28 (25%) presented chronic kidney disease, and 72 (64.28%) underwent emergency surgery. The most common type of surgery was general surgery (62 patients; 55.36%), followed by vascular surgery (15 patients; 13.39%), and thoracic surgery (13 patients; 11.61%). The remaining patients underwent orthopaedic, oral and maxillofacial surgery, plastic surgery, and neurosurgery.

The number of dysfunctional organs most commonly found, according to the Sequential Organ Failure Assessment score, was 5 in 49 patients (43.75%), followed by 4 in 28 patients (25%). The most common types of dysfunction were: kidney in 106 patients (94.64%), respiratory in 104 (92.86%), cardiovascular in 97 (86.61%), haematological in 89 (79.46%), hepatic in 74 (66.07%) and neurological in 28 (25%).

Of the total number of patient, 97 (86.61%) required mechanical ventilation at some time during their stay.

Sepsis was diagnosed in 63 patients (56.25%), with the most common source being the abdomen (39 patients; 34.82%).

The most common type of CRRT was CVVH (98 patients; 87.5%), followed by SCUF (7 patients; 6.25%), and combined (SCUF + CVVH) (7 patients; 6.25%). The main indication for CRRT was AKI (95 patients; 84.82%).

The 30-day survival rate was 58.92% (66 patients). Mean stay in the Postoperative Intensive Care Unit was 16.31 ± 14.46 days, and mean hospital stay was 43.80 ± 39.49 days.

When variables vs risk factors in survivors and non-survivors at 30 days of follow-up were analysed, significant differences were found in age, history of cardiovascular disease, number of dysfunctional organs and indication for CRRT (Table 2).

The univariate analysis (Table 3) showed the following to be 30-day mortality risk factors: age (RR 1.04; CI 95% 1.01–1.06; p = 0.0005) and history of cardiovascular disease (RR 1.57; CI 95% 1.02–2.41; p = 0.039). The foregoing factors and clinically significant variables reported in the literature were included in the multivariate analysis (Table 4) to detect independent risk factors for 30-day mortality. Among the variables included in the multivariate analysis (age, history of cardiovascular disease, sepsis and number of dysfunctional organs), only age was an independent risk factor for 30-day mortality (RR 1.03; CI 95% 1.00–1.05; p = 0.007), suggesting that risk of mortality increases at a rate of 3% for each additional year.

Discussion

The introduction of CRRT was a major breakthrough in life support for critically ill patients; however, the mortality rate of AKI patients requiring CRRT remains high. Although many
Table 1  Patient demographics and clinical particulars.

<table>
<thead>
<tr>
<th>Patients</th>
<th>n = 112 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, n (%)</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>71 (63.39)</td>
</tr>
<tr>
<td>Women</td>
<td>41 (36.61)</td>
</tr>
<tr>
<td>Mean age ± SD (years)</td>
<td>69.86 ± 12.78</td>
</tr>
<tr>
<td>ASA, n (%)</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>24 (21.43)</td>
</tr>
<tr>
<td>III</td>
<td>63 (56.25)</td>
</tr>
<tr>
<td>IV</td>
<td>25 (22.32)</td>
</tr>
<tr>
<td>HTN, n (%)</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>62 (55.36)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>25 (22.32)</td>
</tr>
<tr>
<td>Prior cardiovascular disease, n (%)</td>
<td>39 (34.82)</td>
</tr>
<tr>
<td>CKD, n (%)</td>
<td></td>
</tr>
<tr>
<td>Emergency surgery, n (%)</td>
<td>72 (64.28)</td>
</tr>
<tr>
<td>Surgical speciality, n (%)</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>62 (55.36)</td>
</tr>
<tr>
<td>Vascular</td>
<td>15 (13.39)</td>
</tr>
<tr>
<td>Thoracic</td>
<td>13 (11.61)</td>
</tr>
<tr>
<td>Urological</td>
<td>10 (8.93)</td>
</tr>
<tr>
<td>Orthopaedic</td>
<td>5 (4.46)</td>
</tr>
<tr>
<td>Neurosurgery</td>
<td>3 (2.68)</td>
</tr>
<tr>
<td>Plastic</td>
<td>3 (2.68)</td>
</tr>
<tr>
<td>Oral and Maxillofacial</td>
<td>1 (0.89)</td>
</tr>
<tr>
<td>Organ dysfunction (according to SOFA scale), n (%)</td>
<td></td>
</tr>
<tr>
<td>Renal</td>
<td>106 (94.64)</td>
</tr>
<tr>
<td>Respiratory</td>
<td>104 (92.86)</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>97 (86.61)</td>
</tr>
<tr>
<td>Haematological</td>
<td>89 (79.46)</td>
</tr>
<tr>
<td>Hepatic</td>
<td>74 (66.07)</td>
</tr>
<tr>
<td>Neurological</td>
<td>28 (25)</td>
</tr>
<tr>
<td>Number of dysfunctional organs, n (%)</td>
<td></td>
</tr>
<tr>
<td>Two</td>
<td>9 (8)</td>
</tr>
<tr>
<td>Three</td>
<td>11 (9.82)</td>
</tr>
<tr>
<td>Four</td>
<td>28 (25)</td>
</tr>
<tr>
<td>Five</td>
<td>49 (43.75)</td>
</tr>
<tr>
<td>Six</td>
<td>15 (13.39)</td>
</tr>
<tr>
<td>Mechanical ventilation, n (%)</td>
<td>97 (86.61)</td>
</tr>
<tr>
<td>Sepsis, n (%)</td>
<td>63 (56.25)</td>
</tr>
<tr>
<td>Source of sepsis, n (%)</td>
<td></td>
</tr>
<tr>
<td>Abdominal</td>
<td>39 (34.82)</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>10 (8.93)</td>
</tr>
<tr>
<td>Urological</td>
<td>9 (8.04)</td>
</tr>
<tr>
<td>Soft tissue</td>
<td>5 (4.46)</td>
</tr>
<tr>
<td>Type of CRRT, n (%)</td>
<td></td>
</tr>
<tr>
<td>CVVH</td>
<td>98 (87.5)</td>
</tr>
<tr>
<td>SCUF</td>
<td>7 (6.25)</td>
</tr>
<tr>
<td>Combination</td>
<td>7 (6.25)</td>
</tr>
<tr>
<td>Indication for CRRT, n (%)</td>
<td></td>
</tr>
<tr>
<td>AKI</td>
<td>95 (84.82)</td>
</tr>
<tr>
<td>Hypervolaemia</td>
<td>9 (8.04)</td>
</tr>
<tr>
<td>More than one indication</td>
<td>8 (7.14)</td>
</tr>
<tr>
<td>30-day survival, n (%)</td>
<td>66 (58.92)</td>
</tr>
<tr>
<td>ICU stay, mean ± SD (days)</td>
<td>16.31 ± 14.46</td>
</tr>
<tr>
<td>Hospital stay, mean ± SD (days)</td>
<td>43.80 ± 39.49</td>
</tr>
</tbody>
</table>

AKI: acute kidney injury; ASA: American Society of Anesthesiologists Score; CRRT: continuous renal replacement therapy; CVVH: continuous venovenous haemofiltration; HTN: hypertension; IRC: chronic kidney disease; SCUF: slow continuous ultrafiltration; SD: standard deviation; SOFA: Sequential Organ Failure Assessment.

studies in the use of CRRT in critical care patients with medical and surgical diseases have been published, ours is the first to focus exclusively on postoperative patients.6-8

In terms of demographics, most patients were elderly men, and although we found no statistically significant difference between men and women, age was an independent risk factor for mortality. This is largely consistent with the findings of other studies, in which age over 60 was a clear risk factor for mortality in critical patients with AKI and multiorgan dysfunction treated with CVVH.

We included the patient’s ASA classification among our variables, since this is one of the most widely used tools for classifying the physical status of the patient, and is associated with morbidity and mortality in many studies.10-12 It did not, however, affect mortality in our series, a result that could be due to discrepancies in ASA assessment among anaesthesiologists, and also to the fact that ASA is not a risk assessment tool.13

History of cardiovascular disease was a risk factor for mortality in our study, but the same was not true of hypertension or diabetes mellitus. However, the results of the multivariate analysis suggest that this cannot be extrapolated to the general population.

This study included patients with more or less severe chronic kidney diseases that were not receiving chronic haemodialysis, although this comorbidity did not increase morbidity among patients undergoing CRRT.

Since emergency surgery is more often than not performed in patients with little or no pre-surgical preparation and therefore at risk of aspiration and/or more or less severe haemodynamic or systemic involvement, the risk of mortality14 and postoperative cardiovascular complications is higher. For this reason, we decided to include this variable in our study, although it was not shown to be a mortality risk in this group of patients.

The descriptive analysis showed statistically significant differences between survivors and non-survivors in respect of the number of dysfunctional organs, which is why this variable was included in the univariate analysis. We found that this had a certain trend towards significance as a risk factor in our series (RR 1.23; CI 95% 0.99–1.53; p = 0.059), but since it was not included in the multivariate analysis it could not be confirmed as an independent risk factor for mortality.

Although over half the patients included in our study were diagnosed with sepsis, neither this nor any particular source organ was associated with higher mortality.

Mechanical ventilation did not affect mortality, as can be seen from the descriptive and univariate analyses, even though 86.6% of all patients and 91% of non-survivors received ventilation at some time during their stay.

AKI was the main indication for CRRT in critical postoperative and critical non-surgical patients.16 The most widely used technique was CVVH (87.5% of patients). None of the patients indicated for CRRT due to hypervolaemia (8%) or those undergoing SCUF (6%) died.

Our study has several limitations; being a retrospective study with data collected from chart reviews, possible defects in recording patient information on the charts studied could limit the scope of our conclusions. Failure to classify kidney disease according to the RIFLE score, meanwhile, made it difficult to compare our findings with those
Table 2  Survivors vs non-survivors at 30-day follow-up.

<table>
<thead>
<tr>
<th>Clinical particulars</th>
<th>Survivors, n = 66 (58.92%)</th>
<th>Non-survivors, n = 46 (41.07%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, in years, mean ± SD</strong>a</td>
<td>66.32 (13.19)</td>
<td>74.41 (11.40)</td>
<td>0.000186</td>
</tr>
<tr>
<td><strong>Men, n (%)</strong></td>
<td>43 (65.15)</td>
<td>28 (60.87)</td>
<td>0.6435</td>
</tr>
<tr>
<td><strong>Women, n (%)</strong></td>
<td>23 (34.85)</td>
<td>18 (39.13)</td>
<td>0.9017</td>
</tr>
<tr>
<td><strong>DM, n (%)</strong></td>
<td>15 (22.73)</td>
<td>10 (21.74)</td>
<td>0.9017</td>
</tr>
<tr>
<td><strong>HTN, n (%)</strong></td>
<td>33 (50)</td>
<td>29 (63.04)</td>
<td>0.1719</td>
</tr>
<tr>
<td>**Prior cardiovascular disease, n (%)**b</td>
<td>18 (27.27)</td>
<td>21 (45.65)</td>
<td>0.0446</td>
</tr>
<tr>
<td>**Chronic kidney disease, n (%)**b</td>
<td>14 (21.21)</td>
<td>14 (30.43)</td>
<td>0.2675</td>
</tr>
<tr>
<td><strong>Creatinine clearance, ml/min/1.73 m², mean ± SD</strong></td>
<td>58.03 (29.71)</td>
<td>50.20 (31.05)</td>
<td>0.1449</td>
</tr>
<tr>
<td><strong>ASA, n (%)</strong></td>
<td>16 (24.24)</td>
<td>8 (17.39)</td>
<td>0.2994</td>
</tr>
<tr>
<td><strong>II</strong></td>
<td>37 (56.06)</td>
<td>26 (56.52)</td>
<td>0.6435</td>
</tr>
<tr>
<td><strong>IV</strong></td>
<td>13 (19.70)</td>
<td>12 (26.09)</td>
<td>0.2994</td>
</tr>
<tr>
<td><strong>Emergency surgery, n (%)</strong></td>
<td>41 (62.12)</td>
<td>31 (67.39)</td>
<td>0.5669</td>
</tr>
<tr>
<td>**Number of dysfunctional organs, n (%)**c</td>
<td>8 (12.12)</td>
<td>1 (2.17)</td>
<td>0.0448</td>
</tr>
<tr>
<td><strong>Two</strong></td>
<td>8 (12.12)</td>
<td>3 (6.52)</td>
<td>0.1822</td>
</tr>
<tr>
<td><strong>Three</strong></td>
<td>15 (22.73)</td>
<td>13 (28.26)</td>
<td>0.1822</td>
</tr>
<tr>
<td><strong>Four</strong></td>
<td>28 (42.48)</td>
<td>21 (45.65)</td>
<td>0.2675</td>
</tr>
<tr>
<td><strong>Six</strong></td>
<td>7 (10.61)</td>
<td>8 (17.39)</td>
<td>0.2675</td>
</tr>
<tr>
<td><strong>Sepsis, n (%)</strong></td>
<td>41 (62.12)</td>
<td>22 (47.83)</td>
<td>0.1335</td>
</tr>
<tr>
<td><strong>Mechanical ventilation, n (%)</strong></td>
<td>55 (83.33)</td>
<td>42 (91.30)</td>
<td>0.2230</td>
</tr>
<tr>
<td><strong>Indication for CRRT, n (%)</strong></td>
<td>50 (75.76)</td>
<td>45 (97.83)</td>
<td>0.0052</td>
</tr>
<tr>
<td><strong>AKI</strong></td>
<td>9 (13.64)</td>
<td>0 (0.00)</td>
<td>0.2646</td>
</tr>
<tr>
<td><strong>Combination of indications</strong></td>
<td>7 (10.61)</td>
<td>1 (2.17)</td>
<td>0.2646</td>
</tr>
<tr>
<td><strong>Type of CRRT, n (%)</strong></td>
<td>54 (81.82)</td>
<td>44 (95.65)</td>
<td>0.0517</td>
</tr>
<tr>
<td><strong>CVVH</strong></td>
<td>7 (10.61)</td>
<td>0 (0.00)</td>
<td>0.2646</td>
</tr>
<tr>
<td><strong>Combination</strong></td>
<td>5 (7.58)</td>
<td>2 (4.35)</td>
<td>0.2646</td>
</tr>
</tbody>
</table>

AKI: acute kidney injury; CRRT: continuous renal replacement therapy; CVVH: continuous venovenous haemofiltration; DM: diabetes mellitus; HTN: hypertension; SCUF: slow continuous ultrafiltration; SD: standard deviation.

Creatinine clearance assessment was based on the Chronic Kidney Disease Collaboration equation.17

a Wilcoxon two sample test.
b Chi-square test.
c Cochran–Mantel–Haenszel test.

Table 3  Univariate analysis.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Relative risk</th>
<th>CI 95%</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.0419</td>
<td>1.018–1.0662</td>
<td>0.0005</td>
</tr>
<tr>
<td>Sex</td>
<td>0.8983</td>
<td>0.5726–1.4093</td>
<td>0.6406</td>
</tr>
<tr>
<td>HTN</td>
<td>1.3757</td>
<td>0.8610–2.1982</td>
<td>0.1822</td>
</tr>
<tr>
<td>DM</td>
<td>0.9667</td>
<td>0.5626–1.6610</td>
<td>0.9023</td>
</tr>
<tr>
<td>Prior cardiovascular disease</td>
<td>1.5723</td>
<td>1.0221–2.1982</td>
<td>0.0394</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>1.3125</td>
<td>0.8286–2.0789</td>
<td>0.2465</td>
</tr>
<tr>
<td>Creatinine clearance</td>
<td>1.0598</td>
<td>0.9041–1.2424</td>
<td>0.4734</td>
</tr>
<tr>
<td>ASA</td>
<td>1.1933</td>
<td>0.8563–1.6629</td>
<td>0.2967</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td>1.1481</td>
<td>0.7103–1.8559</td>
<td>0.5729</td>
</tr>
<tr>
<td>Sepsis</td>
<td>0.7130</td>
<td>0.4583–1.1092</td>
<td>0.1335</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>1.6237</td>
<td>0.6806–3.8739</td>
<td>0.2746</td>
</tr>
<tr>
<td>Number of dysfunctional organs</td>
<td>1.2358</td>
<td>0.9919–1.5396</td>
<td>0.0591</td>
</tr>
</tbody>
</table>

ASA: American Society of Anesthesiologists Score; CI: confidence interval; DM: diabetes mellitus; HTN: hypertension.
of other studies; although RIFLE was validated in 2006, it is reasonable to expect a certain delay before its use becomes widespread in clinical practice.

In conclusion, 30-day mortality in critical postoperative patients requiring CRRT is high: 41.07%. AKI is the main indication for these therapies, and risk of mortality increases in parallel with the patient’s age, leading us to conclude that risk of mortality increases by 3% with each additional year of age.

Conflict of interests

The authors declare they have no conflict of interests.

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Appendix 1. SOFA scale

<table>
<thead>
<tr>
<th>SOFA score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \frac{\text{PaO}_2}{\text{FiO}_2} \text{ (mmHg)} )(^a)</td>
<td>&gt;400</td>
<td>&lt;400</td>
<td>&lt;300</td>
<td>&lt;200</td>
<td>&lt;100</td>
</tr>
<tr>
<td>( \frac{\text{SaO}_2}{\text{FiO}_2} )</td>
<td>221–301</td>
<td>142–220</td>
<td>67–141</td>
<td>&lt;67</td>
<td></td>
</tr>
<tr>
<td><strong>Coagulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelets ( \times 10^9 \text{ /mm}^3 )</td>
<td>&gt;150</td>
<td>&lt;150</td>
<td>&lt;100</td>
<td>&lt;50</td>
<td>&lt;20</td>
</tr>
<tr>
<td><strong>Liver</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilirubin (mg/dl)</td>
<td>&lt;1.2</td>
<td>1.2–1.9</td>
<td>2.0–5.9</td>
<td>6.0–11.9</td>
<td>&gt;12.0</td>
</tr>
<tr>
<td><strong>Cardiovascular</strong>(^b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypotension</td>
<td>No hypotension</td>
<td>MAP &lt;70</td>
<td>Dopamine ( \leq 5 \text{ or } ) Dobutamine (any)</td>
<td>Dopamine &gt;5 or epinephrine ( \leq 0.1 ) or norepinephrine ( \leq 0.1 )</td>
<td>Dopamine &gt;15 or epinephrine ( \leq 0.1 ) or norepinephrine ( \leq 0.1 )</td>
</tr>
<tr>
<td><strong>CNS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glasgow scale</td>
<td>15</td>
<td>13–14</td>
<td>10–12</td>
<td>6–9</td>
<td>&lt;6</td>
</tr>
<tr>
<td><strong>Renal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>&lt;1.2</td>
<td>1.2–1.9</td>
<td>2.0–3.4</td>
<td>3.5–4.9</td>
<td>&gt;5.0</td>
</tr>
<tr>
<td>or urine output ml/day</td>
<td></td>
<td></td>
<td></td>
<td>&lt;500</td>
<td>&lt;200</td>
</tr>
</tbody>
</table>

CNS: central nervous system; MAP: mean arterial pressure; \( \text{SaO}_2 \): peripheral arterial oxygen saturation.

\(^a\) \( \text{PaO}_2/\text{FiO}_2 \) ratio was the preferred measurement. If not available, the \( \text{SaO}_2/\text{FiO}_2 \) ratio was used.

\(^b\) Vasoactive medications administered for at least 1 h (dopamine and norepinephrine \( \mu \text{g/kg/min} \)).
References


