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RESEARCH PAPER

Fluid balance and acute kidney injury in septic shock☆

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KEYWORDS
Fluid balance;
Septic shock;
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Abstract
Background: In patients with septic shock, excessive fluid administration can lead to increased morbidity and mortality. The aim of this study was to evaluate the association between fluid balance, acute kidney injury and mortality in patients with septic shock.
Methods: A study of cases and controls was conducted in a pediatric intensive care unit. The fluid balance in the first 72 h and the presence of acute kidney injury was compared in patients diagnosed with septic shock who died against patients who survived the same condition. Univariate and multivariate analyses were performed.
Results: Forty-five cases and forty-five controls were included in the analysis. Mortality was associated with Pediatric Risk of Mortality (PRISM III) $\geq$ 26 points (OR 7.5, 95% CI 2.8-18.7; $p = 0.000$), Pediatric Logistic Organ Dysfunction (PELOD) $\geq$ 24 points (OR 11.0, 95% CI 4.1-29.4; $p = 0.000$), creatinine $\geq$ 0.65 mg/dl (OR 5.6, 95% CI 2.2-13.9; $p = 0.000$), lactate $\geq$ 2.5 mmol/l (OR 2.5, 95% CI 1.1-5.9; $p = 0.033$), SvO2 < 60% (OR 4.6, 95% CI 4.5-4.5; $p = 0.001$), positive balance > 9% in 72 h (OR 4.3, 95% CI 1.6-11.7; $p = 0.003$), acute kidney injury (OR 5.7, 95% CI: 2.2-15.1; $p = 0.000$). In the multivariate model, the values of PRISM $\geq$26 and PELOD $\geq$24 points were significant.
Conclusions: In patients who died due to septic shock, the multivariate model showed an association with PRISM $\geq$26 and PELOD $\geq$24 and a trend toward association with SvO2 <60% and positive balance of liquids > 9%.

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PALABRAS CLAVE
Balance de líquidos;
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Mortalidad;
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Balance de líquidos y lesión renal aguda en el choque séptico

Resumen
Introducción: En el paciente con choque séptico, la administración excesiva de líquidos puede incrementar la morbilidad y mortalidad. El objetivo de este estudio fue evaluar la asociación entre el balance de líquidos, la lesión renal aguda y la mortalidad en pacientes con choque séptico.
Métodos: Se realizó un estudio de casos y controles en una unidad de terapia intensiva pediátrica. Se comparó el balance de líquidos en las primeras 72 h y la presencia de lesión renal aguda en pacientes con diagnóstico de choque séptico que fallecieron contra pacientes que sobrevivieron a la misma patología. Se realizó un análisis univariado y multivariado.
Resultados: Se incluyeron 45 casos y 45 controles en el análisis. La mortalidad se asoció con riesgo pediátrico de mortalidad (PRISM) $\geq$ 26 puntos (RM 7.5, IC 95% 2.8-18.7; $p = 0.000$), disfunción orgánica logística pediátrica (PELOD) $\geq$ 24 puntos (RM 11.0, IC 95% 4.1-29.4; $p = 0.000$), creatinina $\geq$ 0.65 mg/dl (RM 5.6, IC 95% 2.2-13.9; $p = 0.000$), lactato $\geq$ 2.5 mmol/l (RM 2.5, IC 95% 1.1-5.9; $p = 0.033$), SvO_2 < 60% (RM 4.6, IC 95% 4.5-4.5; $p = 0.001$), balance positivo > 9% en 72 h (RM 4.3, IC 95% 1.6-11.7; $p = 0.003$), lesión renal aguda (RM 5.7, IC 95% 2.2-15.1; $p = 0.000$). En el modelo multivariado, PRISM $\geq$ 26 y PELOD $\geq$ 24 puntos permanecieron significativas.
Conclusiones: En los pacientes que fallecieron por choque séptico, el modelo multivariado mostró una asociación con PRISM $\geq$26 y PELOD $\geq$24 y una tendencia hacia la asociación con SvO_2 <60% y balance de líquidos positivo >9%.

1. Introduction

Septic shock approach guided by goals has reduced morbidity and mortality both in adults and children.[1] These guides encompass early recognition of the problem, vascular access, fluid resuscitation, antibiotics therapy and use of vasopressors during the first hour. Early fluid resuscitation is the cornerstone in the management of shock, and it is part of the goal-directed therapy of the ''Surviving sepsis'' campaign, aimed at restoring the hemodynamic integrity and tissue perfusion.[2] However, the critical patient has an increased fluid retention secondary to an enlarged capacity of intravascular space and third space, as well as a decreased renal ability to excrete the fluid excess.[3–5] The positive fluid balance has been associated with an increase in morbidity and mortality in patients with acute lung injury and septic shock. Probably this is because excessive fluid administration in patients with sepsis can lead to impairment of respiratory function, increased intraabdominal pressure, clotting disorders and cerebral edema.[6,7]

Recent observational papers showed an association between fluid overload and increased morbidity and mortality in the pediatric population, especially after cardiac surgery and in children requiring continuous renal replacement therapy.[8–12] Acute kidney injury contributes directly to the water and sodium clearance and excretion and has been established as a mortality risk factor.[13,14] In studies were children with septic shock where fluid overload was evaluated, acute kidney injury and the impact on mortality are scarce and the size of the sample is generally small. This study aimed to compare the positive fluid balance and acute kidney injury (AKI) among a group of pediatric patients who died of septic shock and children with septic shock who survived. The hypothesis assumes that fluid overload and AKI during the first 72 hours was higher in patients who died from septic shock.

2. Methods

The study was conducted in the pediatric intensive care unit (PICU) of the Children's Hospital Dr. Rigoberto Aguilar Pico, in Sinaloa, Mexico, from January 2010 to December 2014. The Institutional Research Committee approved the study.

For the study, physical or electronic records from patients aged $\leq$ 18 years diagnosed with septic shock and hospitalization in PICU $\geq$ 72 hours were included. Patient records with hospital admission < 48 hours, deaths or transfer out of the PICU, infants < 30 days and records with incomplete data were excluded. To homogenize the condition in the case and control groups, children with chronic diseases, such as kidney failure, complex congenital heart disease and with surgical correction of congenital heart disease were excluded.

2.1. Operational definition of variables

The fluid balance was estimated by the difference between the total liquids administered and the total of outflows or losses during the first 72 hours of admission to the PICU. The