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The effect of positive balance on the outcomes of critically ill noncardiac postsurgical patients: A retrospective cohort study☆,☆☆,★

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ABSTRACT

Purpose: Fluid balance remains a highly controversial topic in the critical care field, and no consensus has been reached about the fluid levels required by critically ill surgical patients. In this study, we investigated the relationship between fluid balance and in-hospital mortality in critically ill surgical patients.
Methods: The medical records of adult patients managed in a surgical intensive care unit (ICU) for more than 48 hours after surgery from January 2010 to February 2011 were reviewed retrospectively. Abstracted data included body weights, Acute Physiology and Chronic Health Evaluation (APACHE) II scores, Sequential Organ Failure Assessment (SOFA) scores, fluid therapy values (intake, output, and balance) during the ICU stay, type of operation, length of stay in the ICU and hospital, and in-hospital mortality.
Results: A total of 148 patients were enrolled. The in-hospital mortality rate was 20.8%, and the median length of stay in the ICU and hospital were 5.0 and 24 days, respectively. The median daily fluid balance over the first 3 postoperative days was positive 11.2 mL/kg. Fluid balances in the ICU were 19.2, 15.0, and −0.6 mL kg^{-1} d^{-1}, respectively, during the first 3 days vs SOFA scores (6.8, 6.3, and 6.5). Comparing the nonsurvival group with the survival group, the univariate analysis showed that age ($P = .05$), APACHE II score ($P < .001$), and use of a vasopressor (norepinephrine) ($P = .05$) affect in-hospital mortality. In the overall patients, any of the fluid balances were not significantly associated with mortality. However, in critically ill patients whose APACHE II scores were greater than 20, the nonsurvivor group showed a significant tendency toward a positive balance compared with the survivor group on the second and third days of ICU stay. Nevertheless, the SOFA scores showed no difference between nonsurvivor and survivors during the initial 2 postoperative days.
Conclusion: In critically ill noncardiac postsurgical patients whose APAHCE II scores were greater than 20, a positive balance in the ICU can be associated with mortality risk. To determine the direct effect of positive fluid balance, a larger scaled, prospective randomized study will be required.
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1. Introduction

Fluid management is important during the perioperative period in critically ill surgical patients [1-6]. During the perioperative period, many episodes of reduced tissue perfusion and poor oxygenation occur because of intraoperative hypotension and occult hypovolemia, and these episodes may be associated with postoperative complications, including organ dysfunctions and shock [2-5,7]. However, the amount of fluid required during the perioperative period in critically ill surgical patients remains highly controversial. Furthermore, the issue is complicated by the difficulty of estimating volume status precisely during fluid management. Several variables are used to estimate volume status, but there is no specific, absolute index [8-10]; thus, the amounts and types of fluid required are controversial issues in the context of perioperative management [11-17].

Indeed, the 2 contrary views on fluid management are described by their names, that is, restrictive or liberal fluid therapy [17]. Sufficient fluid administration may prevent hypovolemia, tissue hypoperfusion, and organ dysfunctions, but fluid overload and hypervolemia can cause tissue and cardiopulmonary edema [2,4,5]. Furthermore, the guidelines issued for fluid management have not provided satisfactory results or an optimal goal for fluid therapy [18]. In addition, most studies on fluid management in critically ill patients do not present optimal fluid amounts[19] or consider individual data, such as body weight [19,20].

Abbreviations: APACHE II, Acute Physiology and Chronic Health Evaluation II; EGDT, early goal–directed therapy; ICU, intensive care unit; LOS, length of stay; MV, mechanical ventilator; VASS trial, Vasopressin in Septic Shock trial.

☆ Conflict of interest: The authors declare that they have no vested interest that could be construed to have inappropriately influenced this study.

☆☆ Authors' contributions: H.J. Shim, J.Y. Jang, and J.G. Lee were involved in the design of the study and wrote the manuscript. H.J. Shim and J.Y. Jang collected and analyzed the data. All authors approved the final manuscript.

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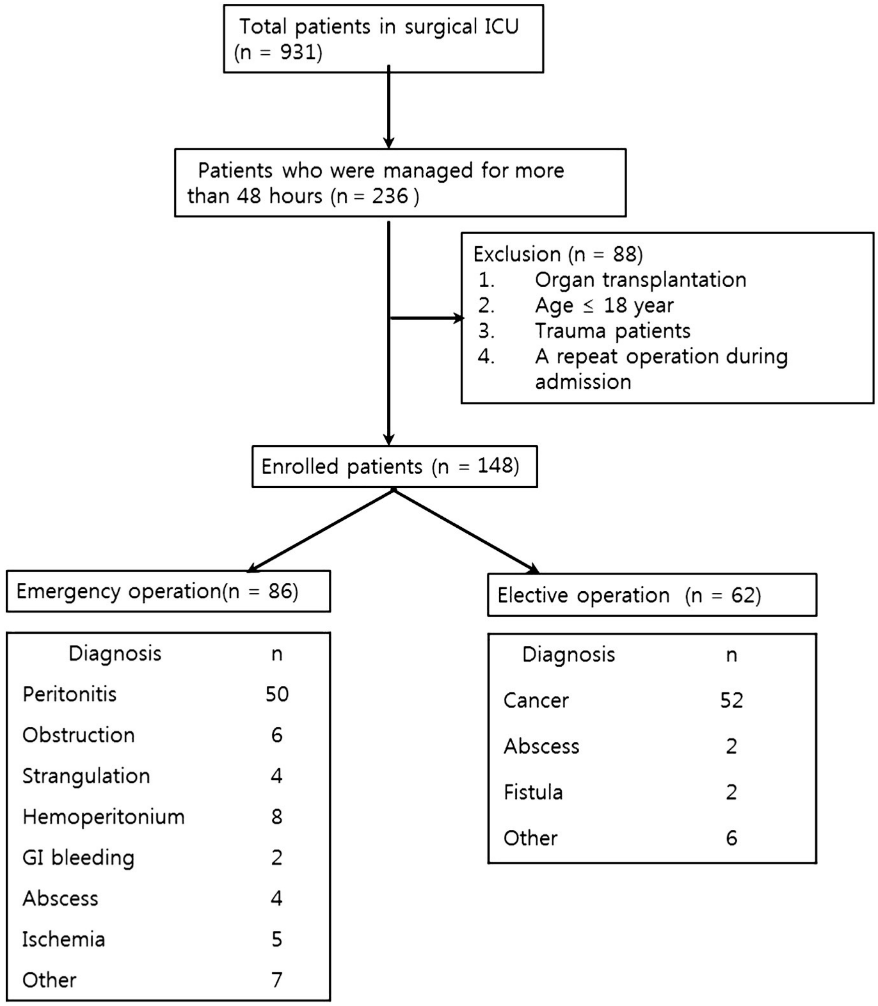

Fig. 1. Flowchart summarizing the patient selection procedure.

The aims of this study were to assess fluid balance during the perioperative period and to evaluate the relationship between fluid index and mortality rate in critically ill surgical patients.

2. Material and methods

We reviewed surgical patients who were cared for in a surgical intensive care unit (ICU) from January 2010 to February 2011. Patients who stayed in the unit for more than 48 hours were selected. The exclusion criteria were as follows: age at least 18 years, organ transplantation, patients with trauma, and a repeat operation during admission (Fig. 1). The type of surgical ICU was semiclosed unit with academic institution. In the surgical ICU, a primary surgeon could consult to surgical intensivist for ICU management or not. Also, surgical intensivist could discuss with primary surgeon to make decision for management. However, fluid strategies might be different depending on the primary surgeon's preferences.

Demographic data, body weight, use of antihypertensive drugs (an acute administration of intravenous calcium-channel blocker to decrease the high blood pressure, not to control underlying hypertension or vasopressors), Acute Physiology and Chronic Health Evaluation (APACHE) II score, and Sequential Organ Failure Assessment (SOFA) score were collected retrospectively from an existing ICU registry after designing this study. In addition, the duration of mechanical ventilation (MV), postoperative ICU length of stay (ICU-LOS), and postoperative hospital LOS (H-LOS) were collected. Intraoperative fluid was not calculated because operative bleeding and transfusion had negative effects on survival rates, which is already known. Fluid intake and output in the ICU during the first 2 postoperative days were also collected. Fluid intake included oral, feeding, and intravenous intake. Fluid output consisted of urine, drainage, bleeding, and renal replacement amounts.

The types of fluid and blood components were not defined separately. The amounts of administered fluids included the amount of transfusion. The fluid balance was calculated by subtracting fluid output from fluid intake. All daily fluid indices such as fluid intake, output, and balance were checked during the first, second, and third days of ICU admission, and all values were adjusted to the initial individual's body weight. Therefore, the amounts of fluid indices are represented as milliliters per kilogram per day.

Patients were divided into 2 groups (the survivors and the nonsurvivors) according to in-hospital mortality. The fluid balances and the SOFA scores during the first 2 postoperative days did not show normal distributions (Shapiro-Wilk test, $P < .05$); comparison between groups was made using nonparametric Wilcoxon on signed ranks and Mann-Whitney tests. Data are represented as the medians with interquartile range. All statistical analyses were performed using SPSS for Windows, version 16.0 (SPSS Inc, Chicago, Ill). The nonparametric test was used for univariate analysis. In the univariate analysis, significant variables were age, APACHE II score, vasopressor, and SOFA score. In terms of fluid balance, there were many variables

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