Restricted Albumin Utilization Is Safe and Cost Effective in a Cardiac Surgery Intensive Care Unit

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Background. **Volume expansion is often necessary after cardiac surgery, and albumin is often administered. Albumin's high cost motivated an attempt to reduce its utilization. This study analyzes the impact limiting albumin infusion in a cardiac surgery intensive care unit.**

Methods. **This retrospective study analyzed albumin use between April 2014 and April 2015 in patients admitted to a cardiac surgery intensive care unit. During the first 9 months, there were no restrictions. In January 2015, institutional guidelines limited albumin use to patients requiring more than 3 L crystalloid in the early postoperative period, hypoalbuminemic patients, and to patients considered fluid overloaded. Albumin utilization was obtained from pharmacy records and compared with outcome quality metrics.**

Results. **In all, 1,401 patients were admitted over 13 months. Albumin use, mortality, ventilator days, patients receiving transfusions, and length of stay were compared for 961 patients before and 440 patients after guidelines were initiated. After restrictive guidelines were instituted, albumin utilization was reduced from a mean of 280 monthly doses to a mean of 101 monthly doses ($p < 0.001$). There was also a trend toward reduced ventilator days. Mortality, length of stay, and transfusion requirements demonstrated no significant change. Based on an average wholesale price and an average monthly reduction of 180 albumin doses, the cardiac surgery intensive care unit demonstrated more than $45,000 of wholesale savings per month after restrictions were implemented.**

Conclusions. **Albumin restriction in the cardiac surgery intensive care unit was feasible and safe. Significant reductions in utilization and cost with no changes in morbidity or mortality were demonstrated. These findings may provide a strategy for reducing cost while maintaining quality of care.**

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Volume expansion is often necessary after cardiac surgery, however the most appropriate solution to administer has not been clearly identified. As consideration for cost has become more intense, there is increasing scrutiny in how health care dollars are spent and whether treatments and medications are justified and supported by existing medical evidence. In such a cost conscious environment and with limited supporting medical evidence, the appropriate routine administration of albumin in postoperative cardiac surgery patients was evaluated in an attempt to reduce its utilization with the goal of cutting costs.

In other settings such as sepsis and general surgery, multiple studies have shown no benefit in using albumin in place of crystalloid for fluid resuscitation. The Saline versus Albumin Fluid Evaluation (SAFE) study compared albumin and normal saline fluid resuscitation in the intensive care unit (ICU) and showed no significant difference in 28-day mortality, length of stay, dialysis requirement, or mechanical ventilation [1]. While a subgroup analysis of this study suggested that there may be a lower risk of death in patients with severe sepsis who receive albumin [2], a recent randomized trial reported no significant survival benefit at 28 and 90 days among such patients who received albumin compared to those who only were treated with crystalloid [3]. While these studies on sepsis included both critically ill medical and surgical patients, a separate study evaluated the efficacy of implementing guidelines to restrict or limit albumin administration in a surgical ICU and demonstrated significant cost savings without detrimental outcomes in critically ill surgical patients [4].

The perioperative management of cardiac surgery patients is associated with unique challenges of fluid management. Volume expansion in response to hypotension is often necessary to treat vasodilation associated with an inflammatory response, optimize pre-load, and / or improve cardiac output. The options available include crystalloid or various colloid solutions and there is

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considerable debate attempting to identify the most appropriate choice. There is some evidence that appears to demonstrate improved hemodynamics after albumin and colloid administration [5–7], and other data that highlights lower mortality after coronary artery bypass graft (CABG) surgery when albumin was used instead of other colloids [8]. However, there has been no evidence of any improvement in quality metrics such as mortality, length of stay and ventilator time associated with albumin administration and an increase in blood product transfusion in association with colloid utilization.

Because there has yet to be evidence of improved outcomes associated with routine albumin utilization, its higher cost and potential for increased bleeding has provided motivation to create restrictive albumin guidelines. This study is a short-term assessment on the effectiveness and safety of those institutional guidelines in the cardiac surgery intensive care unit (CSICU).

Patients and Methods

This Institutional Review Board exempt retrospective study analyzed the utilization of human albumin in the CSICU at a tertiary care medical center in the United States between April 2014 and April 2015. During the first 9 months of the study, there were no restrictions on the administration of albumin. In January 2015, institutional guidelines were implemented in the CSICU that restricted albumin use to patients requiring more than 3 L crystalloid infusion in the early (first 24 hours) postoperative period, hypoalbuminemic patients (albumin less than 3.0 g/dL), and patients considered fluid overloaded, based on central venous pressure greater than 15, pulmonary artery diastolic pressure greater than 20, edema on chest radiograph, or physical examination. Because of the complex fluid management challenges facing patients on mechanical support, and the International Society for Heart and Lung Transplantation guidelines that recommend colloid infusion for hypovolemia [9], extracorporeal membrane oxygenation, ventricular assist device, and transplant patients were excluded from these restrictive guidelines.

Albumin costs and utilization were obtained from pharmacy records and compared with routinely monitored deidentified outcome quality metrics from the institutional The Society of Thoracic Surgeons database. The institution's database also provided the number of monthly admissions to the CSICU, and that included patients who were preoperative, postoperative, and readmitted over the study period. The quality metrics that were tracked included mortality, length of stay, days requiring ventilator support, patients requiring blood transfusion, number of fresh frozen plasma transfusions, and doses of 25% albumin administered. These quality metrics and administered albumin doses were compared for the 9 months before the implementation of the restrictive institutional guidelines and the 4 months after their implementation. The average of these quality metrics was calculated from a sum total over the entire before or after restriction period and divided by the appropriate number of months.

A statistical analysis was performed using an independent samples Student's t test, the Wilcoxon rank sum test, and Fisher's exact test. Also, post hoc sample size calculations were performed in STATA version 12.1 (StataCorp, College Station, TX) to determine the theoretic power required to detect statistically significant decreases in albumin utilization.

Results

There were 1,401 new CSICU patient admissions over the study period from April 2014 through April 2015. Albumin use, mortality, ventilator days, patients receiving packed red blood cell transfusion, ICU days, and average ICU length of stay were compared for 961 patients before and 440 patients after the restrictive guidelines were initiated (Fig 1). Albumin was administered from the hospital pharmacy in aliquots of 100 cc 25% solution, with a total dose of 25 g. Albumin utilization was significantly reduced from a mean of 280 monthly doses to a mean of 101 monthly doses ($p < 0.001$) after restrictive guidelines were implemented. During the quarter before the formal guideline implementation, as the impending changes were frequently discussed and disseminated, there was already a detectable decrease in albumin utilization (Fig 2).

During the study period, there was no significant change in the number of patients outside the scope of the albumin utilization guidelines. A monthly average of 9.44 $\pm$ 5.36 mechanical support or transplant patients were admitted before implementation of albumin restrictions, and 11.00 $\pm$ 2.83 such patients were admitted afterward ($p = 0.41$) based on a Wilcoxon rank sum test.

Analysis of the other outcome metrics demonstrated no difference in mortality between the two cohorts ($p = 0.54$) based on Fisher's exact test, and no difference in mean ventilator days ($p = 0.50$) or length of stay ($p = 0.60$) based on a Wilcoxon rank sum test. Moreover, the number of patients requiring blood transfusion during the course of their hospitalization demonstrated no significant change, and although the utilization of fresh frozen plasma did decline, that was not statistically significant (Table 1). The post hoc power analysis performed with 90% power and an alpha of 5% demonstrated that our sample size of 1,401 total patients should be adequately powered to detect the albumin changes. Based on an average wholesale price obtained by the pharmacy and an average monthly reduction of 180 albumin doses, the CSICU demonstrated more than $45,000 of wholesale cost savings per month though the implementation of a restrictive albumin administration guideline.

Comment

Fluid administration is a critical component of CSICU management and a common requirement for these patients in the immediate postoperative period. However, the optimal fluid to utilize is debated, and there are limited data supporting any particular strategy. Competing goals are often present, and include