doi:10.1016/j.jemermed.2012.01.038

ELSEVIER

Original Contributions

TRANSFUSION OF PACKED RED BLOOD CELLS IS NOT ASSOCIATED WITH IMPROVED CENTRAL VENOUS OXYGEN SATURATION OR ORGAN FUNCTION IN PATIENTS WITH SEPTIC SHOCK

Brian M. Fuller, MD,*† Mithil Gajera, MD,‡ Christa Schorr, RN,‡ David Gerber, DO,‡ R. Phillip Dellinger, MD,‡ Joseph Parrillo, MD,‡ and Sergio Zanotti, MD‡

*Department of Anesthesiology, Division of Critical Care Medicine, †Division of Emergency Medicine, Washington University School of Medicine, St. Louis, Missouri, and ‡Department of Medicine, Divisions of Cardiovascular Disease and Critical Care Medicine, University of Medicine and Dentistry of New Jersey-Robert Wood Johnson Medical School at Camden, Cooper University Hospital, Camden, New Jersey
Reprint Address: Brian M. Fuller, MD, Department of Anesthesiology, Division of Critical Care Medicine, Division of Emergency Medicine, Washington University School of Medicine, 600 South Euclid, Campus Box 8072, St. Louis, MO 63110

☐ Abstract—Background: The exact role of packed red blood cell (PRBC) transfusion in the setting of early resuscitation in septic shock is unknown. Study Objective: To evaluate whether PRBC transfusion is associated with improved central venous oxygen saturation ($ScvO_2$) or organ function in patients with severe sepsis and septic shock receiving early goal-directed therapy (EGDT). Methods: Retrospective cohort study (n = 93) of patients presenting with severe sepsis or septic shock treated with EGDT. Results: Thirty-four of 93 patients received at least one PRBC transfusion. The $ScvO_2$ goal > 70% was achieved in 71.9% of the PRBC group and 66.1% of the no-PRBC group ($p = 0.30$). There was no difference in the change in Sequential Organ Failure Assessment (SOFA) score within the first 24 h in the PRBC group vs. the no-PRBC group (8.6–8.3 vs. 5.8–5.6, $p = 0.85$), time to achievement of central venous pressure > 8 mm Hg (732 min vs. 465 min, $p = 0.14$), or the use of norepinephrine to maintain mean arterial pressure > 65 mm Hg (81.3% vs. 83.8%, $p = 0.77$). Conclusions: In this study, the transfusion of PRBC was not associated with improved cellular oxygenation, as demonstrated by a lack of improved achievement of $ScvO_2 > 70\%$. Also, the transfusion of PRBC was not associated with improved organ function or improved achievement of the other goals of EGDT. Further studies are needed to determine the impact of transfusion of PRBC within the context of early resuscitation of patients with septic shock. © 2012 Elsevier Inc.

☐ Keywords—sepsis; septic shock; early goal-directed therapy; packed red blood cells; transfusion

INTRODUCTION

Sepsis is a common, lethal, and expensive health care problem. In the United States, approximately 215,000 deaths are attributed to sepsis annually (1). More people die annually of sepsis than of lung and breast cancer combined. This results in over 380,000 intensive care unit (ICU) admissions yearly, and an enormous economic burden of over 17 billion dollars (1). The incidence of sepsis is estimated to be increasing steadily at 1.5% annually, with over 1.1 million cases per year by 2020 (1).

Significant improvements in mortality have been shown with an early, quantitative resuscitation strategy for those patients with severe sepsis and septic shock (2). Similar results have been reproduced by many studies, involving thousands of patients, and early goal-directed therapy (EGDT) as a protocolized resuscitation strategy has been recommended by professional organizations to

reduce the mortality from sepsis (3,4). The therapeutic end points of EGDT include maintaining a central venous pressure (CVP) of 8–12 mm Hg, mean arterial pressure (MAP) $\geq$ 65 mm Hg, urine output (as marker of end organ perfusion) of $\geq$ 0.5 cc/kg/hour, and central venous oxygen saturation (ScvO$_2$) $\geq$ 70%.

In the setting of optimized preload, packed red blood cell (PRBC) transfusion is recommended for perceived ongoing oxygen delivery vs. oxygen consumption mismatch, as manifested by an ScvO$_2$ < 70%, if the hematocrit is < 30%. This is based on the physiologic rationale of anemia in the setting of potential delivery-dependent oxygen consumption. Unfortunately, serious doubt has been cast on the ability of stored PRBCs to have a beneficial effect on cellular oxygenation (5–8). Due to changes occurring at the cellular level during PRBC storage, there may be equally compelling physiologic rationales to not transfuse PRBCs in the early stages of septic shock. The aim of this study was to examine the association of PRBC transfusion and ScvO$_2$ and change in organ function, as well as the achievement of the other goals of EGDT.

MATERIALS AND METHODS

This single-center retrospective cohort study was conducted in a large, urban, academic teaching hospital, with an annual emergency department (ED) census of approximately 56,000 patients and a 30-bed medical–surgical ICU. The study protocol was approved by the local institutional review board with waiver of informed consent.

Data were collected on 93 consecutive patients who presented in septic shock and received EGDT. The trigger for EGDT at our institution is systolic blood pressure < 90 mm Hg or MAP < 65 mm Hg despite a crystalloid challenge of 20–30 mL/kg, or initial serum lactate concentration > 4 mmol/L. For the purpose of this study, patients were divided into two groups: PRBC transfusion group and no-PRBC transfusion group.

We collected data on patients identified via the Surviving Sepsis Campaign Chart Review database and linked to the Project IMPACT database. Primary data collection was done by two abstractors (M.G. and C.S.). C.S. has had extensive experience and training in database management and chart review. M.G. was trained in the data retrieval process before study initiation. Variables were defined before data extraction and placed in a standardized format during the data collection process. Regular meetings and monitoring of data collection were performed and the chart reviewers were blinded to study hypothesis. The following data were collected with respect to the PRBC transfusion group and the no-PRBC transfusion group: age, gender, race, Acute Physiology

Table 1. Baseline Characteristics

Variable	PRBC (n = 34)	No PRBC (n = 59)	p Value
Age, years	63.5	59.3	0.199
Gender			
Male	22 (64.7%)	33 (55.9%)	0.512
Female	12 (35.3%)	26 (44.1%)	
Race			
Black	15 (44.1%)	22 (37.3%)	0.676
Hispanic	3 (8.8%)	9 (15.3%)	
White	16 (47.1%)	27 (45.8%)	
Other	0 (0%)	1 (1.7%)	
APACHE II	21.1	20.3	0.682
Lactate (mmol/L)	6.0	5.4	0.463
Initial SOFA score	8.6	5.8	0.003
Initial ScvO$_2$*	66.2 (11)	64.3 (12)	0.821

PRBC = packed red blood cell; APACHE = Acute Physiology and Chronic Health Evaluation; SOFA = Sequential Organ Failure Assessment; ScvO$_2$ = central venous oxygen saturation.
* Values represent the mean (SD).

and Chronic Health Evaluation (APACHE II) score, initial lactate level, estimated time to first antibiotic (measured from time to recognition of septic shock), total intravenous fluids administered, first vasoactive medication given, Sequential Organ Failure Assessment (SOFA) score, estimated time to CVP goal (CVP 8ET), and achievement of central venous ScvO$_2$ $\geq$ 70%.

The primary outcome measure was the achievement of ScvO$_2$ $\geq$ 70%. Secondary outcomes included improvement in SOFA score, achievement of CVP > 8 mm Hg, and use of vasoactive medications to achieve MAP > 65 mm Hg. The PRBC group and no-PRBC group were compared by the Pearson chi-squared and Fisher's exact test to analyze statistical significance. Statistical significance was defined as $p \leq 0.05$.

RESULTS

A total of 93 patients were included in this study; 97% of patients in the PRBC group originated in the ED before ICU admission, compared with 94.9% of patients in the no-PRBC group (p = NS). Thirty-four patients received PRBC transfusion as part of EGDT, with an average of 4.56 units per patient early (ordered during the first 6 h and administered within 24 h) in their resuscitation. There were no significant differences in baseline characteristics between the two groups, except for SOFA score at time of presentation (Table 1). Average age was 63.5 years in the PRBC group and 59.3 years in the no-PRBC group (p = 0.199). There were no significant differences in gender or race distributions. Baseline APACHE II score was 21.1 in the PRBC group and 20.3 in the no-PRBC group (p = 0.682). Initial lactate was 6.0 and 5.4, respectively (p = 0.463), and initial ScvO$_2$ in the two groups was 66.2 and 64.3 (p = 0.821). There was also no significant difference in estimated time to administration of