Pre-Trauma Center Red Blood Cell Transfusion Is Associated with Improved Early Outcomes in Air Medical Trauma Patients

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BACKGROUND: Hemorrhage is the leading cause of survivable death in trauma and resuscitation strategies including early RBC transfusion have reduced this. Pre-trauma center (PTC) RBC transfusion is growing and preliminary evidence suggests improved outcomes. The study objective was to evaluate the association of PTC RBC transfusion with outcomes in air medical trauma patients.

STUDY DESIGN: We conducted a retrospective cohort study of trauma patients transported by helicopter to a Level I trauma center from 2007 to 2012. Patients receiving PTC RBC transfusion were matched to control patients (receiving no PTC RBC transfusion during transport) in a 1:2 ratio using a propensity score based on prehospital variables. Conditional logistic regression and mixed-effects linear regression were used to determine the association of PTC RBC transfusion with outcomes. Subgroup analysis was performed for scene transport patients.

RESULTS: Two-hundred and forty treatment patients were matched to 480 control patients receiving no PTC RBC transfusion. Pre-trauma center RBC transfusion was associated with increased odds of 24-hour survival (adjusted odds ratio [AOR] = 4.92; 95% CI, 1.51−16.04; p = 0.01), lower odds of shock (AOR = 0.28; 95% CI, 0.09−0.85; p = 0.03), and lower 24-hour RBC requirement (Coefficient −3.6 RBC units; 95% CI, −7.0 to −0.2; p = 0.04). Among matched scene patients, PTC RBC was also associated with increased odds of 24-hour survival (AOR = 6.31; 95% CI, 1.88−21.14; p < 0.01), lower odds of shock (AOR = 0.24; 95% CI, 0.07−0.80; p = 0.02), and lower 24-hour RBC requirement (Coefficient −4.5 RBC units; 95% CI, −8.3 to −0.7; p = 0.02).

CONCLUSIONS: Pre-trauma center RBC was associated with an increased probability of 24-hour survival, decreased risk of shock, and lower 24-hour RBC requirement. Pre-trauma center RBC appears beneficial in severely injured air medical trauma patients and prospective study is warranted as PTC RBC transfusion becomes more readily available. (J Am Coll Surg 2015; 220:797−808. © 2015 by the American College of Surgeons)

Hemorrhage remains a major driver of early mortality in injured patients.[1,2] Recent literature has focused on resuscitation in the trauma center to reduce this burden. Strategies include minimizing crystalloid use,[3,4] high ratio of plasma and platelets to RBC transfusion,[5-8] and massive transfusion protocols.[9] Approaches to early blood transfusion have received significant attention recently.[1,10]

Prehospital resuscitation has also received considerable interest. To date, studies in the civilian population have focused on the use of crystalloids for resuscitation in the prehospital setting.[11-13] However, blood transfusion remains the mainstay of resuscitation for traumatic shock.[14] The capability to provide RBC transfusion during transport is generally limited to well-developed helicopter

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Abbreviations and Acronyms

HEMS = helicopter emergency medical services
HR = heart rate
INR = international normalized ratio
ISS = Injury Severity Score
PTC = pre-trauma center
SBP = systolic blood pressure
TIC = trauma-induced coagulopathy
TMPM = Trauma Mortality Prediction Model
UPMC = University of Pittsburgh Medical Center

emergency medical service (HEMS) systems.[15,16] Because of this, there is little evidence examining the use of prehospital RBC transfusion to mitigate early hemorrhage and shock in injured civilians.[17]

Military data have demonstrated that >90% of potentially survivable casualties die from hemorrhage, and medevac platforms from the United States and United Kingdom have prehospital RBC transfusion capabilities that have been associated with improved survival.[18-21] Given the encouraging results from military- and hospital-based resuscitation strategies, applying the lessons learned to the civilian prehospital setting is appealing.

Our group presented the first preliminary civilian data documenting improved outcomes associated with pre-trauma center (PTC) RBC transfusion in the severely injured Glue Grant Cohort.[22] However, this study was limited as a secondary analysis and only a small number of patients underwent PTC RBC transfusion. A more recent larger study evaluated outcomes of prehospital RBC and plasma transfusion in HEMS patients, finding improved acid–base status and decreased transfusion requirements in patients receiving prehospital blood products.[23]

The objective of this study was to evaluate the association of PTC RBC transfusion with early outcomes in trauma patients undergoing air medical transport. Given mounting evidence in support of PTC RBC transfusion, we hypothesized that PTC RBC transfusion would be associated with improved 24-hour mortality, lower 24-hour RBC requirements, and lower risk of shock and coagulopathy on admission.

METHODS

Data sources and study population

This is a retrospective cohort study conducted at the University of Pittsburgh Medical Center (UPMC) Presbyterian Hospital, an urban Level I trauma center with the highest volume of trauma patients in the state of Pennsylvania. All injured patients aged older than 15 years who underwent air medical transport by STAT MedEvac to UPMC Presbyterian Hospital between 2007 and 2012 were eligible for inclusion. STAT MedEvac is a large HEMS provider managed through the University of Pittsburgh's Center for Emergency Medicine, and accounts for approximately 40% of Pennsylvania's HEMS transports. During the study period, STAT MedEvac was staffed by a paramedic/nurse team and carried 2 U type O negative RBCs on each mission. A standing protocol was in place to allow RBC transfusion to trauma patients who have evidence of decreased tissue perfusion (Table 1).

Data sources included emsCharts, a prospectively collected prehospital database fed by electronic documentation of STAT MedEvac personnel, the UPMC trauma registry, and the UPMC electronic health record. Patients meeting inclusion criteria were identified through the emsCharts database. These patients' data were merged with the other data sources to obtain demographics, injury characteristics, time at referring facility, prehospital time and distance, prehospital and admission vital signs, crystalloid and RBC volumes, prehospital and admission laboratory values, ICU admission, emergency department disposition, surgical procedures, complications, and hospital disposition for each patient.

Missing data

For analysis variables missing >1% but <25% of observations, multiple imputation was performed. Imputed variables included race, admission Glasgow Coma Scale, admission systolic blood pressure (SBP), and admission heart rate (HR). Multiple imputation using an iterative Markov chain Monte Carlo fully conditional specification model based on available demographics, injury severity, ICU admission, and survival was performed using 5

Table 1. Protocol for Helicopter Emergency Medical Services Red Blood Cell Transfusion

RBC transfusion should be administered after 1 to 2 L crystalloid total has been received by an injured patient and any one of the following are present:
1. Hypotension with systolic blood pressure <90 mmHg
2. Changes in mental status
3. Changes in skin color (pallor, mottling, or cyanosis)
4. Tachycardia with heart rate >120 bpm
5. Capillary refill >2 s
6. Urine output <30 mL/h for ≥4 h (inter-facility transports)
7. Lactate level ≥4 mmol/L
8. Shock index (HR/SBP) >0.9
9. RBC transfusion initiated at a referring facility (inter-facility transports)

In cases of penetrating wounds or clinical evidence of active bleeding, RBC can be initiated earlier through consultation with a medical command physician.

HEMS, helicopter emergency medical services; HR, heart rate; SBP, systolic blood pressure.