Prehospital Red Blood Cell Transfusion is Associated with Improved Early Outcomes in Air Medical Trauma Patients

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Disclosures
No conflicts to disclose

Background
• Hemorrhage major driver of early mortality in trauma
• Significant advances in hospital-based resuscitation
• Prehospital (PH) resuscitation focused on crystalloids
Background

- Next logical step \(\rightarrow\) take blood based resuscitation to the prehospital arena
- PH blood products becoming more common, particularly in HEMS
- Few limited civilian studies

Objective

Evaluate association of PH RBC transfusion with early outcomes in trauma patients undergoing air medical transport

Patients

- Air medical trauma patients treated at level I urban trauma center 2007 – 2012
  - Single HEMS provider
- Age \(\geq\) 16 years old
- PH RBC vs No PH RBC
  - Other blood products excluded
PH RBC Protocol

PH RBC transfusion if 1-2L of crystalloid and any of the following:

- Hypotension with systolic blood pressure <90mmHg
- Changes in mental status
- Changes in skin color (pallor, mottling or cyanosis)
- Tachycardia with heart rate >120 beats per minute
- Capillary refill >2 seconds
- Urine output <30 ml/hour for ≥4 hours (inter-facility transports)
- Lactate level ≥4 mmol/L
- Shock index (HR/SBP) >0.9
- RBC transfusion initiated at a referring facility (inter-facility transports)

If penetrating injury or clinical evidence of active bleeding, RBC may be initiated earlier through medical command.

Propensity Score Matching

- PH RBC not randomly assigned, patients “sicker” with higher risk of mortality
- Model to predict likelihood of receiving PH RBC
- Predictors:
  - Age, Transfer, MOI, SBP, HR, Pre-HEMS arrival RBC/crystalloid, HEMS crystalloid, transport distance

Propensity Score Matching

- Generates probability of receiving PH RBC
- Nearest neighbor 1:2 treated:control match
- Balance assessed using standardized differences after matching
  - |Standardized difference| >0.2 = residual imbalance
Outcomes

• Primary
  ▪ 24-hr survival

• Secondary
  ▪ Shock (BD≥6 or lactate>4)
  ▪ 24-hr in-hospital RBC requirement

• Safety
  ▪ ARDS
  ▪ Prehospital transfusion reactions

Analysis

• Conditional logistic regression
  ▪ 24-hour survival
  ▪ Shock

• Mixed-effects linear regression
  ▪ 24-hour RBC requirement

• Models adjusted for:
  ▪ Gender, race, ISS, admission VS, admission labs, ICU admission, emergent operation, TMPM

Sub-group Analysis

• Patients transported from the scene of injury

• Separate propensity score matching

• Similar models used to assess outcomes
Study Population

- 54,415 trauma patients, 2001-2012
- 8,616 patients undergoing air medical transport

- 953 patients matched
- 499 treated patients
- 454 control patients

Propensity Score

C-statistic = 0.915
### Propensity Score Match

<table>
<thead>
<tr>
<th></th>
<th>PH Blood n = 240</th>
<th>No PH Blood n = 480</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>49 (28, 71.5)</td>
<td>49 (31, 68)</td>
<td>0.59</td>
</tr>
<tr>
<td><strong>Transfer (%)</strong></td>
<td>68</td>
<td>75</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Mechanism (% blunt)</strong></td>
<td>80</td>
<td>82</td>
<td>0.38</td>
</tr>
<tr>
<td><strong>EMS SBP (mmHg)</strong></td>
<td>84 (66, 106)</td>
<td>88 (73, 109)</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>EMS HR (bpm)</strong></td>
<td>114 (93.5, 136)</td>
<td>113 (96, 131)</td>
<td>0.81</td>
</tr>
<tr>
<td><strong>Pre-HEMS Crystalloid (mL)</strong></td>
<td>800 (200, 2000)</td>
<td>1000 (200, 1950)</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>HEMS Crystalloid (mL)</strong></td>
<td>500 (100, 1000)</td>
<td>400 (100, 1000)</td>
<td>0.31</td>
</tr>
<tr>
<td><strong>HEMS RBC (mL)</strong></td>
<td>300 (200, 500)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>ISS</strong></td>
<td>18 (10, 29)</td>
<td>17 (9, 27)</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Base deficit (mEq/L)</strong></td>
<td>8 (4, 12)</td>
<td>5 (3, 9)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td><strong>24-hour RBC (units)</strong></td>
<td>5 (2, 11)</td>
<td>4 (3, 10)</td>
<td>0.06</td>
</tr>
</tbody>
</table>

### Outcomes

![Diagram showing 24-hour survival and Adjusted Odds Ratios]

**Adjusted Odds Ratios**

**PH Blood vs No PH Blood**
Outcomes

24-hr in-hospital RBC transfusion requirements
PH RBC coefficient -2.8 RBC units
95% CI -5.6, -0.1; p=0.04

Safety

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<tr>
<td>ARDS (%)</td>
<td>2</td>
<td>3</td>
<td>0.61</td>
</tr>
<tr>
<td>Transfusion Rxn (%)</td>
<td>0</td>
<td>-</td>
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Scene Patients: Propensity Score

C-statistic = 0.959

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### Scene Patients: Propensity Score

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<tr>
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<th>PH Blood n = 71</th>
<th>No PH Blood n = 142</th>
<th>p value</th>
</tr>
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<tbody>
<tr>
<td>Age (years)</td>
<td>42 (24, 55)</td>
<td>37 (25, 65)</td>
<td>0.77</td>
</tr>
<tr>
<td>Mechanism (% blunt)</td>
<td>72</td>
<td>69</td>
<td>0.67</td>
</tr>
<tr>
<td>EMS SBP (mmHg)</td>
<td>72 (60, 91)</td>
<td>80 (60, 92)</td>
<td>0.47</td>
</tr>
<tr>
<td>EMS HR (bpm)</td>
<td>131 (104, 146)</td>
<td>120 (100, 140)</td>
<td>0.27</td>
</tr>
<tr>
<td>Pre-HEMS Crystalloid (mL)</td>
<td>500 (100, 1200)</td>
<td>500 (100, 1000)</td>
<td>0.95</td>
</tr>
<tr>
<td>HEMS Crystalloid (mL)</td>
<td>1000 (500, 1800)</td>
<td>1000 (500, 1500)</td>
<td>0.91</td>
</tr>
<tr>
<td>HEMS RBC (mL)</td>
<td>300 (200, 500)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ISS</td>
<td>22 (10, 34)</td>
<td>22 (13, 29)</td>
<td>0.90</td>
</tr>
<tr>
<td>Base deficit (mEq/L)</td>
<td>9 (4, 13)</td>
<td>8.5 (4, 12)</td>
<td>0.24</td>
</tr>
<tr>
<td>24-hour RBC (units)</td>
<td>9 (3, 13)</td>
<td>8 (2, 18)</td>
<td>0.66</td>
</tr>
</tbody>
</table>

### Scene Patients: Outcomes

#### Adjusted Odds Ratios

<table>
<thead>
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<tr>
<td>24h Survival</td>
<td></td>
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<tr>
<td>Shock</td>
<td></td>
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<td>Adjusted Odds Ratios</td>
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#### 24h Survival vs Shock

- 24h Survival: 6.31
- Shock: 0.24

**Adjusted Odds Ratios**
24-hr in-hospital RBC transfusion requirements

PH RBC coefficient: -3.4 RBC units
95% CI: -6.5, -0.2; \( p = 0.03 \)

Safety

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<tr>
<td>ARDS (%)</td>
<td>4</td>
<td>1</td>
<td>0.07</td>
</tr>
<tr>
<td>Transfusion Rxn (%)</td>
<td>0</td>
<td>-</td>
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Scene Patients: Outcomes

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95%CI -6.5, -0.2; p=0.03

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<td>4</td>
<td>1</td>
<td>0.07</td>
</tr>
<tr>
<td>Transfusion Rxn (%)</td>
<td>0</td>
<td>-</td>
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Summary

• Matched cohort of severely injured patients with shock, PH RBC associated with:
  ▪ Increased probability of 24-hour survival
  ▪ Decreased risk of shock on admission
  ▪ Lower 24-hr in-hospital RBC transfusion requirements

Summary

• Safety
  ▪ No difference in ARDS rates
  ▪ No prehospital transfusion reactions

• Benefits persist in scene patients