Clinical use of red cells for transfusion - epidemiology of red blood cell use

FDA, Natcher Center, 6 Oct 2016

John R. Hess, MD, MPH, FACP, FAAAS

Professor of Laboratory Medicine and Hematology
Medical Director, Transfusion Service, Harborview MC
U of Washington School of Medicine, Seattle
Conflict of Interest

• I am the inventor of the RBC storage solution AS-7 (SolX®) and I receive royal payments based on 4 US patents held by the US Army and the University of Maryland and licensed to the Haemonetics Corporation.

• I have been a critic of the way the FDA regulates RBC storage.
CONCLUSIONS: Attempts to expand the useful regulatory requirements for RBC storage system licensure are limited by poor understanding of the storage lesion and its effect of RBC performance. Measures of $^{51}$Cr 24-hour in vivo recovery remain critical and resources for this measure are limiting. The interaction between limited testing resources and large donor variability remains a major limit on RBC storage system development. It is important that new required tests contribute meaningful information and not make development and licensure of better products more difficult.

There are many RBC storage lesions.

Only some of them matter.
“RBCs for transfusion ... Safe, Available, Effective, Cheap ... not irrevocably wrapped in red tape”

John Collins, NAS, 1973
Red blood cells are the most commonly transfused blood product.
US National Use

- 35,000 RBCs a day
- Several days of supply on hand
  - Large buffer for emergencies on either the supply or demand sides
  - Supply of group O and especially O Neg RBCs is always the question
- Many remote locations need a few RBCs.
  - Rural safety net hospitals
  - Remote hospitals
Decreasing national blood use

- National Blood Collection and Utilization Survey
  - 2011 – 15.7 million units collected
  - 2013 – 13.6 million units collected

- A 12.6% decrease
Demographic Bind:
People over 65 use half the blood donated. Their numbers double 2000 to 2025.

Fewer middle-aged individuals means less blood will be donated.
Current recommended RBC transfusion triggers

- 6 g Hb – young and fit adults (ASA)
- 7 g Hb – most hemodynamically stable patients including ICU
- 8 g Hb – active cardiac illness, elderly
- 9 g Hb – pregnant mothers with HbSS

- No evidence duration of storage of RBCs makes a difference (4 RCTs)
Blood Product Use at Harborview 2003-2014

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RBCs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Units Crossmatched</td>
<td>43378</td>
<td>36813</td>
<td>30596</td>
<td>28175</td>
<td>27672</td>
<td>27685</td>
<td>27210</td>
<td>25068</td>
<td>12180</td>
<td>9832</td>
<td>9983</td>
</tr>
<tr>
<td>Units Transfused</td>
<td>14650</td>
<td>13357</td>
<td>12420</td>
<td>11508</td>
<td>11728</td>
<td>10627</td>
<td>10070</td>
<td>8933</td>
<td>9216</td>
<td>7804</td>
<td>7760</td>
</tr>
<tr>
<td>C/T Ratio</td>
<td>3.0</td>
<td>2.8</td>
<td>2.5</td>
<td>2.4</td>
<td>2.4</td>
<td>2.6</td>
<td>2.7</td>
<td>2.8</td>
<td>1.32</td>
<td>1.26</td>
<td>1.29</td>
</tr>
<tr>
<td>Units Outdated/Expired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Units Wasted</td>
<td>78</td>
<td>128</td>
<td>166</td>
<td>153</td>
<td>195</td>
<td>135</td>
<td>28</td>
<td>25</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Wasted (Waste/Transfused)</td>
<td>0.63</td>
<td>1.11</td>
<td>1.42</td>
<td>1.44</td>
<td>1.94</td>
<td>1.51</td>
<td>0.30</td>
<td>0.32</td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Platelets</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Units Transfused</td>
<td>5852</td>
<td>4846</td>
<td>3922</td>
<td>2809</td>
<td>2929</td>
<td>2894</td>
<td>2205</td>
<td>2105</td>
<td>1726</td>
<td>1480</td>
<td>1534</td>
</tr>
<tr>
<td>Units Outdated/Expired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>76</td>
<td>93</td>
<td>64</td>
</tr>
<tr>
<td>Units Wasted</td>
<td>625</td>
<td>384</td>
<td>182</td>
<td>274</td>
<td>254</td>
<td>343</td>
<td>641</td>
<td>18</td>
<td>10</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>% Wasted (Waste/Transfused)</td>
<td>11%</td>
<td>11%</td>
<td>9%</td>
<td>6%</td>
<td>9%</td>
<td>11.85</td>
<td>29.07</td>
<td>0.86</td>
<td>0.58</td>
<td>0.54</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Plasma</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Units Transfused</td>
<td>13185</td>
<td>13658</td>
<td>13989</td>
<td>13332</td>
<td>9889</td>
<td>9715</td>
<td>6814</td>
<td>6520</td>
<td>5024</td>
<td>3855</td>
<td>3875</td>
</tr>
<tr>
<td>Units Outdated/Expired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td>33</td>
<td>41</td>
</tr>
<tr>
<td>Units Wasted</td>
<td>2700</td>
<td>1866</td>
<td>297</td>
<td>290.0</td>
<td>283</td>
<td>266</td>
<td>307</td>
<td>359</td>
<td>22</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>% Wasted (Waste/Transfused)</td>
<td>20.48</td>
<td>13.66</td>
<td>2.12</td>
<td>2.18</td>
<td>2.86</td>
<td>2.74</td>
<td>4.51</td>
<td>5.51</td>
<td>0.44</td>
<td>0.47</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>Cryo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Units Transfused</td>
<td>2899</td>
<td>2756</td>
<td>3136</td>
<td>3372</td>
<td>3342</td>
<td>2826</td>
<td>2902</td>
<td>2544</td>
<td>245</td>
<td>211</td>
<td>333</td>
</tr>
<tr>
<td>Units Outdated/Expired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Units Wasted</td>
<td>602</td>
<td>570</td>
<td>708</td>
<td>570</td>
<td>602</td>
<td>497</td>
<td>908</td>
<td>1110</td>
<td>22</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>% Wasted (Waste/Transfused)</td>
<td>20.8</td>
<td>20.7</td>
<td>22.6</td>
<td>16.9</td>
<td>18.0</td>
<td>17.59</td>
<td>31.29</td>
<td>43.63</td>
<td>8.98</td>
<td>6.16</td>
<td>5.41</td>
</tr>
<tr>
<td><strong>Total Transfusions</strong></td>
<td>36586</td>
<td>34617</td>
<td>33467</td>
<td>31021</td>
<td>27888</td>
<td>26062</td>
<td>21991</td>
<td>20102</td>
<td>16211</td>
<td>13350</td>
<td>13502</td>
</tr>
</tbody>
</table>

Blood use is down by 60%
Wastage is at historically low levels
Transfusion service lab savings are $2 million / year
Moving from just in case to just in time

Blood Product Use at Harborview 2003-2014

Red Blood Cells
- RBC U x-matched
- RBC U transfused

Platelets
- Platelet Units # Transfused
- Platelet Units # Outdated/Expired
- Platelet Units Wasted

Plasma
- Plasma Units Transfused
- Plasma Units Outdated/Expired
- Plasma Units Wasted

Cryoprecipitate
- Cryo Units Transfused
- Cryo Units Outdated
- Cryo Units Wasted
Moving from just in case to just in time

Red Blood Cells

Puget Sound Blood Center / HMC TSL
40% decrease in ICU patients transfused

3533 unique medical ICU patients at U. Maryland Medical Center

Netzor et al. Transfusion 2009

Fig. 2. Percentage of patients transfused, by interval. Linear regression estimated a 1.1% absolute reduction in percentage of patients transfused per interval (95% CI, 0.6% to 1.6%; p < 0.001).
Changes in Massive Transfusion over Time: An early shift in the right direction?

Kautza et al. J Trauma 2012 (Glue Grant, NIH)

With earlier administration of FFP and Plts, Massive transfusion has decreased.
HMC uses 20 units of RBCs a day
We have blood at airfields to serve remote locations.
US Military Use

• 500 RBCs a day
  – From Afghanistan to Korean DMZ
  – High rates of non-use (98% in Bosnia)
  – Need for more durable blood products of all categories
Frozen RBCs

• Support the national rare donor program
  – Associated with 4 x cost and 20% additional loss / unit
  – Are licensed for 10 years and demonstrated to be effective for 37 years

• Shown to be efficient and effective in supporting low intensity military theaters by the Dutch and Czech militaries.
Safe
Available
Effective
Cheap

...not
irrevocably
wrapped in
red tape
Thank you

hessj3@uw.edu