BACK TO THE FUTURE
Pre-hospital Fresh Whole Blood resuscitation program in a military setting

by

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Blood Far Forward
– Time to rethink?
“In 1918, transfusions were carried out farther forward than casualty clearing stations, ........The syringe technique could "easily" be applied in advanced dressing stations and in the average regimental aid post. If casualties were given blood in these areas, they would be kept alive until they reached the casualty clearing station, where they could be
almost 100 years later........
LSI’s were required by most casualties undergoing urgent evacuation, and a lack or delay in their performance was associated with increased mortality. Scope-of-practice for LSI was beyond the current civil-sector equivalent of combat medics, and few were performed by them near point of injury. EMT-paramedic scope-of-practice and emergency medical direction may ameliorate this situation. Forward deployment of blood components may represent the next addition to LSI’s if logistical and scope-of-practice issues can be overcome.
## Logistical challenges:

<table>
<thead>
<tr>
<th>Blood component</th>
<th>Storage temp.</th>
<th>Preparation</th>
<th>Shelf life</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBCs</td>
<td>1 to 6 °C</td>
<td></td>
<td>6 weeks</td>
</tr>
<tr>
<td>Plasma</td>
<td>– 20 °C</td>
<td>Thawed Refrigerated</td>
<td></td>
</tr>
<tr>
<td>Platelets</td>
<td>20 to 24 °C</td>
<td>Continous agitation</td>
<td>5 – 7 days</td>
</tr>
</tbody>
</table>
DIFFERENT STORAGE

FRIEZE DRIED PRODUCTS? SYNTHETIC HEMOGLOBIN? NOT YET AVAILABLE
MOTHER NATURES
DISCUSSION: FROM CRYSTALLOID/COLLOID TO

- RED CELLS: PLASMA: PLATELETS
- 1:1:1?
- Ratio in massive bleeding patients
- Is CT designed for massive bleeding?
- Only one ratio available far forward
DISCUSSION: FROM CRYSTALLOID/COLLOID TO

• MOTHER NATURE`S RATIO
Answer:
Remote Damage Control Resuscitation

Use of warm fresh whole blood adress:

– Acidosis
– Hypothermia
– Coagulopathy
– Tissue hypoxia
NorNavSoc/Haukeland research program on Blood Far Forward

• Blood **availability** (“buddy transfusion”)

• **Fresh Whole Blood quality**

• **Resuscitation skills**

Donor safety,
Combat performance
Large enough volume of FWB

Storing quality
Effect of transport
Pathogen reduction
Leukoreduction
Additive solutions

Diagnose/Indication
Venous access
Safety issues

Medic or soldier
Training methods
Unit implementing
FWB availability far forward

"Buddy transfusion"

- Well proven concept (WWI/WWII/Korea)
- Little research on FWB after CT was introduced
- New technologies (screening, pathogen reduction, leukoreduction)
- Modern warfare
- TCCC
- Buddy soldier availability

Transfusion apparatus from WWI
FWB availability far forward

Pilot study on donor safety:
- All tests before and after donating 450 ml:
  - Endurance test (Bruce Protocoll + hang−/pushups)
  - Pistol shooting (9mm standard test)
  - Uphill march (20 kg backpack)
FWB availability far forward

Bruce Protocoll (n=7)

<table>
<thead>
<tr>
<th></th>
<th>Pre-donation</th>
<th>Post-donation</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR*10 (beats/min)</td>
<td>19.0</td>
<td>18.9</td>
<td></td>
</tr>
<tr>
<td>Lactate (mmol/L)</td>
<td>12.3</td>
<td>11.3</td>
<td></td>
</tr>
</tbody>
</table>

Serie 3

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FWB availability far forward

Muscle endurance (n=7)

Repetitions

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Pre-donation</th>
<th>Post-donation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hangups</td>
<td>15.6</td>
<td>14.2</td>
</tr>
<tr>
<td>Pushups</td>
<td>50.4</td>
<td>50.7</td>
</tr>
</tbody>
</table>
FWB availability far forward

Pistol shooting – 50 rounds (n=12)

Hits (x/50)

- Pre-donation
- Post-donation

L hand
S hand
10M 2+1
Average

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FWB availability far forward

Uphill march (n=12)

UPHILL WALK
SLOPE 28%
ALTITUDE DIFF:
450METER

DONATION=
06`34``.

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FWB availability far forward

Necessary volume of FWB for resuscitation?

• Donation pre-mission
• Donation on site
• Re-infuse FWB to donor

Donation prior to mission

Donation

Warm Fresh Whole Blood

Storage

Transfusion

admin area

far forward

PI
FWB availability far forward

Re-infusion of FWB stored for 24 hours at 19 °C:

Hb (g/dl)

<table>
<thead>
<tr>
<th></th>
<th>PREDON</th>
<th>POSTDON</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,00</td>
<td>14,42</td>
<td>14,35</td>
</tr>
<tr>
<td>11,00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12,00</td>
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<td>13,00</td>
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<td>14,00</td>
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<td>15,00</td>
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TRANSPORT PILOT
Conclusions:

- Buddy transfusion is feasible (and safe?)
- Donor combat performance is negligible reduced
- Human error is the problem, not the blood.
- 1) infuse blood to a casualty not needing it
- 2) infuse wrong blood
Fresh Whole Blood Quality

Pilot studies to test quality:
• Storing under field conditions
• Transport study (air, land, sea)
• Pathogen reduction
• Leukoreduction
• Immune modulation
• Tissue oxygenation
• Additive solutions
• In vivo–in vitro?
Fresh Whole Blood Quality

Storing under field conditions:
• 19 °C
• ?? Hrs
Resuscitation Skills

- Indications for transfusion
- Use of IO device
- Safety issues
  - Screening (predeployment)
  - Typing
  - ”Dog-tag”
Resuscitation Skills

Here was video of sternal infusion of wb
20 infusions of 450 ml of wb sternal
Infusion rate vary from 8,5 min– 30 min gravity only, average 19,5 minutes
Device used : fast one
Resuscitation Skills

Indications for transfusion:
• Difficult !! (maybe the biggest hurdle?)
• TCCC for IV fluids:
  – altered mental status
  – weak or absent peripheral pulses
  – Too late?
Training/Education

100 donations and reinfusions
Training/Education

- Soldier/operator or medic only?
- Training methods/simulated combat
- Implementing into unit
TUSEN TAKK