Virtual Lectures Planning Committee
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No relevant financial relationship(s) with industry:
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- Donald Jenkins, MD – program presenter
- Sharon Praus – program planning committee
- Bobbi Pritt, MD, MSc, DTMH – program planning committee
- Cara Schmidt – program planning committee

References to off-label and/or investigational usage(s) of pharmaceuticals or instruments in their presentation:
None

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- Jim Stubbs, MD and Lisa Button Mayo Clinic Rochester
- Phil Spinella and Geir Strandenes, THOR
- LTC Andre Cap USAISR
- Rosemary Kozar and Shibani Pati

Blood transfusion as a predictor of injury mortality

- 1 in 400 injured people die
- 1 in 50 of the hospitalized injured die
- 20% of transfused injured die
- 40% of injured who receive more than 10 U RBC die
As blood use increases, mortality increases. Other predictors of mortality, such as ISS, become less discriminant.

Hemorrhage and Shock
- Sometimes it can be easy to spot
- The longer in shock, the more likely to die
- It takes a human being very little time to bleed to death
  - ~22 minutes from penetrating injury
  - This could be internal and/or external
  - ~28 minutes from blunt injury
- Most often this is 'hidden bleeding' internally
- Define Massive Transfusion
  - ≥10u PRBC 24 hrs vs 5u/60 minutes = same mortality

Background

By the time of arrival at the ED, 28% (2,994 of 10,790) of trauma patients had a detectable coagulopathy that was associated with poor outcome

Rationale:
Coagulopathy & the “Golden Hour”
- Trauma Induced Coagulopathy (TIC) predicts mortality
- Plasma and RBC resuscitation should occur early in the hemorrhagic / coagulopathic pt
- Catchment area / Rural location provides geographic obstacles
Remote Damage Control Resuscitation

- Austere/rural environment patients
  - Modified transfusion strategy
  - Different than those with scene/pre-hospital time < 30 minutes
  - Limited resources available
  - Lack of plasma availability
  - 40% of the population, 60% of the trauma mortality
- Current treatment options for uncontrolled hemorrhage in this environment are very limited
- >75% of combat fatalities occur in the field

Remote Damage Control: Civilian Experience in the Pre-Hospital Setting

SMRTAC Level 1 Trauma Transfers Analysis

- Rarely plasma, no platelets 20/22 hospitals
- Level 1 activations transferred from SMRTAC hospitals 2011-2012
  - Level I criteria = 81% ICU or OR next stop
  - PI process shows under <3% & over triage <10%
  - Average TOI to definitive care 209 minutes.
- 21.5% in hospital mortality = rotary wing scene mortality for same patients
- All comers mortality: transfer = 5.2%; scene = 0.2% and N = ~850 per group
Secondary transfer patients have similar mortality with less severe injuries compared to scene transfers.

<table>
<thead>
<tr>
<th></th>
<th>SMRTAC Transfers</th>
<th>Direct from Scene</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>130</td>
<td>112</td>
</tr>
<tr>
<td>TOI to definitive care (average)</td>
<td>209*</td>
<td>79*</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>21.5</td>
<td>19.2</td>
</tr>
<tr>
<td>ISS overall (average)</td>
<td>17.3*</td>
<td>23.4*</td>
</tr>
<tr>
<td>ISS mortalities (average)</td>
<td>26.6*</td>
<td>40.0*</td>
</tr>
</tbody>
</table>

* P < 0.5

Early Use of Blood in the Pre-hospital Setting

- Mayo Clinic Experience
- 1993-96 retrospective review
- Criteria: Hgb<10, shock, hypotension after resuscitation
- ~2100 helicopter flights, 94 patients received PRBC’s (4%, 91% interfacility transfer)
- 48% trauma patients, 25% GI bleed, 38% AAA
- Hgb increased from 8.9 to 10.2 after 2 PRBC
- No transfusion reactions or complications
- Average 12 u PRBC after admission

Protocol – Helicopter Phase

**Indications for PRBC and Plasma administration in adult trauma patients**

<table>
<thead>
<tr>
<th>pRBC + Plasma</th>
<th>Plasma Alone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hypotension (single reading of systolic blood pressure ≤ 90mmHg)</td>
<td>1. Point of care INR ≥ 1.5</td>
</tr>
<tr>
<td>2. Tachycardia (single reading of heart rate ≥ 120)</td>
<td>2. Stable Hemodynamics</td>
</tr>
<tr>
<td>3. Penetrating mechanism</td>
<td></td>
</tr>
<tr>
<td>4. Point of care lactate ≥ 5.0 mg/dl</td>
<td></td>
</tr>
<tr>
<td>5. Point of care INR ≥ 1.5</td>
<td></td>
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</table>

Trauma Patients (n=10)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>71.5 [30-75.3]</td>
</tr>
<tr>
<td>Male</td>
<td>8/10</td>
</tr>
<tr>
<td>ISS</td>
<td>25.5 [16.8-29.3]</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>4.5 [1.8-24.8]</td>
</tr>
<tr>
<td>Mortality</td>
<td>4/10</td>
</tr>
</tbody>
</table>

Admission Laboratory Values

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coumadin</td>
<td>5/10 (50%)</td>
</tr>
<tr>
<td>Lactate</td>
<td>2.8 [1.7-5.7]</td>
</tr>
<tr>
<td>Base</td>
<td>-4.1 [-12.5- -0.5]</td>
</tr>
<tr>
<td>PLT</td>
<td>149 [114-180]</td>
</tr>
<tr>
<td>PTT</td>
<td>30 [28-42]</td>
</tr>
<tr>
<td>Hgb</td>
<td>10.8 [10.1-13.5]</td>
</tr>
<tr>
<td>Post-Flight INR</td>
<td>1.6 [1.3-2.8]</td>
</tr>
<tr>
<td>Pre-Flight INR</td>
<td>2.7 [1.6- 4.0]</td>
</tr>
</tbody>
</table>

Protocol Evolution

- During the study period, total of 771 flights
- Only two pts received all 4 units of PRBC during transport
- Product Order and Ratio
  - 2009: 2 PRBC, 2 Plasma, 2 PRBC
  - 2010: 2 Plasma, 2 PRBC, 2 PRBC
  - 2011: 3 Plasma, 3 PRBC
### Time & the ‘Geographic Plasma Deficit’

<table>
<thead>
<tr>
<th>Facility Transfer</th>
<th>Control (n=50)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport → Trauma Ctr (min)</td>
<td>40</td>
<td>39</td>
</tr>
<tr>
<td>Injury → First Plasma (min)</td>
<td>194</td>
<td>231</td>
</tr>
<tr>
<td>Trauma Ctr arrival → Plasma (min)</td>
<td>34</td>
<td>97</td>
</tr>
</tbody>
</table>

### Beilman Study
- Over a 15-month period, seven Level I trauma centers in the USA enrolled 383 patients, 50 of whom developed MODS.
- Patients who had sustained major blunt and/or penetrating trauma and required blood transfusion within six hours of admission were enrolled.
- StO2 monitoring was started on the thenar eminence within 30 minutes of ED arrival and recorded continuously for 24 hours.
- Clinicians were blinded to StO2 results.
- Standard hemodynamic parameters recorded as part of patient care were collected for the first 24 hours including base deficit and clinical outcomes.

### Results
- StO2 below 75% indicates serious hypoperfusion in trauma patients.
- 78% of patients who developed MODS, and 91% of patients who died, had StO2 below 75% in the first hour.
- StO2 above 75% indicates adequate perfusion.
- Trauma patients who maintained StO2 above 75% within the first hour had an 88% chance of MODS-free survival.
- StO2 functions as well as base deficit in indicating hypoperfusion in trauma patients.
- No device-related adverse events were observed during the study.

### Continuous Noninvasive Tissue Oximetry In The Early Evaluation Of The Combat Casualty: A Prospective Study
- StO2 recorded in the emergency department.
- 147 combat casualties enrolled in the trial, 72 (49%) required an LSI, 42 (29%) required blood transfusion, and 10 (7%) required massive transfusion.
- On multivariate logistic regression analysis: SBP, INR and hematocrit (Hct) predicted blood transfusion.
- When just the group with an SBP >90 was analyzed, independent predictors of patients requiring blood transfusion were StO2 & Hct.
- CONCLUSIONS: StO2 obtained on arrival predicts the need for blood transfusion in casualties who initially seem to be hemodynamically stable (SBP >90).

### Low StO2 is Associated with Requirement for Transfusion in Rural Trauma Population
Mohammad Khasawneh, MBBS; Boris Srvantstyan, MD; Martin Zielinski, MD; Donald elementa, Scott Zarew MD; Henry Schioler MD; Marilza River MD
Division of Trauma, Critical Care and General Surgery
Department of Surgery Mayo Clinic, Rochester MN
WJ Surg. March 2014
Results

- Total 632 level 1 trauma
- 325 patients with recorded StO2
- Mean age 46 years
- Males 74%
- Blunt trauma 87%

<table>
<thead>
<tr>
<th>Variable</th>
<th>StO2&lt; 65 n=23</th>
<th>StO2&gt;65 n=302</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin, (SD)</td>
<td>13 (3)</td>
<td>13 (2)</td>
<td>NS</td>
</tr>
<tr>
<td>Hematocrit, (SD)</td>
<td>38 (9)</td>
<td>38 (6)</td>
<td>NS</td>
</tr>
<tr>
<td>pH, (SD)</td>
<td>7.29 (0.1)</td>
<td>7.33 (0.1)</td>
<td>NS</td>
</tr>
<tr>
<td>Base deficit, (SD)</td>
<td>-3.8 (3.1)</td>
<td>-2.4 (5.1)</td>
<td>NS</td>
</tr>
<tr>
<td>Lactate, (SD)</td>
<td><strong>3.9 (3.2)</strong></td>
<td><strong>2.4 (2.1)</strong></td>
<td>0.003</td>
</tr>
<tr>
<td>FAST done</td>
<td>9 (39%)</td>
<td>80 (27%)</td>
<td>NS</td>
</tr>
<tr>
<td>Positive FAST</td>
<td>1 (17%)</td>
<td>9 (12%)</td>
<td>NS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>StO2&lt; 65 n=23</th>
<th>StO2&gt;65 n=302</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU days, (SD)</td>
<td>5.1 (8.8)</td>
<td>2.9 (5.4)</td>
<td>NS</td>
</tr>
<tr>
<td>Hospital length of stay, (SD)</td>
<td>12.1 (9.8)</td>
<td>8 (12.6)</td>
<td>NS</td>
</tr>
<tr>
<td>Mortality</td>
<td>3 (13%)</td>
<td>40 (13%)</td>
<td>NS</td>
</tr>
<tr>
<td>Surgical intervention</td>
<td><strong>18 (78%)</strong></td>
<td><strong>152 (50%)</strong></td>
<td>0.007</td>
</tr>
<tr>
<td>Morbidity</td>
<td>11 (48%)</td>
<td>68 (23%)</td>
<td>0.006</td>
</tr>
</tbody>
</table>
Multivariate analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>StO2 &lt; 65%</td>
<td>0.01</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>0.11</td>
</tr>
<tr>
<td>Heart rate</td>
<td>0.97</td>
</tr>
<tr>
<td>O2 saturation</td>
<td>0.91</td>
</tr>
<tr>
<td>Lactate level</td>
<td>0.25</td>
</tr>
<tr>
<td>Age</td>
<td>0.32</td>
</tr>
<tr>
<td>ISS</td>
<td>0.33</td>
</tr>
<tr>
<td>GCS</td>
<td>0.74</td>
</tr>
<tr>
<td>Positive FAST</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Conclusion

- **StO2 value <65% correlates with:**
  - Greater requirement for pRBCs transfusion within 24 hours of injury
  - Need for surgical intervention
  - In hospital complications
  - 6 months ago, MN State trauma system adopted StO2<70 as part of definition of shock in the injured patient
  - Critical access hospital StO2 program
  - 21/22 surrounding hospitals StO2 on-line

Hemostatic Resuscitation

- Pre- and in-hospital direct and indirect hemostatic measures (pressure, tourniquets, plasma, TXA, etc)
- Patient need based: TEG (3 studies showing MA is low and #1 coagulopathy in serious traumatic injury/hemorrhage)
- Pre-hospital extension of ED care

Hemostatic Resuscitation in Our Trauma Center

- Pre-hospital plasma, TXA and POC testing
- Early Diagnosis in ED
- 1:1 ratio (thawed plasma to RBC)
- Plasma-first transfusion sequence
- ED use of TXA and/or Pro-thrombin Complex Concentrate
- Frequent TEG and early platelet use
- **Minimal crystalloid**
- Repeated blood product transfusion and/or doses of PCC in OR and ICU as indicated by TEG

TEG and Benchmarking Trauma Center Studies

- In the face of normal platelet counts, the MA component of TEG detects a hypocoagulable state in the trauma patient which drives transfusion therapy (Plotkin, Ballinger, Demetriades, et al)
- During 2009-2013 time frame, trauma center mortality rose to top decile in TQIP benchmarking report and DVT/PE rate cut 50% to national norm
- Overall trauma center mortality over last 4 years has dropped from 3.3% to 2.1%
Conclusions

...Does Plasma First Resuscitation Matter?

• Pre-hospital Thawed Plasma corrects INR
• Plasma-First Protocol esp in patients with Hgb 10.8 g/dl baseline
  - Lower Plasma Deficit early & sustained
  - 1:1 Resuscitation goal reached early
• Significantly less Crystalloid administered to PTP patients as compared to controls

Other Pre-hospital Plasma Use

• Pediatric experience
  - 50+ children have received pre-hospital blood for a variety of indications
  - That experience is now being investigated
• Non-trauma experience
  - 50+ GI bleed patients have received pre-hospital blood
  - That experience is being published soon (favorable)

Does Early Plasma Really Matter?

• Just submitted abstract
• Compared RBC first to thawed plasma first
• Looked specifically at trauma patients with severe head injury
• Groups equally matched
• Significant improvement in neurologic outcomes in plasma first group
• Go to AAST meeting in Hawaii next Sept.

Oh, Wait, There’s More

• Pati and Kozar presented at Trauma Hemostasis Oxygenation and Research Network (THOR) June 2015
• Showed the benefit of restoring the glycocalyx of the endothelium
• Plasma is good
• Platelets are better

CONCLUSION

• We successfully implemented pre-hospital thawed plasma use into our rural Level-I trauma system
• To date, we have over 1000 units of pre-hospital plasma transfused which is currently under study
• Feasibility studies now complete and the protocol was expanded to other transports in our system
• TXA use is low (fewer than 90 patients)
• Now what?
Platelet First Transfusion Strategy

- Apheresis pack of platelets is carried by a unit of A plasma
- Giving platelets first directly addresses the endotheliopathy of traumatic hemorrhage
- Giving platelets first means simultaneous plasma administration with single donor exposure
- Giving platelets first is hemostatic resuscitation at its finest

Time Frame

- Warm platelets in the ED for 6+ months: done
- ED cold platelets: done (wait, what?)
- Cold stored whole blood: O vs O + A = O
- Helicopter phase: depends upon above
  - The more products, the tougher the logistics for everyone
  - Our prehospital use profile goes well beyond trauma patients

Cold Stored Platelets for Treatment of Hemorrhage

US Army Institute of Surgical Research

LTC Andrew P. Cap, MD, PhD, FACP
Dr. Heather F. Pidcoke, MD, PhD
Dr. Philip C. Spinella, MD, FCCM
Coagulation and Blood Research Program
October 23, 2013

COLD PLATELETS ARE:

BEFTER

- Better hemostatic function:
  - \textit{in vitro} and clinical data demonstrate better:
    - Clot strength
    - TEG
    - Aggregation
    - Metabolics

\begin{figure}
\centering
\includegraphics[width=\textwidth]{cold_platelets}
\caption{Cold platelets form stronger clots compared to room temperature (RT)\textsuperscript{*}}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{becker_study}
\caption{Becker Study 1973}
\end{figure}
COLD PLATELETS ARE:

SAFER

- Reduced bacterial growth
- Less inflammatory material released
- Longer shelf life:
  - could potentially ship from CONUS (fully tested for TTDs)

Bacterial risk without refrigeration!


- 1 in 2,000 Apheresis Platelet transfusions
- 1 in 3,000 pooled platelet transfusions

- 1 in 25,000 platelet transfusions
- 1 in 250,000 RBC transfusions

Less bacteria with refrigeration!


- 6°C with ThromboSol
- 22°C control PCs


Bacterial load (colonies/mL)

Fresh Whole Blood

- There is fresh experience and a new enthusiasm
- The science of transfusion is evolving
- Chimerism and transfusion transmitted infection are potential rate limiting steps
- Check out THOR

Plan for Platelets and Whole Blood in Pre-hospital

- First do no harm
- Pre-hospital extension of care in ED
- Platelets in early resuscitation phase of injured patient with early signs of shock are dysfunctional: my personal practice is platelet first transfusion for bleeding trauma patients
- Patients bleed whole blood and over 10 million whole blood units have been successfully administered to bleeding trauma patients in combat theater over several wars
- What’s next?
Dilution is inevitable when giving blood components: Is Whole Blood Better for Trauma?

- Whole blood 500 mL
  - Hct 38-50%
  - Plts 150-400K
  - Plasma coag factors = 100%
  - 1500 mg fibrinogen

- Components
  - 1 U pRBC = 335 mL with Hct 55%
  - 1 U platelets = 50 mL with 5.5 x 10^10 Plts
  - 1 U plasma = 275 mL with 80% coag activity
  - 750 mg fibrinogen

Thus: 1U pRBC + 1U platelets + 1U FFP = 660 mL with Hct 29%, Plts 88K/µL, and Coag activity 65% and exposure to 3 donors

US Military Death Distribution

- 4,596 Combat Deaths (2001-11)
- 90% of combat deaths occur before reaching Role 2
  - PRE-HOSPITAL
- 25% of pre-hospital deaths are preventable
  - 90% of these are due to hemorrhage, mostly truncal

Transfusion Medicine

Tenets that need Re-evaluation

- Blood components therapy is as effective or superior to whole blood for patients with severe hemorrhage
- Whole blood is not safe
  - WBCs within whole blood cannot be filtered and are immunologically active
- Whole blood MUST be ABO specific
  - Low titer group O whole blood will cause severe adverse reactions

Change from Whole Blood to Component Therapy

- 70-80’s shift from whole blood to individual blood components
  - Technology made it possible
  - Concept was to provide specific components for single deficiencies
    - Anemia – RBCs
    - Thrombocytopenia – platelets
    - Coagulopathy – plasma
  - No clinical data to support equivalence
Trauma Patients with Massive Bleeding

- Patients don’t have a specific deficit
- Trauma resuscitation dogma became
  - Give fluids and RBCs first since this will treat the shock
  - Wait for documented coagulopathy
    - Plasma
  - Wait for documented thrombocytopenia
    - Platelets

Whole Blood Availability Became Restricted

- Inability to leukoreduce and maintain platelets
- Hard to maintain inventory of ABO specific whole blood
- Concept that platelets at 4C are non-functional

Questioned Dogma: Component Therapy is Equivalent or Superior to Whole Blood for Hemorrhagic Shock

- Previously thought that patients with massive hemorrhage will benefit from use of individual blood components to treat specific deficits
  - Shock is primary problem so give RBCs to reverse shock
  - RBCs at storage age transfused suboptimal for O2 delivery
  - Hemostasis supported by 30% of coagulation factors
    - Plasma can be given later in resuscitation
    - THIS IS FALSE!
  - Platelets are not required early in resuscitation of bleeding patients
    - Can be given late once count is low
    - THIS IS FALSE!

Rationale for Whole Blood Superiority to Components

- More concentrated product vs. reconstitution of whole blood with components in 1:1:1 unit ratio
  - Fresh product
    - Improved efficacy
  - Avoids storage lesion
    - Improved safety
    - Improves efficacy

Fresh whole blood use by forward surgical teams in Afghanistan is associated with improved survival compared to component therapy without platelets

TRANFUSION 2013;53:1075-113S.
Shawn C. Nessen, Brian J. Eastridge, Daniel Cronk, Robert M. Craig, Ollie Berthou, Richard Ellison, Kyle Bennick, Jason Sorey, Jami Shah, and Philip C. Spinelli

Nessen Whole Blood at FST Methods

- Retrospective study of prospectively collected data
- 6 FST from 2005-2010
- Included patients transfused any blood products
  - FWB group
    - RBC, plasma, FWB
  - No FWB group
    - RBC, plasma
- Propensity analysis used to adjust for differences between patients transfused FWB or not
  - In hospital mortality was primary outcome
Nessen Whole Blood at FST Results

- 488 patients transfused any blood

| TABLE 1. Admission vitals sign and laboratory data by fresh whole blood (FWB) use |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| FWB use         | No FWB (n = 348)| FWB (n = 50)    | p Value         |
| Age (years)     | 28.4 ± 15.3     | 29.1 ± 14.7     | 0.06            |
| Sex, male (%)   | 53 (27.8)       | 14 (27.9)       | 0.77            |
| Mean [Hb] (g/dL)| 13 ± 2 (11.0-15.3) | 14 ± 2 (12.3-15.0) | 0.05          |
| SVO2 (%)        | 72 (66.7)       | 75 (70.6)       | 0.09            |
| SO2 (%)         | 106 (94.1)      | 108 (106.0)     | 0.06            |
| Annual BP (mmHg)| 110±17 (80-130) | 112±21 (80-140) | 0.08            |
| Annual Hb (%)   | 65 (60-70)      | 67 (60-70)      | 0.08            |

Mortality

- No FWB, 8.8%
- FWB, 5.3%

| TABLE 6. Propensity score used as continuous variable in logistic regression predicting effect of FWB on death |
|---------------------------------------------------------------|-----------------|-----------------|-----------------|
| FWB use            | Odds ratio | 95% CI | p Value |
| No FWB             | 0.088      | 0.0004 | 0.0013 |
| FWB use            | 0.078      | 0.0007 | 0.0018 |
| Glasgow coma score | 0.12       | 0.001  | <0.001 |
| Propensity score   | 0.72       | 0.14   | 0.019  |

Questioned Dogma #2: Whole Blood Must be ABO Specific

- If whole blood is not ABO specific
  - High risk of hemolysis and adverse effects

Dogma Challenge #2

- Low titer Type O whole blood is actually safer than ABO specific whole blood.
  - This would allow for increased availability
    - Inventory needed to stock just low titer Type O

Multi-disciplinary and Multi-National Review

SHOCK, Vol. 43, Supplement 1, pp. 30-73, 2014

LOW TITER GROUP O WHOLE BLOOD IN EMERGENCY SITUATIONS

Gair Strandenes,1 Olle Berus,2 Andrew P. Cap,3 Tor Hervig,4 Michael Rapo,5 Nicolas Prot,6,7 Anne Salitip,6,7 Richard Gonzales,6,7 Clayton D. Simon,8 Paul News,9 Heidi A. Daughey,10 Philip C. Spinella,8,11 and Einar K. Kristofferson8
1Department of Immunology and Transfusion Medicine, Rikshospitalet University Hospital, and 2Norwegian National Special Operation Command, Bergen, Norway; 3Department of Transfusion Medicine, Oslo University Hospital, Oslo, Norway; 4Lund University, Lund, Sweden; 5US Army Institute of Surgical Research, FT Sam Houston, Texas; 6Institute of Clinical Science, The University of Bergen, Norway; 7Australian Defence Force Joint Health Command, Centenary, Australian Capital Territory; 8French Ministry of Medical Service, Clermont, France; 9Commander French Military Blood Transfusion Centre, Clermont, France; 10Director, US Army Blood Programs and 11US Army Transfusion Medicine Consultant to the Surgeon General, San Antonio Military Medical Center, JBSA, Fort Sam Houston, Texas; 12Transfusion Medicine Division, army reserve Medical Institutions, Baltimore, Maryland; 13HHS Blood and Transplant, Birmingham, England, United Kingdom; and 14Division of Pediatric Critical Care, Department of Pediatrics, Washington University in St Louis, St Louis, Missouri.

Conclusion: Low Titer Group O is preferred alternative for emergency transfusions where safe ABO identical transfusions cannot be ensured

Royal Caribbean Cruise Liners

- 100,000 guests plus 37,000 crew at sea in 34 different ships each day
- Many guests, elderly, overweight, over-eating and on anticoagulants
- High risk of GI bleeding
- Often vessels 24 hours from any port
- Operationalized a Fresh Whole Blood Transfusion Program
  - Recurrent training and education of 250 medical personnel
  - Screening questionnaires, rapid ABO typing and infectious disease testing
  - 40 months there were 40 whole blood emergent transfusions
  - 1-6 Units per patient
  - One allergic reaction, no infectious complications

When somebody says whole blood just can’t be done…….
Platelets in Trauma Resuscitation

- Room Temp agitator in ED plan 07/2013
  - Logistical exercise
  - No pbml getting pts delivered to pt bedside
  - Easily delivered to ED: not the point
    - Logistics
    - Shelf life
    - Function
    - Efficacy
  - Jumbo pts debated (2 vs 1 unit plasma)
  - Agitator and location debated
  - If we can do it in trauma resusc area, we can do it in the pre-hospital arena

Platelets in Trauma Resuscitation

- Programmatic pause for 4 months
  - Safety first
  - Agitator operational
  - Construction
  - Platelets in trauma bay by 15 February 15
  - Cold platelet option discussed
    - HOLD on program until final variance and decisions made to eliminate confusion and defeatism (prevent the skeptics from saying: “I knew this was a bad idea”)
    - We now have cold stored platelets in the ED and a platelet first transfusion strategy for hemorrhage

Stored Whole Blood

- O low titer universal donor
  - Trauma patients only
  - Filtered? CMV risk?
  - 4 faculty with vast personal experience
    - Meet established criteria for 1:1:1
  - Prove safety and efficacy
    - Then move platelets and whole blood to pre-hospital
    - Close monitoring of safety
    - Close monitoring of efficacy
    - Kick off date = 14 December 2015

Time Frame

- Warm platelets in the ED for 6+ months: done
- ED cold platelets: done
- Cold stored whole blood: O vs O + A = O
- Helicopter phase: depends upon above
  - The more products, the tougher the logistics for everyone
  - Our prehospital use profile goes well beyond trauma patients

Our Work Thus Far

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<tr>
<th>Month</th>
<th>Total WB Transfused</th>
<th>Total PLTs Transfused</th>
<th>Cold PLT only</th>
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Conclusion

• Just ‘do it’ versus ‘focused empiricism’
• Long track record of pre-hospital blood use, whole blood use, TEG use, StO2 use, careful PI process and stringent training protocol
• Renewed focus on all aspects of hemorrhage control, early hemostatic resuscitation and undeniable success in our trauma system
• Refrigerated platelet and whole blood use in the infancy stage but useful and successful thus far
• You make the call