Fluid Resuscitation in Trauma

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Areas to consider

- Background
- How sick is the patient
- Crystalloid vs blood products
- Ratio and timing of Blood products
- Restrictive vs permissive fluid resuscitation
- Other Bits and Pieces
- Children
Haemorrhage in trauma

- 40% trauma deaths in civilian practice due to haemorrhage
- Haemorrhage is the number one cause of potentially avoidable death on the battlefield
- 50% of those who die do so from exsanguinating haemorrhage.
Trauma induced coagulopathy

- About $\frac{1}{4}$ patients coagulopathic on arrival
- 4 times more likely to die if coagulopathic
- Cause of Coagulopathy incompletely understood
- Patient factors influencing coagulopathy
  - Severity of tissue trauma (ISS)
  - Level of shock pre-hospital
  - Consumption
- Hypothermia, dilution, acid load and Inflammation
Stanworth et al, Critical Care, 2010

- International database study of 5,693 cases
- No plateau, each unit transfused associated with increased risk of death
  - 0 – 5 units mortality 9%
  - 6 – 9 units mortality 22%
  - $\geq 10$ units mortality 42%
Risks of Transfusion - Infection

- **Bacterial** – more common in platelet transfusions – 40 per million components
- **Viral** – Hep B – 2.2 per million, HIV – 0.22 per million
- **UK** – 49 transfusion transmitted infections 1996 - 2004
- **Prion** – 3 known transfusion transmitted infections from 66 infected units
- **Number prion infections decreasing since 1999**
- **Parasitic** – malaria
Risks of Transfusion – Immune mediated

- Anaphylaxis 1 in 20,000 – 50,000
- Transfusion Related Acute Lung Injury – TRALI
  - More common with FFP, esp. from female donors
  - Incidence falling with screening of women donors
  - Incidence 1 per 3.2 million FFP units
Risks of Transfusion – Immune mediated

- Transfusion Related Immune Modulation – TRIM
- Effects on rejection of transplants, tumor growth and infection rates
- Meta analysis of 5,993 trauma patients
  – odds ratio for association of blood transfusion to post op bacterial infections, 5.26

- Not known if transfusion a marker of increased morbidity of patient, or cause of increased morbidity
How sick is the patient
(and are they just trauma sick)

- Sometimes difficult to tell
- Were they sick before the trauma (dehydrated, drunk, neglected, drugs)
- ATLS classification?
- Scoring systems?
Scoring systems to predict massive blood transfusion

- ATLS classification very specific but not sensitive
- Assessment of Blood Consumption (ABC)
  - Developed and validated in USA with high amounts of penetrating trauma
  - In Australia (low penetrating trauma) sensitivity 46%
- Trauma Associated Severe Haemorrhage (TASH)
  - Low sensitivities (41%) even in development database
- Prince of Wales Hospital (PWH)
  - Poor sensitivity (40%) outside developmental area
Pulse Rate Military casualties

Bar Chart

Acute or Traditional MT
- No MT
- MT

Count
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200

Pulse on arrival
- 0 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- 100 - 110
- 110 - 120
- 120 - 130
- 130 - 140
- 140 - 150
- 150 - 160

Medical Directorate
Systolic BP on arrival military casualties
When considering massive transfusion factor in:

- Age and fitness
- Large abnormalities in observations quite specific
  - Pulse > 120
  - SBP < 90
- Multiple more ‘normal’ observations can be significant
- Consider
  - burden of injury
  - observations
  - physiological derangement
Crystalloid vs blood products

- Blood products (both PRBC and FFP) are bad for you
- Receiving crystalloid when you need blood is worse for you
- Reduction in mortality with higher RBC:FFP ratios may be partly reduction in crystalloid load
- Found both pre-hospital and in hospital
- AVOID CRYSTALLOID if giving blood products acutely
- Colloid probably worse than Crystalloid
Ratio of Blood products: Background

- Multiple studies suggested ratios of RBC:FFP:Platelets should be 1:1:1 or 1:2:1
- Problems in all studies
  - Survivor bias
  - Retrospective or theoretical
- Became generally accepted that ratios between 1:1 and 1:2 FFP:RBC was correct
- Some evidence that need to reach these ratios early rather than later (median death from haemorrhage 2.7 hours in one study)
- Concerns re safety of FFP
Original Investigation

Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients With Severe Trauma

The PROPPR Randomized Clinical Trial

John B. Holcomb, MD; Barbara C. Tilley, PhD; Sarah Baraniuk, PhD; Erin E. Fox, PhD; Charles E. Wade, PhD; Jeanette M. Podbielski, RN; Deborah J. del Junco, PhD; Karen J. Brasel, MD, MPH; Eileen M. Bulger, MD; Rachael A. Callcut, MD, MSPH; Mitchell Jay Cohen, MD; Bryan A. Cotton, MD, MPH; Timothy C. Fabian, MD; Kenji Inaba, MD; Jeffrey D. Kerby, MD, PhD; Peter Muskat, MD; Terence O'Keeffe, MBChB, MSPH; Sandro Rizoli, MD, PhD; Bryce R. H. Robinson, MD; Thomas M. Scalea, MD; Martin A. Schreiber, MS; Deborah M. Stein, MD; Jordan A. Weinberg, MD; Jeannie L. Callum, MD; John R. Hess, MD, MPH; Nena Matijevic, PhD; Christopher N. Miller, MD; Jean-Francois Pittet, MD; David B. Hoyt, MD; Gail D. Pearson, MD, ScD; Brian Leroux, PhD; Gerald van Belle, PhD; for the PROPPR Study Group
PROPPR

- 680 patients
- Randomised to 1:1:1 or 1:1:2
- Primary outcomes 24 hour and 30 day mortality
- No significant difference found between groups (about 4% non significant improvement in mortality in 1:1:1 group with significant reduction in deaths from haemorrhage in first 24 hours)
- No evidence that FFP caused increased complications
- Underpowered for the mortality reduction shown
Hypotensive Resuscitation

- Balance between
  - shock leading to cellular ischaemia
  - Disruption of clot and dilution of coagulation factors

- 1 non randomised trial showed 8% reduction in mortality in penetrating torso trauma when fluid resuscitation delayed until surgery

- 2 other trials showed no difference but considerable methodological problems existed making results unsound
Pre-hospital fluid management of adults and older children following trauma: NICE

- IV fluid should not be administered if a radial pulse can be felt (or, for penetrating torso injuries, if a central pulse can be felt).

- In the absence of a radial pulse (or a central pulse for penetrating torso injuries) it is recommended that IV fluid should be administered in boluses of no more than 250 ml. The patient should then be reassessed, and the process repeated until a radial pulse (or central pulse for penetrating torso injuries) is palpable.
In the patient in front of you

- **Weigh up**
  - length of time they have been hypotensive
  - Your ability to control the haemorrhage
  - Time to surgery or interventional radiology
  - Types of injury
  - Pre-existing medical conditions

- **DO NOT use permissive hypotension in Head Injury patients, shock increases mortality**
Other things

- Use Tranexamic Acid if you think you are going to give blood products
- Hypothermia kills
- Don’t use vasopressors
- Remember calcium
- Check potassium
- Fibrinogen should be substituted at levels of <1.5 g/L
- Massive transfusion protocols seem to increase survival
1014 IO devices were used in 830 adult patients with no major complications. Minor complication rate of 1.38%, mostly device failure.

5124 separate infusions of blood products or fluids occurred via IO access and 32 different drugs were infused to 367 patients.

Used both pre and in hospital.
Haemostatic resuscitation

- Consider moving to bespoke blood product replacement after initial resuscitation
Middle ground

- Very sick and uninjured patients easy
- Many patients fall between the 2 extremes

I Suggest

- Practice permissive hypotension initially (Less HI)
- Examine and add up the abnormalities
- Investigate FAST, CT, Gas, coagulation
- If evidence ongoing bleeding and shock: 1:1 resuscitation
- If bleeding controlled can top up with PRBC alone if anaemic but not shocked or coagulopathic
- If well can they drink?
Children

- Limited evidence, assumed adult research applies
- Children are not small adults but soldiers are big kids
- APLS recommends 10ml/kg boluses
- PHPLS recommends 5ml/kg boluses and giving fluid to a palpable radial
- 5ml/kg roughly equivalent to adult unit, which allows key points (platelets, Calcium etc) to be given at the same intervals
- Minimise fluids other than blood products
Medical Directorate