The principle of 1:1:1 blood product use in the resuscitation of trauma victims



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Annual Controversies and Problems in Surgery

Lack of a plan in your life should not constitute a crisis in mine







Control of vascular haemorrhage

Local

- Press on it!
- Local haemostatic agents

Regional

- Source control
- Tourniquet
- Stent / embolize

Systemic

Maximize coagulation parameters





Adjuncts to bleeding control

• The commonest cause of bleeding... is Factor XIV deficiency

Factor XIV = The surgeon!





Adjuncts - Local

- Mechanical (tourniquets and plugs)
 - Foley Catheter
- Fibrin Sealants
 - Dry fibrin sealant dressing
 - Tisseel[®]
 - Floseal[®]
- Chitosan Dressing (Hemcon[®] / Celox[®])
- QuickClot[®]
- Surgicel[®]
- Gelfoam[®] (Thrombin)





Chitosan (Hemcon[®])

- Extracted from mollusc shells (e.g. shrimp / prawns)
- Muco-adhesive
- Quality control difficult







Zeolite (QuikClot®)

- Lava Product Granular zeolite
- Absorbs water
- Exothermic
- "Tea bags"







Tourniquets



Adjuncts: Regional







Stent / embolise



Coagulopathy

- After direct bleeding, coagulopathy is the commonest cause of bleeding-related mortality
- Pathogenesis is complex and multifactorial
- Vascular injury and haemorrhage causes direct loss of
 - Circulating volume
 - Cells
 - Clotting factors
 - Platelets





Impact of transfusion on complications following trauma



1. Malone DL et al. J Trauma 2003; 898-905.

2. Claridge JA et al. Am Surg 2000;68:566-72.

Blood transfusion requirement has a greater predictability of mortality than ISS



Units RBC Administered

ISS and mortality as a function of the number of RBCs given. The increase in mortality with greater transfusion was highly significant (p=10⁻⁶). ISS was significant only for the 1-10 units group (p=10⁻¹³)

Blood transfusion is like marriage...

It should not be entered upon lightly, unadvisedly or wantonly...



or more often than is absolutely necessary."

Would the FDA grant a licence for blood as a drug in 2016?

Minimise blood use

Minimize blood loss

- Optimise conditions
- Avoid haemodilution or starches
- Avoid hypothermia
- Recombinant Factor VIIa(?)
- Minimise transfusion requirements
 - Haemostasis
 - Haemoglobin Oxygen carriers (HBOC's)
- Massive haemorrhage protocol





Bickel (Houston) Study - 1994

In hypotensive patients with penetrating torso injury, survival improved when resuscitation was delayed until surgical control of haemorrhage had been achieved

> Bickell WH, Wall MJ Jr, Pepe PE, et al: Immediate versus delayed fluid resuscitation for hypotensive patients with penetrating torso injuries. N Engl J Med 331:1105, 1994

Subset analysis showed that this was actually only the case in penetrating cardiac injury, but not in major vascular, abdominal, or non cardiac thoracic injury





Adjuncts to bleeding control

- Red cells
- White cells
- Platelets

The US army has discovered that if you add thes together, you get something called "whole blood"





Fresh whole blood

- More function than purely that of an oxygen carrier
- Oncotic pressure
- Coagulation function
- Temperature homeostasis
- Constituents are in natural proportions
- After 24 hours
 - Factors V and VIII levels decline quickly
- After 3 days
 - No platelet fucntion





PROMMT Study

- Prospective Observational Multicenter Major Trauma Transfusion Study
- Objective
 - To relate in-hospital mortality to early transfusion of plasma/ and/or platelets and to time-varying plasma: red blood cell: platelet ratios
- Design
 - Prospective cohort study documenting transfusion outcomes during active resuscitation in 10 US Level I trauma centres
- Outcome measure
 - Mortality

Conclusion

• Higher plasma and platelet: Blood ratios were associated with a decreased mortality in patients who received transfusions of at least 3 units.





PROPPR Trial

- 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
- Objective
 - Effectiveness and safety of transfusion patients with major bleeding using plasma, platelets and red blood cells in a 1:1:1 or 1:1:2 ratio
- Design
 - 680 injured patients directly from scene and requiring a massive transfusion
- Outcome
 - 24 hour and 30 day mortality. Ancillary outcomes included time to haemostasis, blood product volumes transfused, complications.

Conclusions

- No significant differences in mortality 1:1:1 or 1:1:2 ratios
- More patients in the 1:1:1 achieved haemostasis and there were fewer deaths



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 JAMA 2015; 313(5): 471-482



Adjuncts - Systemic

- Whole blood
- Aprotinin
- Tranexamic acid
 - Selected cases
- Desmopressin
 - No evidence of efficacy in trauma
- Recombinant FVIIa
 - Used in haemophilia
 - Poor activity if pH > 7.1
 - Limited evidence for use in trauma
 - Should not be used as a therapy of last resort





Tranexamic acid (TXA)

CRASH-2 Study

- Data primarily from developing countries
- 20,000 patients
- - WITH TXA 10,000 Patients, 1400 died
- WITHOUT TXA 10,000 patients 1600 died
- BOTH groups only received 3 units of blood
- NO data regarding mortality or causes

Tranexamic acid administration

- Selected cases only do NOT use for every case
- Rural areas
- Some military applications





Thrombo-Elastogram (TEG)



Thrombo-Elastogram (TEG)







r = reaction time	< 8 mir
K = Kinesis time	< 2
α = Alpha angle	> 70°
mA = Max amplitude	> 50
Lys _{30 =} Lysis	< 8%

Visco-elastic studies

A10:

15mm

MCF:

15mm

ML:

Increased r time

- Fresh frozen plasma
- Clotting factors
- rFVIIa
- Decreased α angle
 - DDAVP
- Increased k time
- Fibrinogen
- Decreased mA
 - Platelets

Increased Ly₃₀

• Tranexamic acid





A10:

49mm

HCF:

53mm

HL: *

14%

Baseline bloods

- Hb and Platelets
- TEG / ROTEM
- Fibrinogen
- PT, aPTT, INR
- D-dimer
- Repeat after every 6 Units





Transfusion guidelines

- Use emergency blood if necessary
- Micro-aggregate filters not advised
- Use packed red cells (PRBC)
- Use leucodepleted blood if massive transfusion expected
- Use cross-matched blood if available
- Administration after 2 units 1:1:1 Blood : FFP : Platelets





If ongoing blood loss expected, initiate massive haemorrhage protocol



Summary

- Blood transfusion is a last resort
- ...and an admission of failure of haemostasis
- Haemostasis must be GOAL DIRECTED

All aspects and participants must be heading in the same direction







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