Bleeding In The Trauma Patient: When More Sutures Won’t Fix The Problem

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Trauma is a serious global health issue

- 5 million people are killed every year worldwide as a consequence of trauma (10% of worldwide deaths)\(^2\)

- In 2002 road traffic accidents were responsible for a similar number of deaths as cancers of the lung, bronchus and trachea (1,239,000)\(^1\)

- By 2020 an estimated number of 8.4 million people will die as a result of trauma\(^3\)

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MVA: motor vehicle accidents

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1. WHO. World Health Report 2003
Bleeding: Major Cause of Death in Trauma

MOF: 7%
Other: 4%
Unknown: 2%
CNS: 42%
Bleeding: 39%
Bleeding + CNS: 6%

n=289

Sauaia A et al. J Trauma 1995;38:185-93
Goals of Trauma Resuscitation: Primary Survey (A,B,C,D,E’s)

• Hemorrhage control, maintenance of blood volume, and restoration of circulation are specific aims
• Circulating blood volume is maintained by:
  - replacing lost blood using crystalloid and red blood cells
  - preventing further blood loss through surgery AND an effective coagulation process
• However:
  - transfusion increases the risk of complications
  - coagulation process may be compromised (coagulopathy)
Complications increase with transfusions following trauma

Relationship between units of transfused blood in the first 12 hours and the incidence of MOF

- p<0.001

Association between 0-15 units of pRBCs and infection rate

- y = 0.1375e^{0.1187x}
- R² = 0.7566
- n=1,593

Blood transfusion requirement has a greater predictability of mortality than ISS

ISS and mortality by number of RBC units 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 ($p=10^{-13}$)

Como JJ et al. Transfusion 2004; 44: 809-813
Coagulopathy is a Major Cause of Bleeding-Related Mortality in Trauma Patients

Failure to clot caused by:

• Consumptive coagulopathy: coagulation factors and platelets are depleted by formation of clot
• Dilutional coagulopathy: resuscitation of hypovolemic shock with intravenous crystalloid dilutes normal clotting proteins and platelets
• Hypothermia: inhibits clotting protein and platelet function, slows fibrin formation
• Metabolic derangements: acidosis and hypocalcemia compromise clotting
Effective Management of Bleeding in Trauma has the Potential to Decrease Early and Late Morbidity and Mortality

- Select injured blood vessels are controlled and damaged organs are repaired or removed
- Bleeding solid organs may not be easily repaired
- Major vascular bleeding sites may be surgically inaccessible (skull base, thoracic inlet, pelvis)
- Attempted surgical control of specific bleeding sites may lead to diffuse coagulopathic bleeding from the surgical sites themselves
- VICIOUS CYCLE (hypothermia, acidosis, coagulopathy, hemorrhage)
Management of Bleeding

• Surgical exposure, direct control
• Parenchymal packing
• Angiographic embolization
• Argon beam coagulator
• Hemostatic agents
• Pelvic binder, external fixator
• Endovascular techniques (stents)
• Damage control surgery
Hemostatic Agents

• Gelfoam: gelatin sponge prepared from purified pork skin; absorbs and holds within its interstices, many times its weight of blood and fluids

• Surgicel: knitted fabric prepared by controlled oxidation of regenerated cellulose, effects hemostasis by its low pH causing denaturation of albumin and globulin

• Avitene: water-insoluble acid salt of bovine collagen, enhances platelet adhesion/aggregation and the release of fibrin

• Topical epinephrine, thrombin: epinephrine solution at 1:10,000 concentration; bovine thrombin spray
Glues and Sealants

- **BioGlue**: two-component adhesive composed of glutaraldehyde and purified BSA. Glutaraldehyde cross-links the BSA molecules to each other and to the tissue protein at the repair site. Polymerizes in 30 seconds.
- **Crosseal**: derived from human plasma. Fibrin sealant, shipped frozen, thawed in 1 minute, no reconstitution.
- **Tisseel VH**: derived from human plasma. Fibrin sealant which requires heating for activation, requires reconstitution.
Novel Hemostatic Agents

- Poly-N-Acetyl Glucosamine (P-NAG): naturally occurring, biodegradable, complex polysaccharide. Isolated from microalgal cultures; chitin or chitosan. Mechanism(?): adhesion to tissues, attraction of platelets, nitric oxide scavenger
easy to apply

The user simply rips open the outer packaging, removes the accelerated clotting sponge and packs it into the wound.

easy to remove

Once the patient has been moved from the scene of injury to the hospital setting, medical personnel simply remove the entire sponge.
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