

# Trauma Resuscitation: Who, What, When and Why

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Trauma Trust

# History

- ▶ Pope Innocent VIII – 1492
  - Venovenous transfusion
  - Donors and recipient died

Acta Anaesth. Belg., 205, 56, 271–282



# History

- ▶ **Andreas Libavious – 1597**
  - Described blood transfusion
  - Silver tubes
  - No recorded attempts

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# History

- ▶ Christopher Wren – 1658
  - Quills
  - Pig bladder

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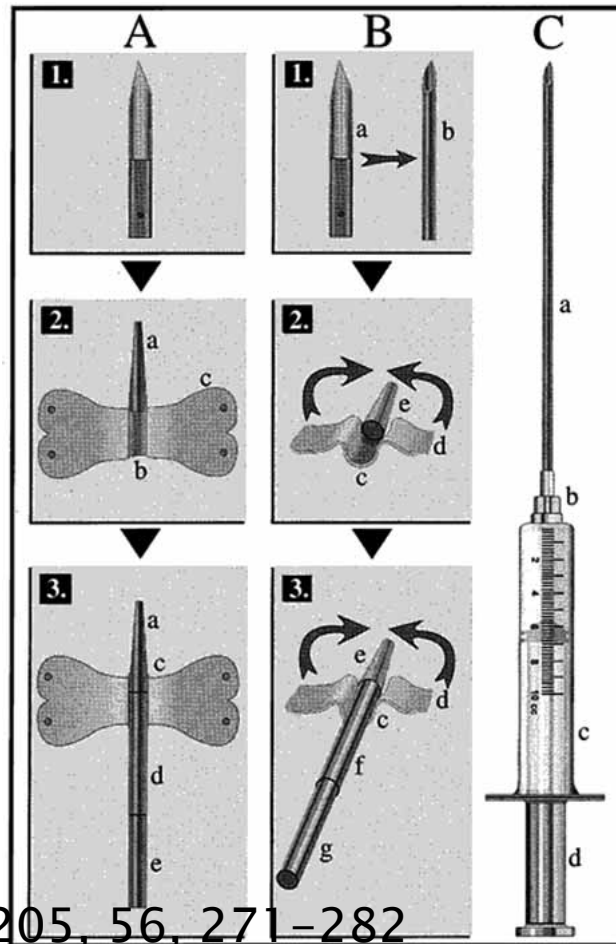


# History

- ▶ Richard Lower – 1665
  - First dog – dog transfusion
  - Instruments to cannulate veins

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Acta Anaesth. Belg., 2005, 56, 271-282

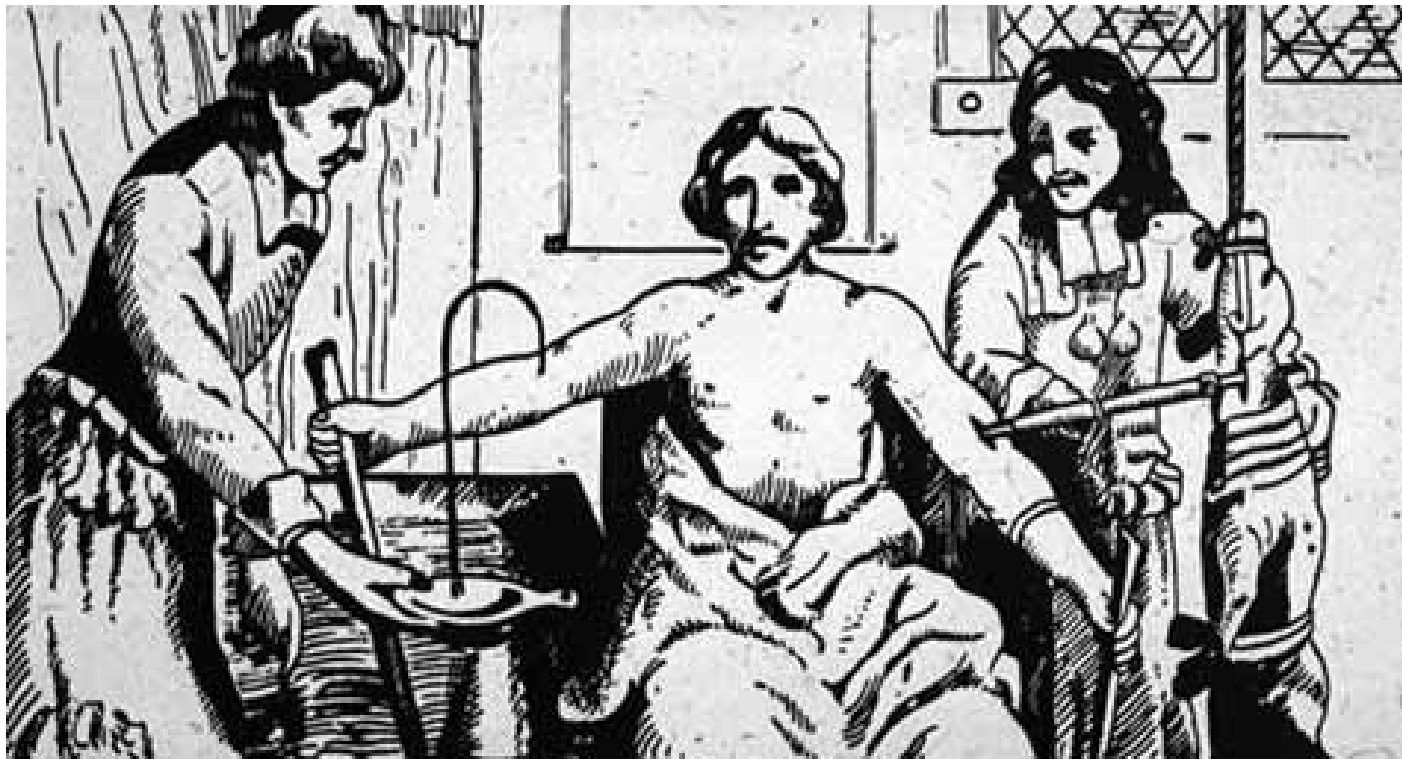


# History

- ▶ Jean Baptiste Denis – 1667
  - Lamb – Human transfusion
  - 9 oz of lamb's blood
  - Subsequent attempts resulted in first documented transfusion reaction
  - Ban on blood transfusion by British Royal Society and the Vatican

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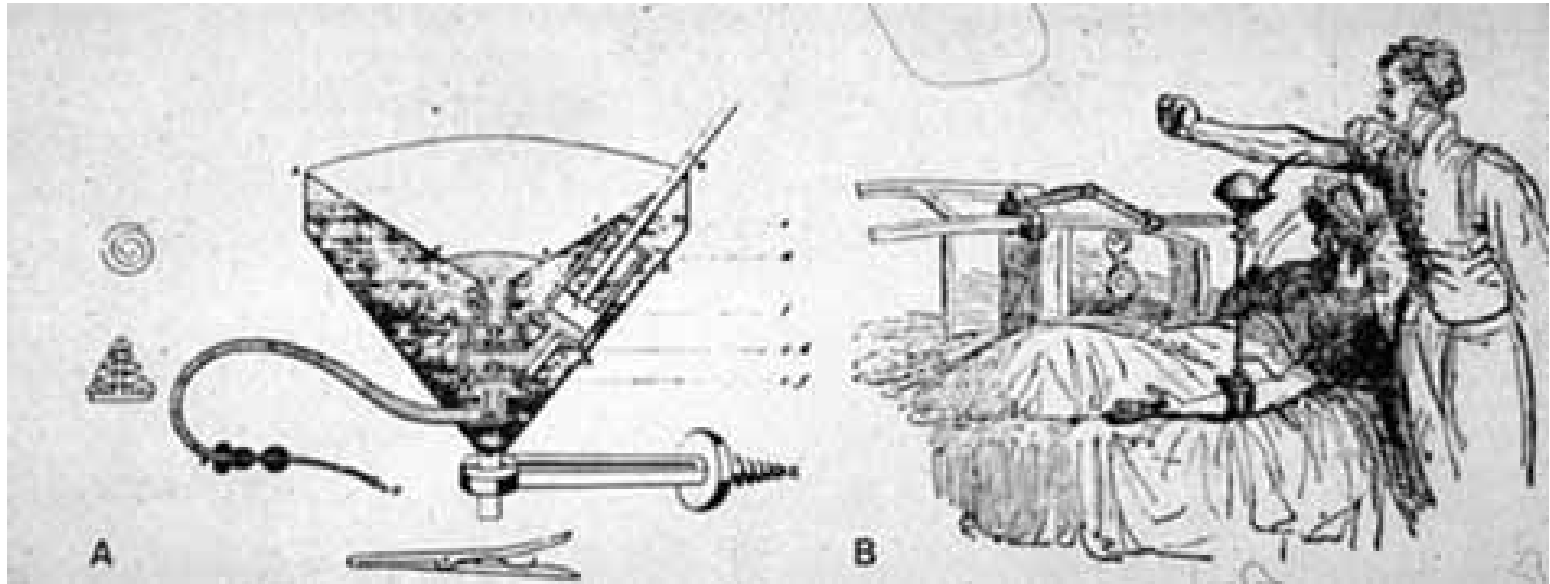


# History

- ▶ James Blundell – 1818
  - Human – Human transfusion
  - Performed 10 transfusions
  - 5 successful

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# History

- ▶ Cholera epidemic 1831–1832
- ▶ “Loosening of the sphincters on both ends, the liquefaction of the gastrointestinal tract, and a pouring out”
- ▶ 1 in 19 effected

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# History

- ▶ William Brooke O'Shaughnessy
- ▶ Cholera epidemic 1831–1832
- ▶ “Normal Salts of the blood”
- ▶ Infused water, salts, and egg white (albumin)

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# History

- ▶ 1843 – sugar solution
- ▶ 1850 – proteins
- ▶ 1869 – fats
- ▶ 1876 – Ringer's solution

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# History

- ▶ 1845 – hollow needle perfected
- ▶ 1853 – metal syringe

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# History

- ▶ Blood Transfusion
  - 1901 – ABO blood types identified
  - 1908 – ABO blood types are inherited
  - 1915 – sodium citrate

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The Graduate



# History

- ▶ **Plastics**
  - Modern day catheters
  - Plastic IV bags
  - Disposable
  - Commercially available

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# Best Practice

## ▶ Literature Review

### ◦ EAST Guidelines

#### • Recommendations

- Level 1 convincingly supported by scientific data
- Level 2 reasonably supported by scientific data and expert opinion
- Level 3 Supported, but scientific data lacking



# Where?

- ▶ Pre-hospital vascular access
  - EAST Trauma Practice Guidelines
    - Level 2 – Placement at the scene should not be attempted
    - Level 3 – Placement during transport is feasible

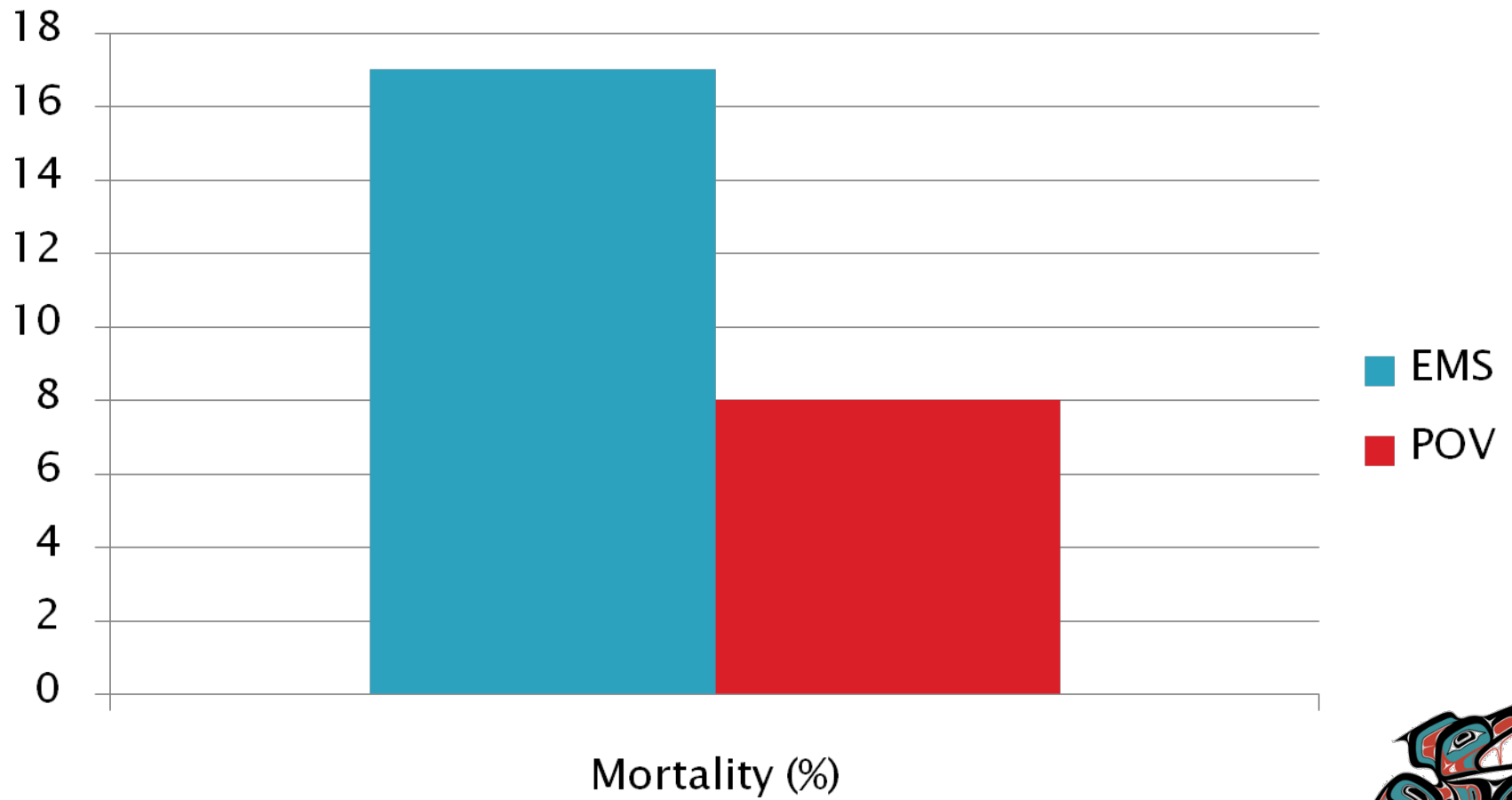


# Pre-hospital Vascular Access

- ▶ No benefit to pre hospital access
- ▶ Scene access associated with increased risk of death
- ▶ Each prehospital procedure reduced the odd of survival by 62%

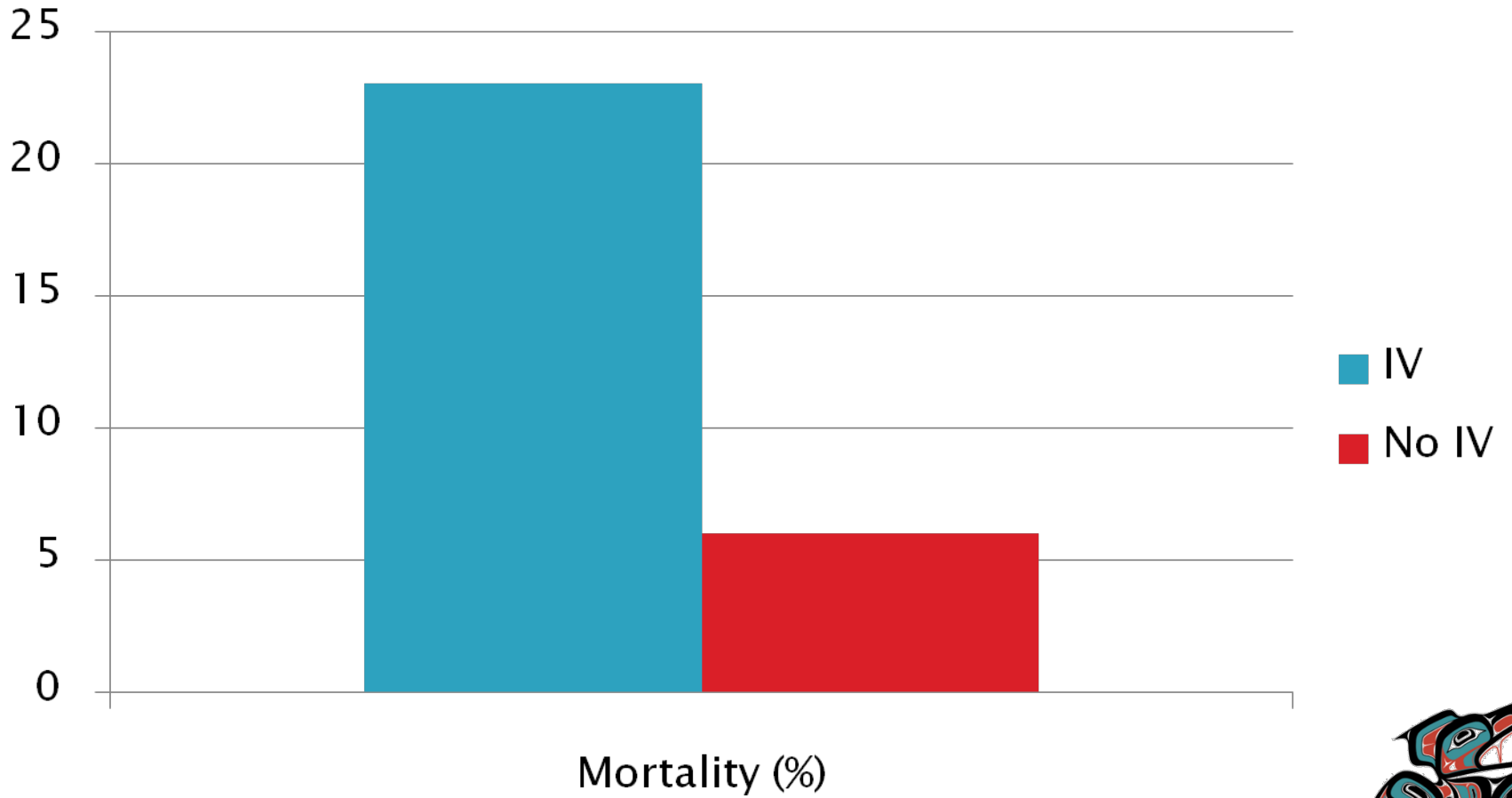
J Trauma 2007 July;63(1):113-20  
J Trauma 1997 October;43(4):608-15  
J Trauma 1993 September; 35(3):460-6





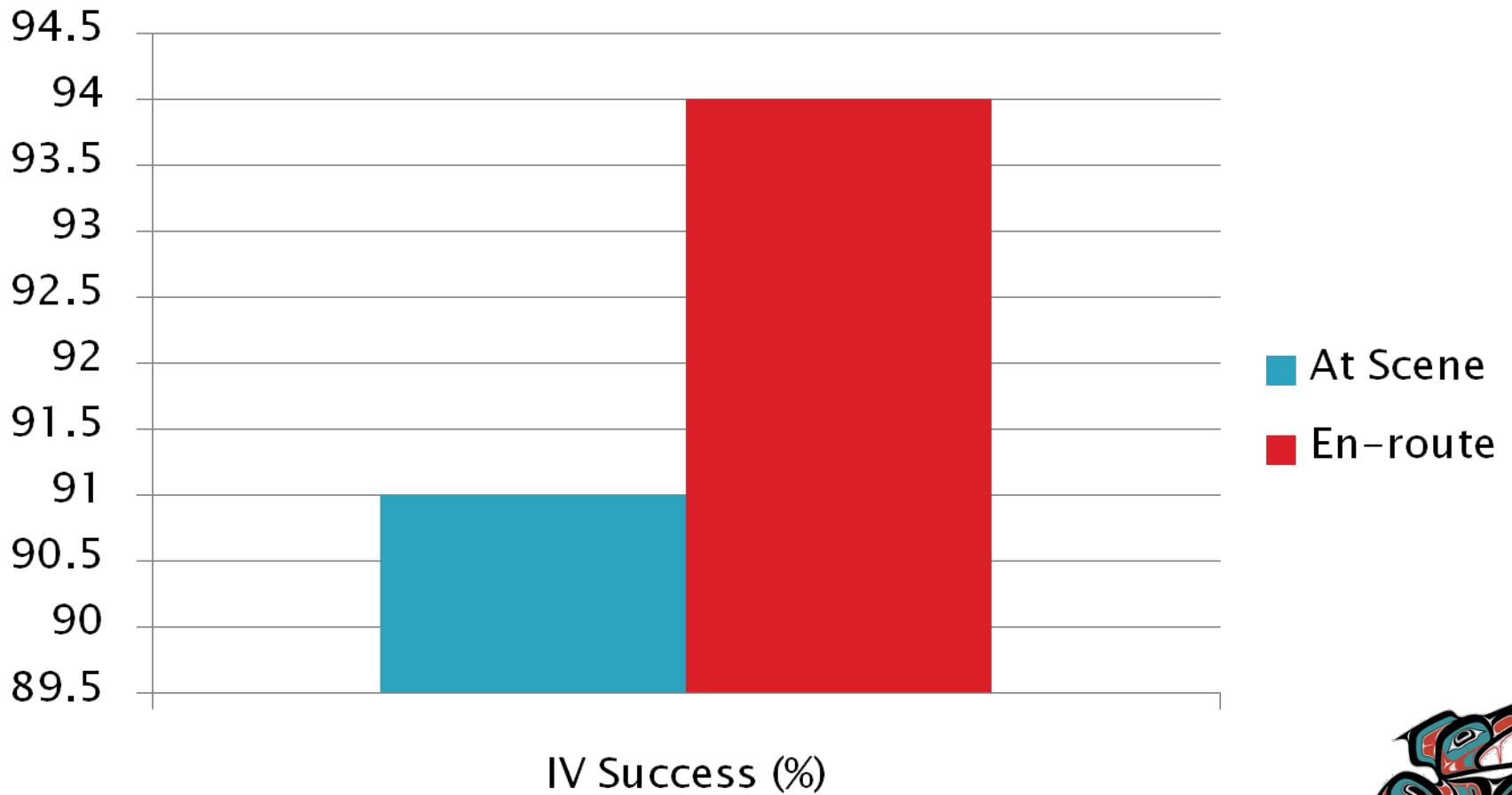
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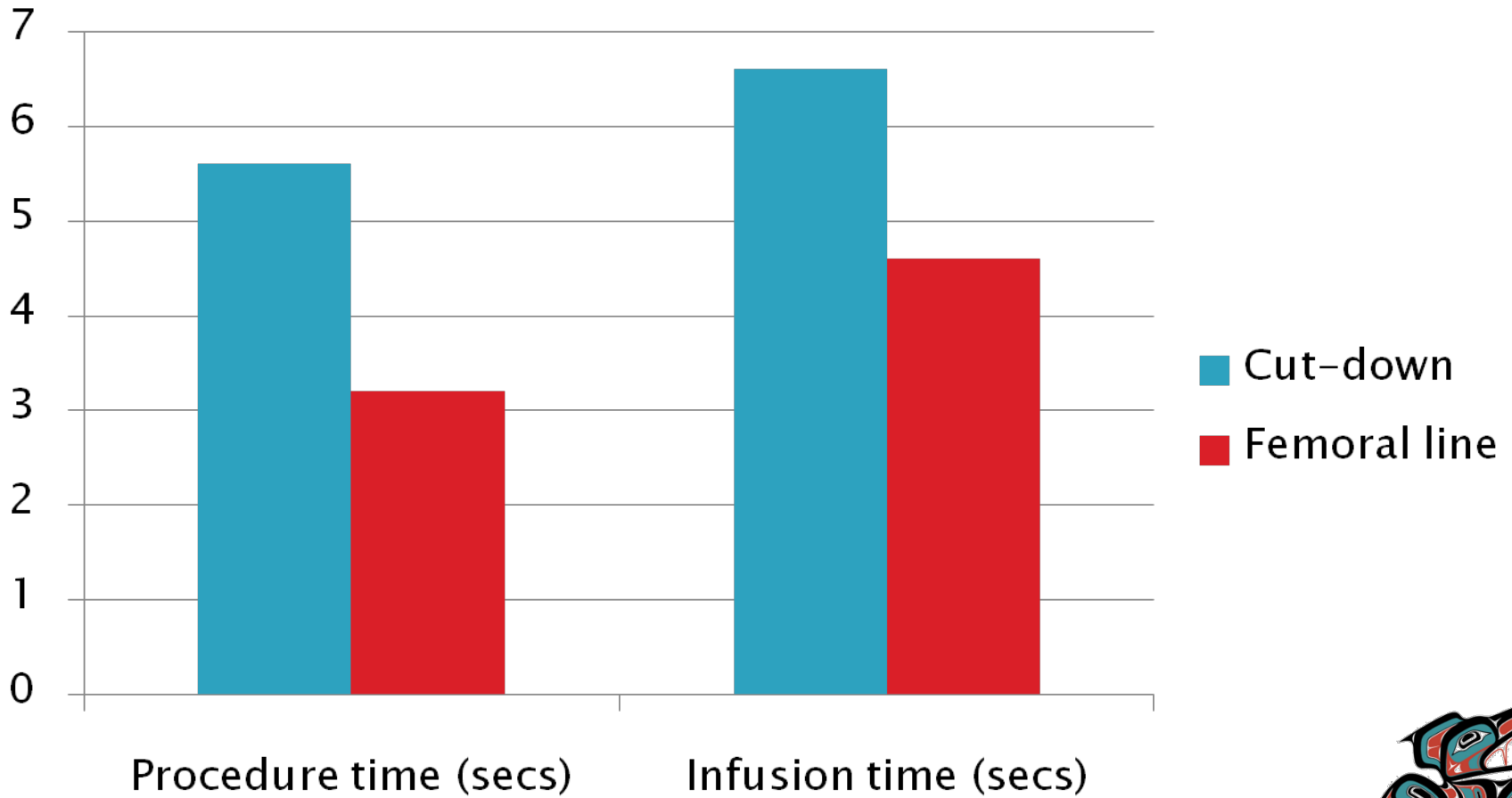
Ann Emerg Med 1989 March;18(3):244-6



# How?

- ▶ How should access be obtained
  - EAST Trauma Practice Guidelines
    - Level 2 – Percutaneous preferred over cut-down  
Intra-osseous indicated after 2 failed attempts
    - Level 3 – Limit attempts to 2





Ann Emerg Med 1994 March;23(3):541-5



# Flow rates

- ▶ Peripheral 14–18 ga
- ▶ 8.5 fr Sheath
- ▶ 8.0 fr catheter

J Emerg Med 1990 March;8(2):173–6  
Air Med J 1997;16(1):7–10



# Intraosseous

- ▶ Success rates 72–87%
- ▶ Insertion time similar to IV
- ▶ Sites include proximal tibia, sternum, humeral head
- ▶ Infusion rate only that of 21 ga



# When?

- ▶ Prehospital resuscitation
  - EAST Trauma Practice Guidelines
    - Level 2 – Intravenous fluids should be held in patients with penetrating torso injuries
      - Saline–lock equivalent to continuous infusion
    - Level 3 – Fluid should be withheld until active bleeding addressed
      - IV fluid should be titrated for palpable radial pulse using small boluses



# Pre-hospital Resuscitation

- ▶ No benefit from fluid administration in field
- ▶ 80% received less than 600 mls of fluid
- ▶ Mortality the same in patients with fluid and without fluid
- ▶ No survival benefit with fluid administration
- ▶ Delays transport of critically ill

J R Soc Med 1995 April;88(4):213P-6P

J Trauma 1990 October;30(10):1215-8

Prehosp Emerg Care 2002 October;6(4):417-20



# Pre-hospital Resuscitation

- ▶ Despite lack of pre-hospital fluid
  - Mean arrival BP the same
  - Intra operative blood loss decreased
  - LOS shorter
  - Mortality rate lower

N Engl J Med 1994 October 27;331(17):1105-9



# What?

- ▶ Prehospital resuscitation
  - EAST Trauma Practice Guidelines
    - Level 1 – No one fluid appears better than others
      - 250 ml bolus of 3 and 7.5% Saline equivalent to 1000 ml bolus of NS
    - Level 3 – Administration of blood pre-hospital is safe and feasible



# Fluid

- ▶ Isotonic fluids equivalent
- ▶ Hypertonic saline preferred in austere environments
- ▶ Blood transfusion pre hospital feasible, but wastage high



# How Much?

- ▶ How much fluid to give?
  - EAST Trauma Practice Guidelines
    - Level 2 – KVO rates adequate
    - Level 3 – Rapid infusion devices should not be used pre-hospital



# Fluid Boluses

- ▶ More bleeding seen with bolus vs continuous
- ▶ Rapid infusers associated with 5 time mortality risk
- ▶ Resuscitation to “lower expectations” did not affect mortality



# Summary

- ▶ Rapid transport to hospital key
- ▶ Delay in transport to obtain IV access not warranted
- ▶ Saline lock may be better alternative than any fluid given pre-hospital



# In Hospital

- ▶ Hemorrhage control primary consideration
- ▶ 1:1:1 improves outcomes
- ▶ Resuscitation endpoints remain unclear



# What was true then is true now

- ▶ Uncontrolled hemorrhage remains the leading preventable cause of death following trauma
- ▶ Incidence as high as 15% in severe trauma
- ▶ Mortality ranges between 20% and 50%

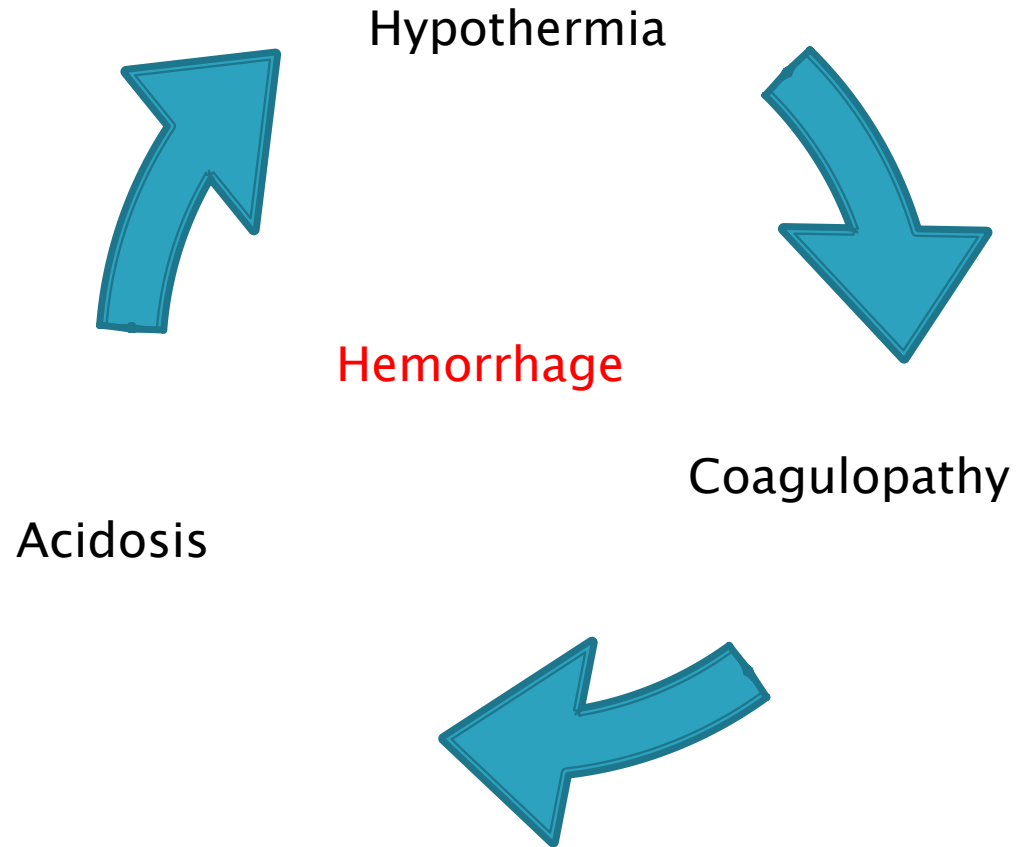
Gruen RL, et. al. Ann Surg. 2006 Sep;244(3):371–80.

Huber–Wagner S, et.al. Vox Sang. 2007 Jan;92(1):69–78.

Sauaia A, et. al. J Trauma. 1995  
Feb;38(2):185–93.



# Circle of death



# Stop the Bleeding

- ▶ External bleeding
  - Pressure dressing
  - Whip stitch/staples
  - Traction/splinting/pelvic binder
  - Tourniquet
  - OR
- ▶ Internal bleeding
  - OR
  - IR



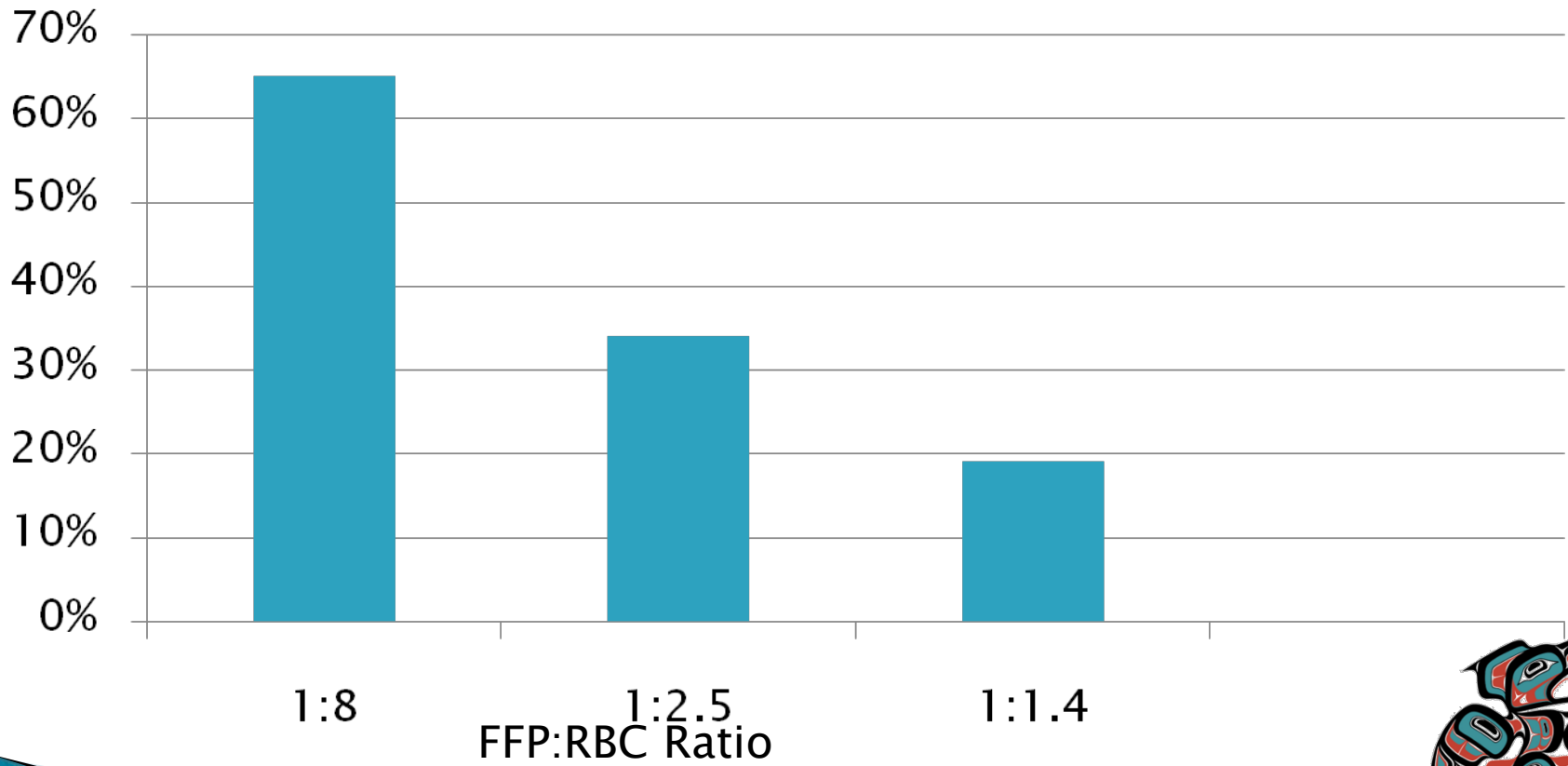
# Correct Physiology

- ▶ Coagulopathy
- ▶ Anemia
- ▶ Thrombocytopenia



# Massive Transfusion Protocol

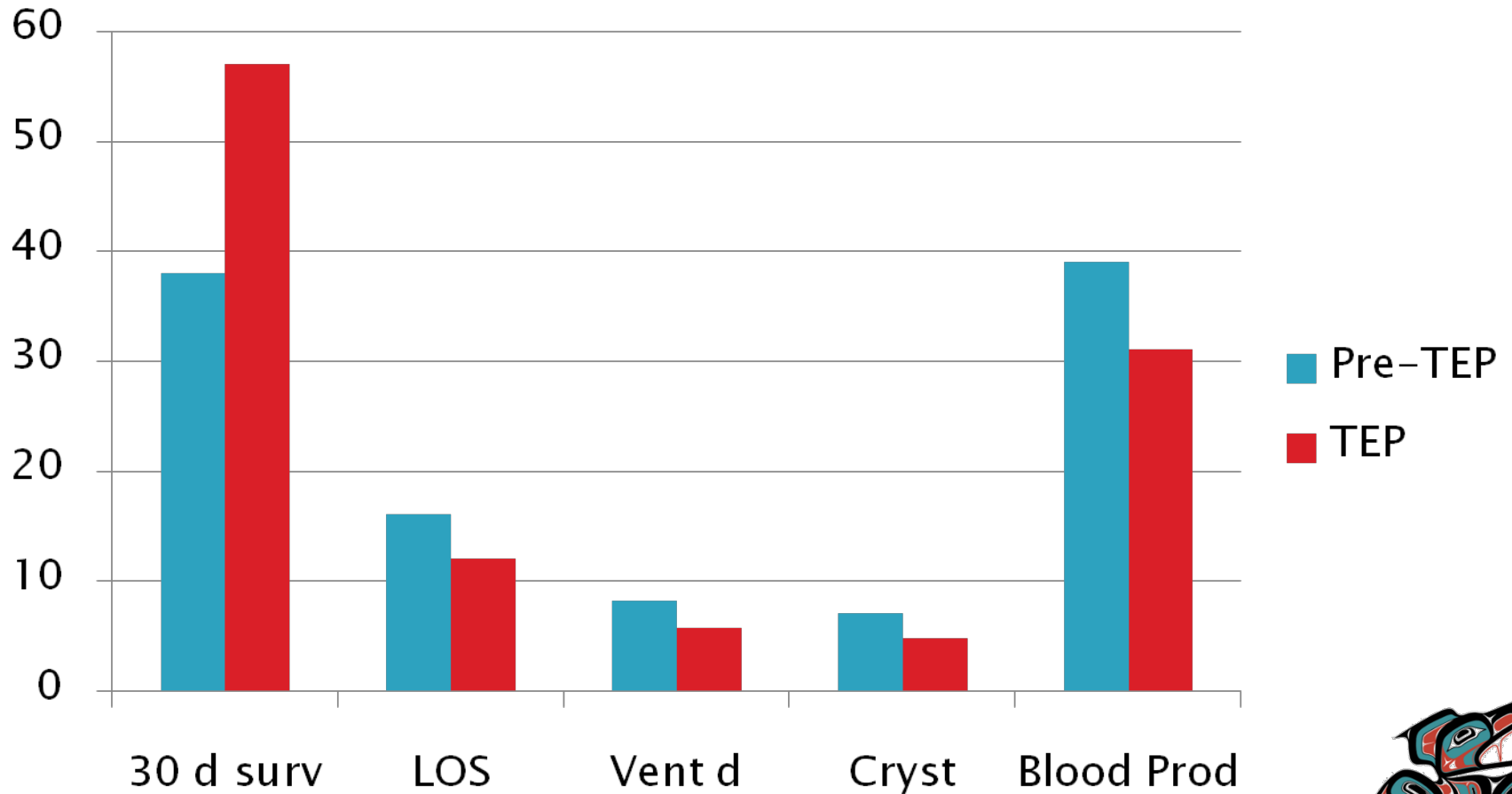
## Mortality



Borgman MA, et al. J Trauma Oct 2007;63(4):805-813.



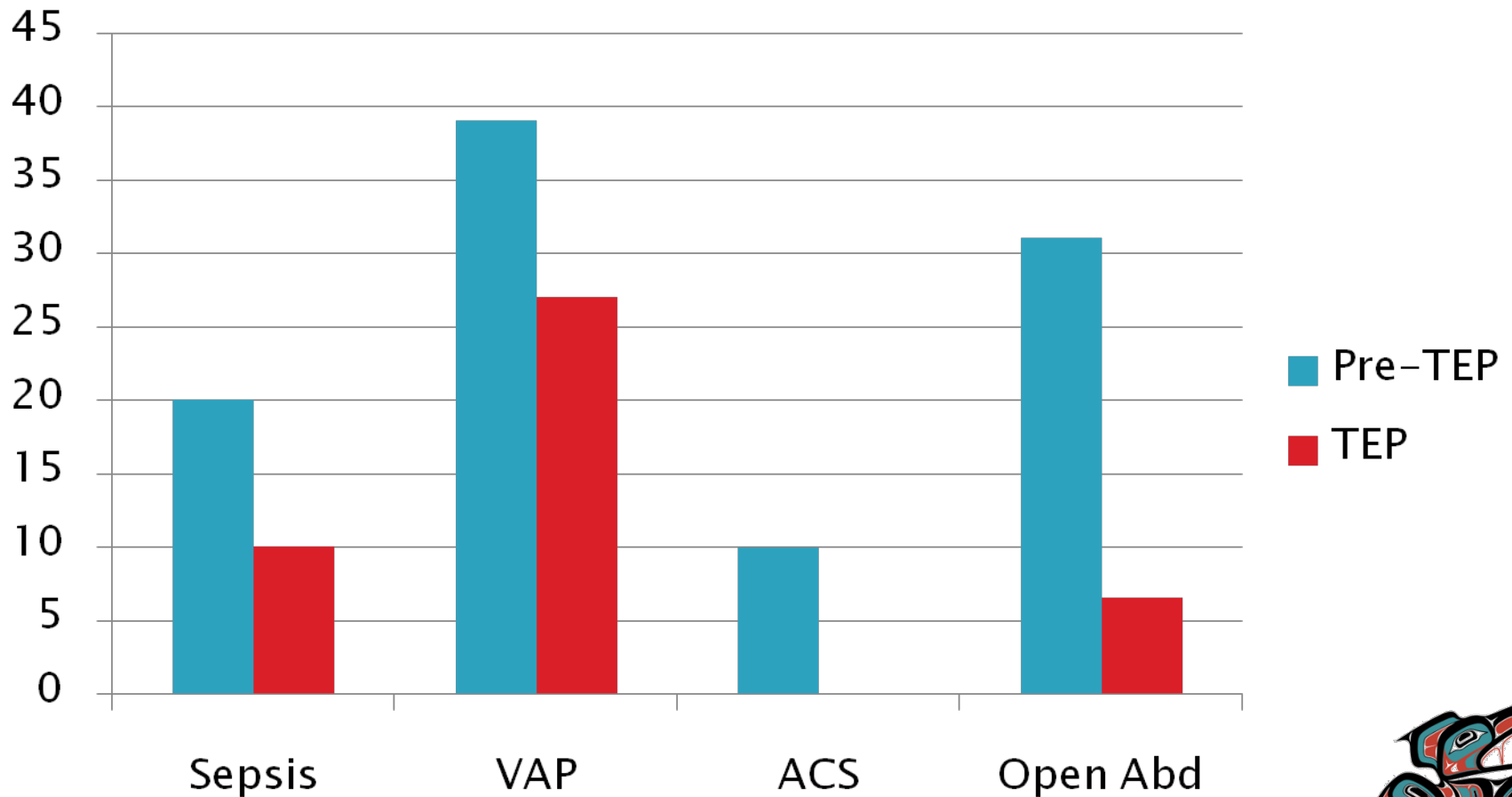
# Massive Transfusion Protocol



Cotton BA, et al. J Trauma Jan 2009;66(1):41-49.



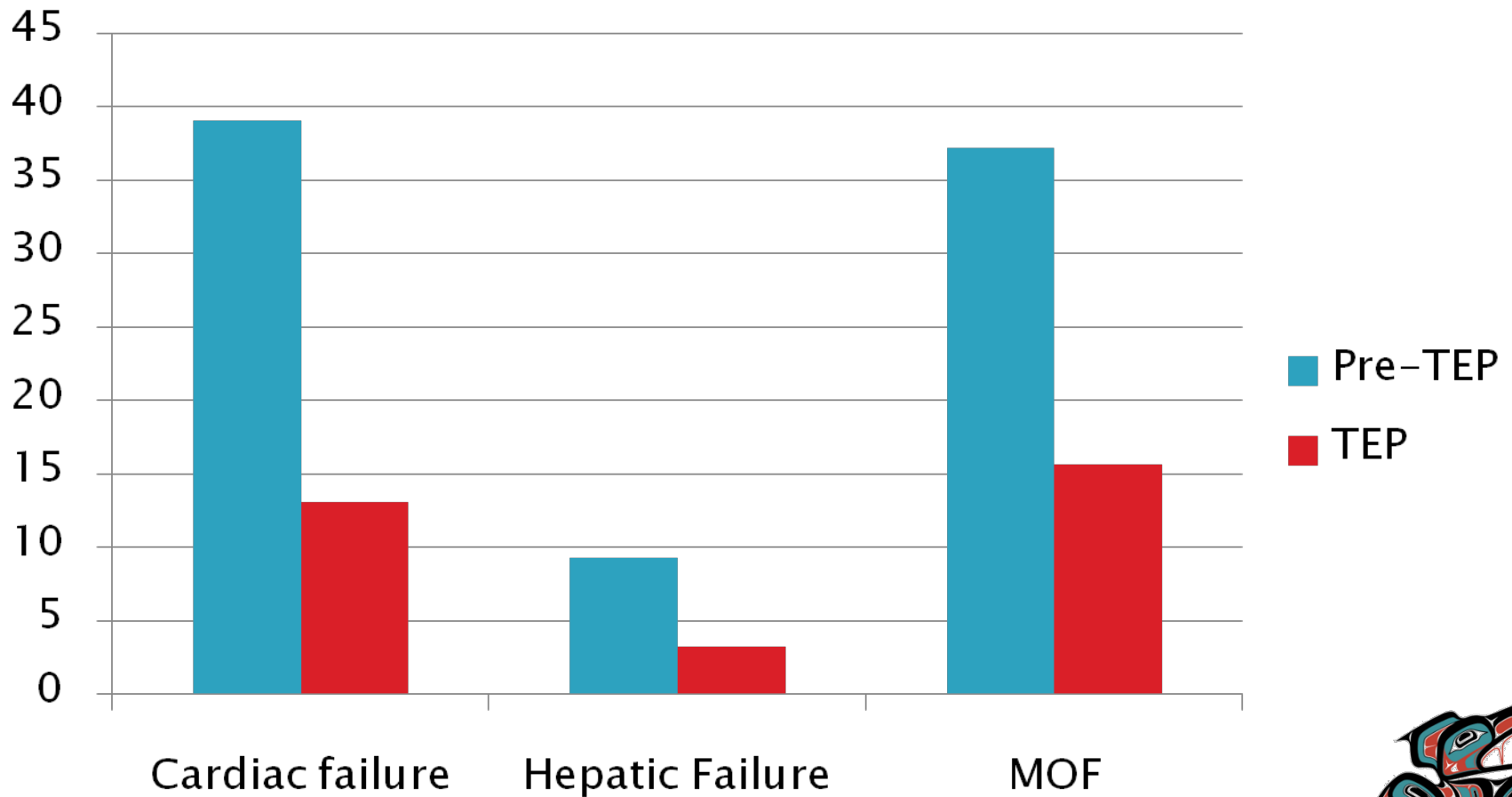
# Massive Transfusion Protocol



Cotton BA, et al. J Trauma Jan 2009;66(1):41-49.



# Massive Transfusion Protocol



Cotton BA, et al. J Trauma Jan 2009;66(1):41-49.



# Who will need massive transfusion

- ▶ Age
- ▶ SBP
- ▶ HR
- ▶ FAST
- ▶ Pelvic fractures
- ▶ Penetrating trauma

Nunez TC, et al. J Trauma. 2009 Feb;66(2):346–52.



# Massive Transfusion Protocol

- ▶ Team Approach
- ▶ 1:1:1 product delivery (Whole blood)
- ▶ Monitor/replace Ca
- ▶ Factor VIIa



# Endpoints of Resuscitation

- ▶ Standard hemodynamic parameters do not adequately quantify the degree of physiologic derangement
- ▶ Ability to attain supranormal O<sub>2</sub> delivery correlates with survival
- ▶ Initial base deficit may indicate need for ongoing resuscitation
- ▶ Time to normalization of base deficit correlates with survival
- ▶ Tissue O<sub>2</sub> and CO<sub>2</sub> may identify patients in need of ongoing resuscitation



**Hypotensive Resuscitation**



# Damage Control Resuscitation

- ▶ Hemorrhage control
- ▶ Minimize crystalloid
- ▶ 1:1:1 Transfusion ratio
- ▶ Resuscitate to adequate tissue perfusion, not a specific endpoint



# Questions

