Crystalloids and colloids in RDCR

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What is Remote DCR?

- Far forward
- Prehospital
- No/limited surgical capability
What is Remote DCR?

- Life-saving interventions
- Use of hemostatic agents
- Blood transfusions
- Hypotensive fluid resuscitation
"Lethal triad"

- Hypothermia
- Coagulopathy
- Acidosis
• Very little room for colloids and crystalloids in RDCR
In fact, most clinical evidence suggests that we are better off giving no fluids.
”For hypotensive patients with penetrating torso injuries, delay of aggressive fluid resuscitation until operative intervention improves the outcome.”

Multiple logistic regression showing odds ratio of death for trauma patients with prehospital IV fluid administration-subset analyses.

Prehospital Intravenous Fluid Administration Is Associated With Higher Mortality in Trauma Patients: A National Trauma Data Bank Analysis.
Haut, Elliott; Kalish, Brian; Cotton, Bryan; MD, MPH; Efron, David; Haider, Adil; MD, MPH; Stevens, Kent; MD, MPH; Kieninger, Alicia; Cornwell, Edward; Chang, David; MBA, MPH

“The review found no evidence to suggest that prehospital IV fluid resuscitation is beneficial, and some evidence that it may be harmful.”

Hypotensive fluid resuscitation

- Restrict prehospital fluid resuscitation in patients with a radial pulse and normal mental status
- Hypotension, coagulation and vasospasm will limit blood loss
The concept of hypotensive resuscitation is extrapolated from ‘delayed resuscitation’ and mostly supported by animal studies.
”Titration of initial fluid therapy to a lower than normal SBP during active hemorrhage did not affect mortality in this study.”

"Hypotensive resuscitation is a safe strategy for use in the trauma population and results in a significant reduction in blood product transfusions and overall IV fluid administration. (...) lowers the risk of early postoperative death and coagulopathy."

Colloids or crystalloids?

Blood
Crystalloids/colloids vs blood

**Blood:**
- Expands blood volume
- Risk of transmission of pathogens
- Transports oxygen
- Contains platelets and coagulation factors

**Crystalloids/colloids**
- Expands blood volume
- No risk of disease transmission
- No oxygen carrying capacity
- Dilutes platelets and coagulation factors
Crystalloids or colloids?

- Colloids have the advantage of staying longer in circulation
- Less colloids needed for same expansion of intravascular volume
- Colloids cause less edema

However...
Colloids cause coagulopathy
Comparisons of lactated Ringer’s and Hextend resuscitation on hemodynamics and coagulation following femur injury and severe hemorrhage in pigs

Wenjun Z. Martini, PhD, Michael A. Dubick, PhD, and Lorne H. Blackbourne, MD, Fort Sam Houston, Texas

**BACKGROUND:** This study compared coagulation function after resuscitation with Hextend and lactated Ringer’s (LR) solution in pigs with tissue injury and hemorrhagic shock.

**METHODS:** Pigs were randomized into control (n = 7 each), LR, and Hextend groups. Femur fracture was induced using the captive bolt stunner at midshaft of the pigs’ left legs, followed by hemorrhage of 60% total blood volume and resuscitation with either Hextend (equal to bled volume) or LR to reach the same mean arterial pressure. Pigs in the control group were not bled or resuscitated. Hemodynamics was monitored hourly for 6 hours. Blood samples were taken at baseline (BL), after hemorrhage, 15 minutes, 3 hours, and 6 hours after resuscitation for blood and coagulation measurements.

**RESULTS:** Mean arterial pressure decreased to 50% of BL by the 60% hemorrhage but returned to near BL within 1 hour after LR or Hextend resuscitation. Heart rate was increased (from 91 ± 4 beats per minute to 214 ± 20 beats per minute) by hemorrhage and decreased after resuscitation but remained elevated above BL in both groups. Resuscitation with Hextend (42 mL/kg) or LR (118 ± 3 mL/kg) reduced hematocrit, total protein, fibrinogen, and platelet counts, with greater decreases shown in the Hextend group. Clot strength was lower but returned to BL by 3 hours in the LR group, whereas it remained reduced for the 6-hour period after Hextend. The overall clotting capacity after LR was decreased after hemorrhage and resuscitation but returned to BL by 3 hours, whereas it remained low after Hextend for the 6-hour experiment period.

**CONCLUSION:** After traumatic hemorrhage, coagulation function was restored within 6 hours with LR resuscitation but not with Hextend. The lack of recovery after Hextend is likely caused by greater hemodilution and possible effects of starches on coagulation substrates and further documents the need to restrict the use of high-molecular-weight starch in resuscitation fluids for bleeding casualties. (J Trauma Acute Care Surg. 2013;74: 732–740. Copyright © 2013 by Lippincott Williams & Wilkins)

**KEY WORDS:** Hemorrhagic shock; Hextend; lactated Ringer’s (LR) solution; thrombelastography; pig.
Dextran > HES > Gelatins

Dextran: platelet dysfunction (acquired von Willebrand’s state)
HES: coating of platelets
Gels: impaired fibrinogen polymerization
Effect of crystalloids vs. colloids on mortality in trauma patients.

**Crystalloids vs. colloids in fluid resuscitation: A systematic review.**
Choi, Peter; MD, FRCPC; Yip, Gordon; Quinonez, Luis; Cook, Deborah; MD, FRCPC

Colloids

Conclusions: Overall, there is no apparent difference in pulmonary edema, mortality, or length of stay between isotonic crystalloid and colloid resuscitation. Crystalloid resuscitation is associated with a lower mortality in trauma patients. Methodologic limitations preclude any evidence-based clinical recommendations. Larger well-designed randomized trials are needed to achieve sufficient power to detect potentially small differences in treatment effects if they truly exist.

(Crit Care Med 1999;27:200-210)
Colloids versus crystalloids for fluid resuscitation in critically ill patients (Review)

Perel P, Roberts I

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in The Cochrane Library 2012, Issue 11

http://www.thecochranelibrary.com
There is no evidence from RCTs that resuscitation with colloids reduces the risk of death, compared to resuscitation with crystalloids, in patients with trauma, burns or following surgery. As colloids are not associated with an improvement in survival, and as they are more expensive than crystalloids, it is hard to see how their continued use in these patients can be justified outside the context of RCTs.
Hypertonic saline

Hypertonic resuscitation of hypovolemic shock after blunt trauma: a randomized controlled trial.

Bulger EM, Jurkovich GJ, Nathens AB, Copass MK, Hanson S, Cooper C, Liu PY, Neff M, Awan AB, Warner K, Maier RV.

Arch Surg. 2008 Feb;143(2):139-48; discussion 149.

…stopped for safety reasons
My opinion:

The only reason to choose colloids is logistical: less volume, less weight.

Choose colloids if you have to carry it yourself.
What about crystalloids?

- Edema
- ARDS
- Hyperchloraemic acidosis (NS)
- Compartment syndromes
- Dilution coagulopathy
What crystalloid?

- ‘Balanced’ crystalloids cause less hyperchloraemic acidosis
- Less electrolyte disturbances
What are the alternatives?
Blood?
Thrombin generation after dilution. Thrombin generation patterns in platelet-poor plasma are shown before and after dilution to about 40% of baseline. The patterns are similar between baseline and dilution with fresh frozen plasma (FFP).

Questions?