Crystalloids and colloids in RDCR

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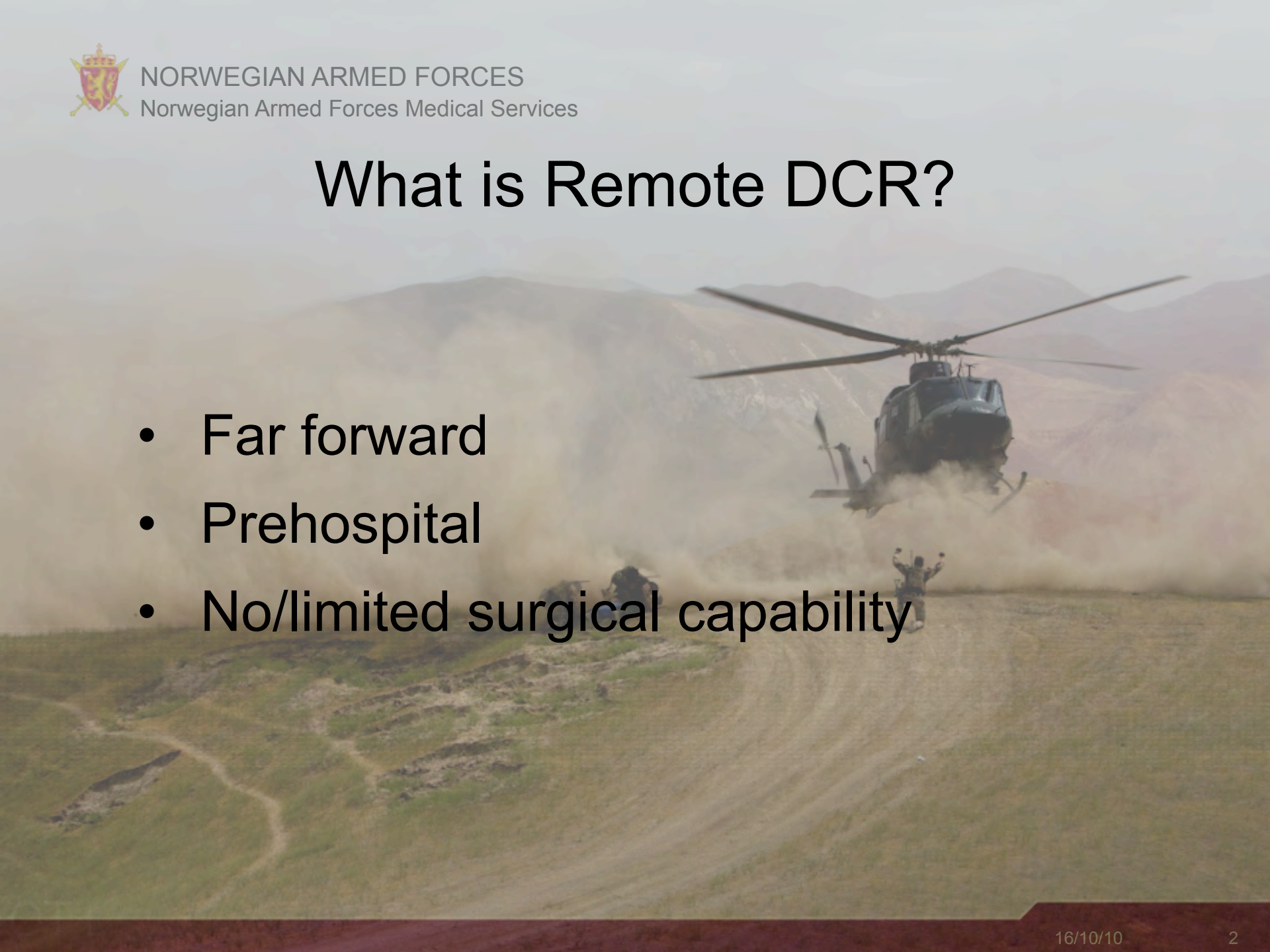
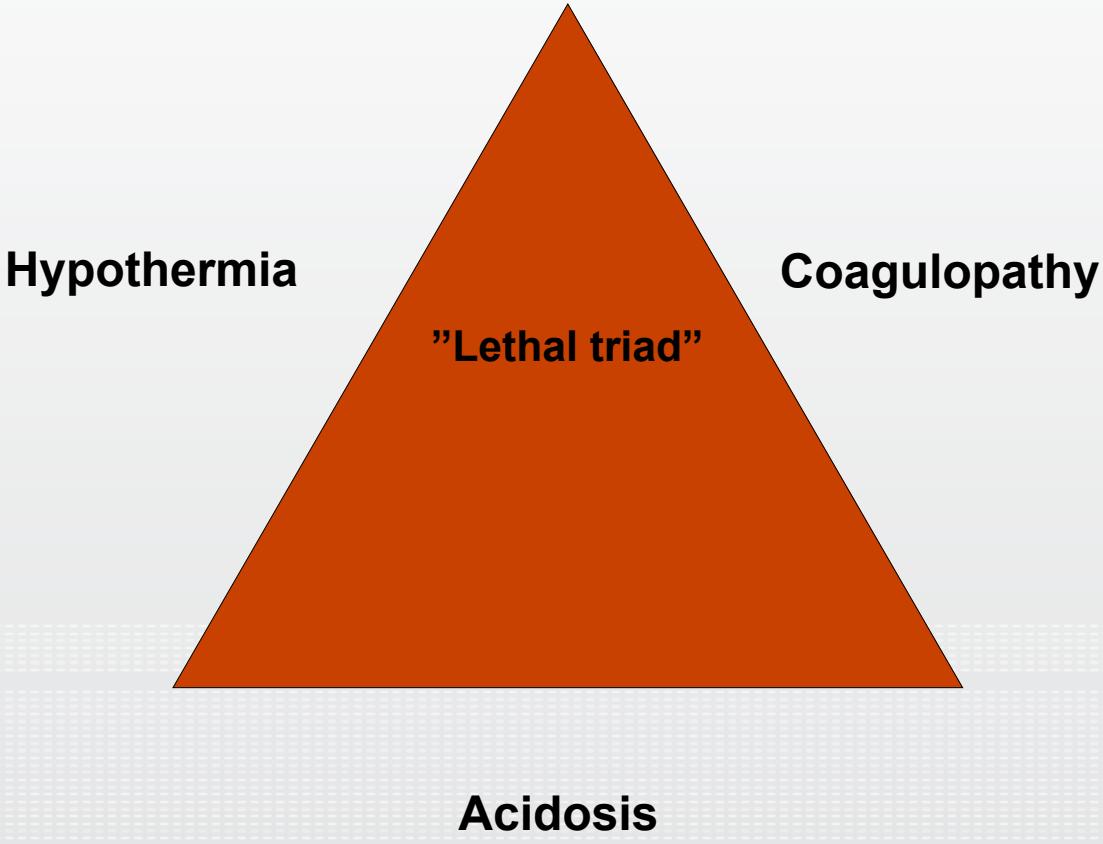
What is Remote DCR?



- Far forward
- Prehospital
- No/limited surgical capability

What is Remote DCR?

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


Hypothermia
Coagulopathy
”Lethal triad”
Acidosis

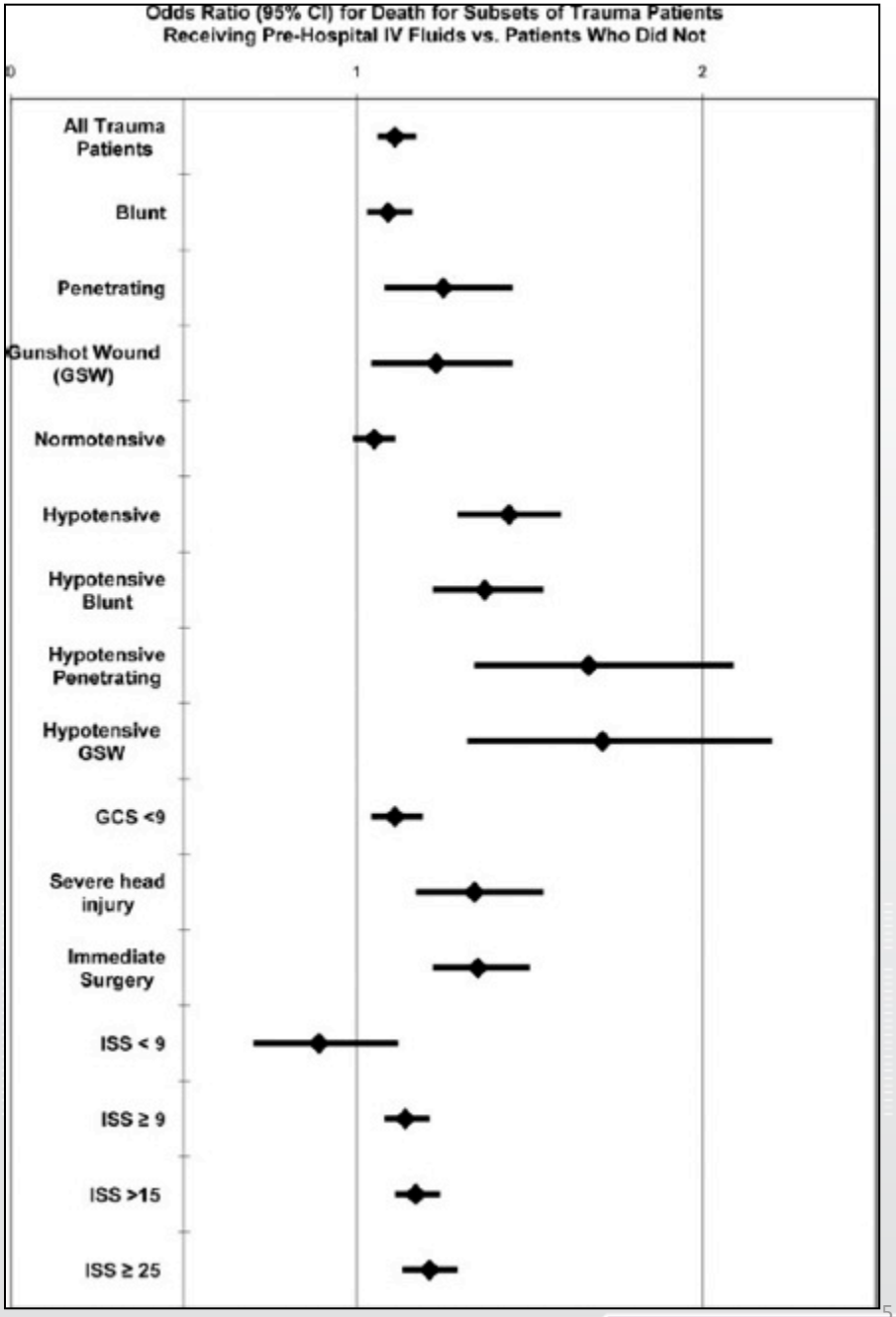
- Very little room for colloids and crystalloids in RDCR

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.”

Bickell, W. H., Wall, M. J., Pepe, P. E., Martin, R. R., Ginger, V. F., Allen, M. K., & Mattox, K. L. (1994). Immediate versus delayed fluid resuscitation for hypotensive patients with penetrating torso injuries. *New Eng J Med*, *331*(17), 1105–9

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

Annals of Surgery. 253(2):371-377, February 2011.
DOI: 10.1097/SLA.0b013e318207c24f

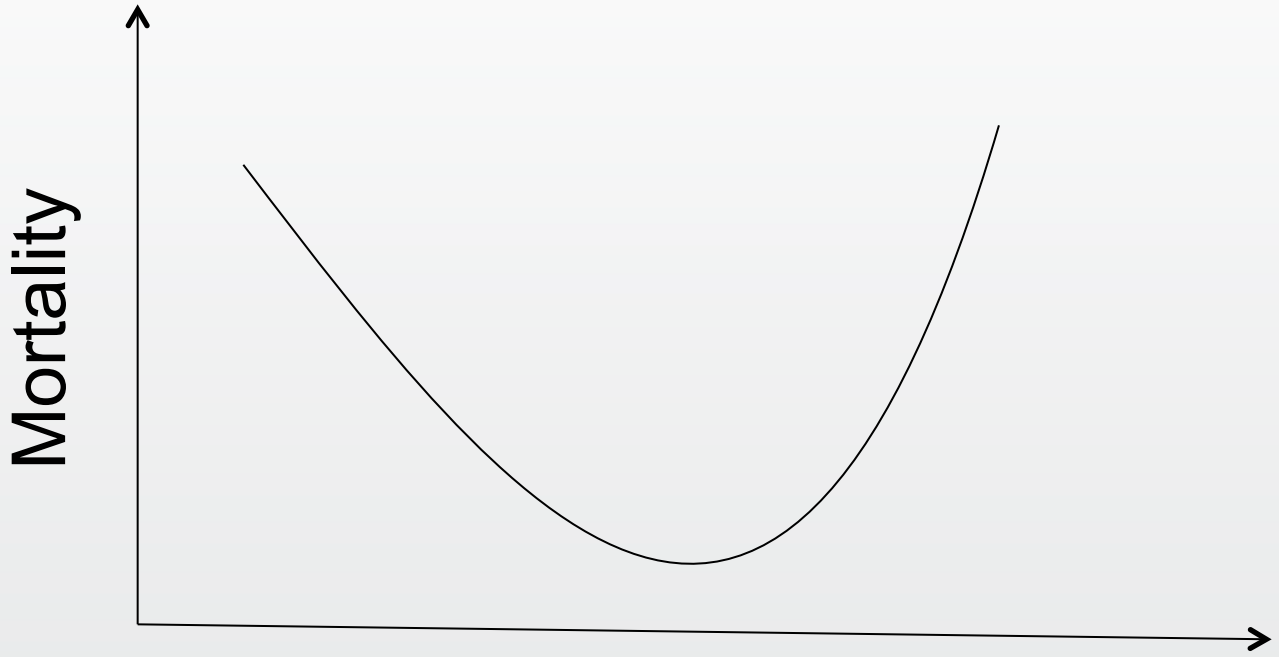
”The review found no evidence to suggest that prehospital IV fluid resuscitation is beneficial, and some evidence that it may be harmful.”

Dretzke J, Sandercock J, Bayliss S, Burls A. Clinical effectiveness and cost-effectiveness of prehospital intravenous fluids in trauma patients. *Health Technol Assess* 2004;**8**(23).

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



HAHN, R. G. (2012). Fluid therapy in uncontrolled hemorrhage - what experimental models have taught us. *Acta Anaesthesiologica Scandinavica*, *57*(1), 16–28.

”Titration of initial fluid therapy to a lower than normal SBP during active hemorrhage did not affect mortality in this study.”

Dutton, R. P., Mackenzie, C. F., & Scalea, T. M. (2002). Hypotensive resuscitation during active hemorrhage: impact on in-hospital mortality. *J Trauma*, *52*(6), 1141–6.

”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.”

Morrison, C. A., Carrick, M. M., Norman, M. A., Scott, B. G., Welsh, F. J., Tsai, P., et al. (2011). Hypotensive resuscitation strategy reduces transfusion requirements and severe postoperative coagulopathy in trauma patients with hemorrhagic shock: preliminary results of a randomized controlled trial. *J Trauma*, *70*(3), 652–63.

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

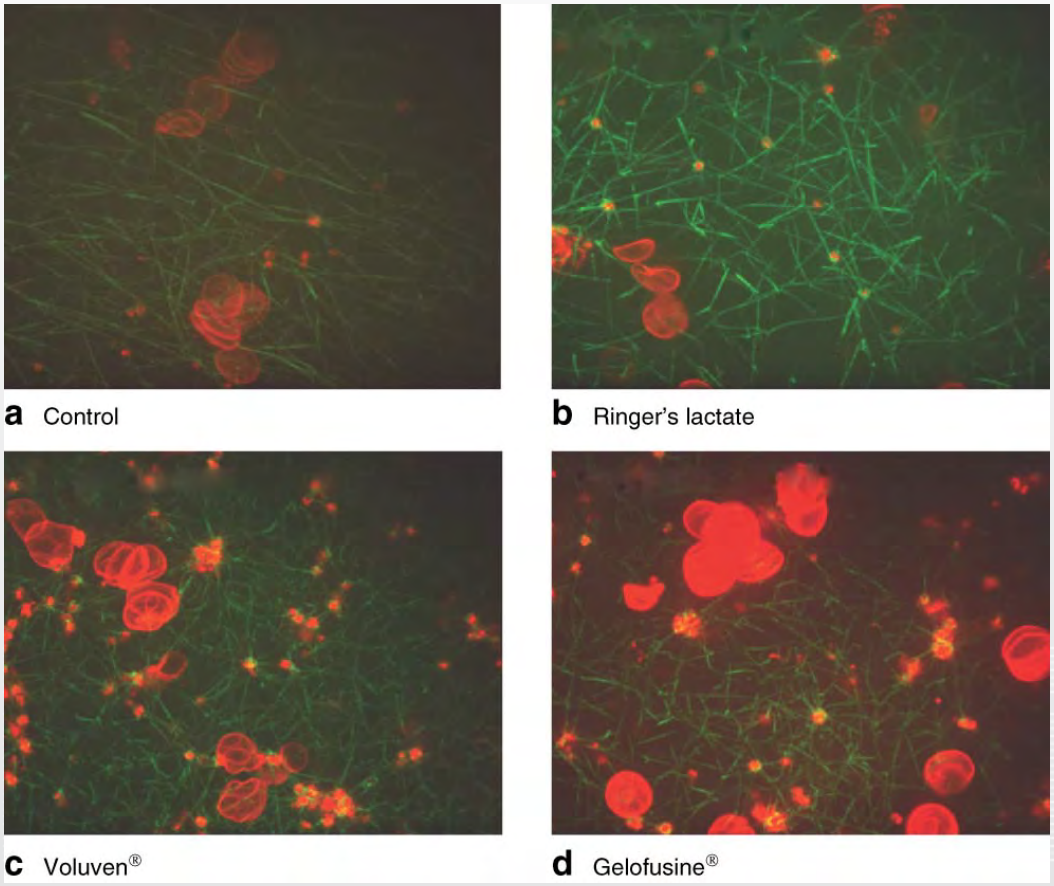
- Expands blood volume
- No risk of disease transmission
- No oxygen carrying capacity
- Dilutes platelets and coagulation factors

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



Sorensen, B., & Fries, D. (2011). Emerging treatment strategies for trauma-induced coagulopathy. *Br J Surg*, *99*(S1), 40–50.

AAST 2012 PLENARY PAPER

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)

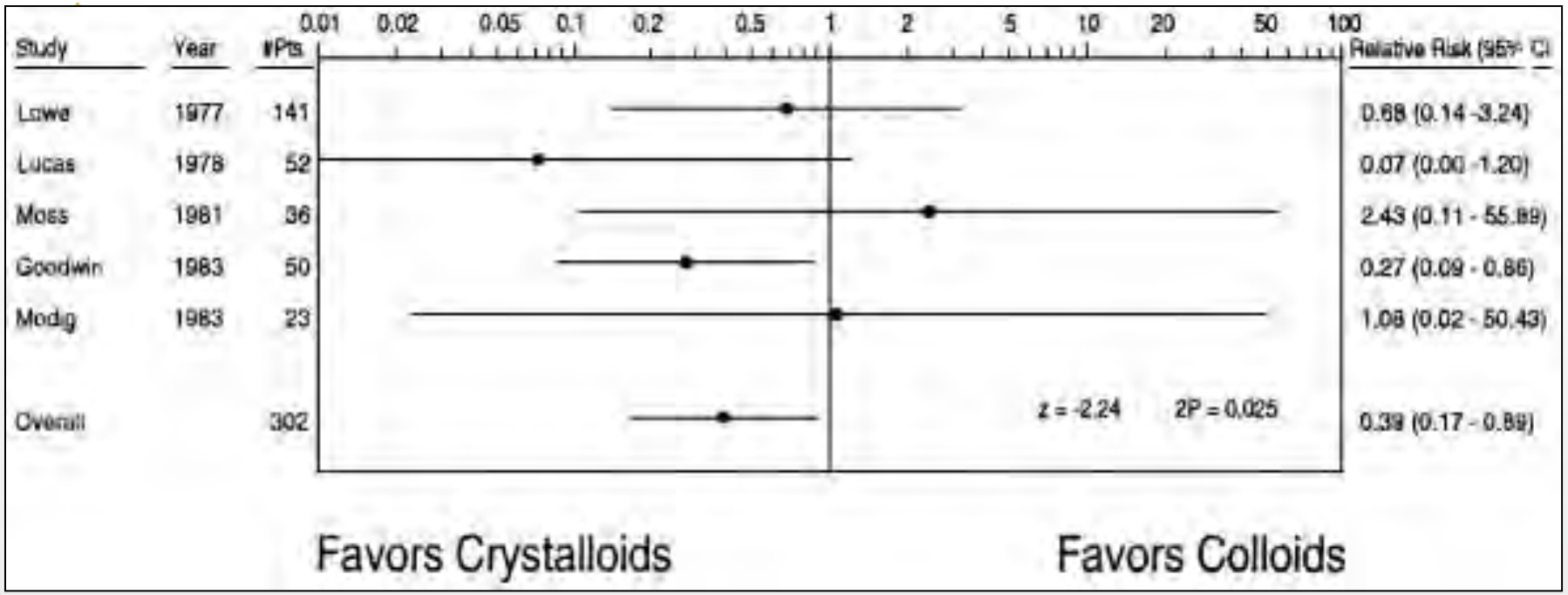
KEY WORDS: Hemorrhagic shock; Hextend; lactated Ringer's (LR) solution; thrombelastography; pig.

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

Critical Care Medicine. 27(1):200-210, January 1999.

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

THE COCHRANE COLLABORATION®

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

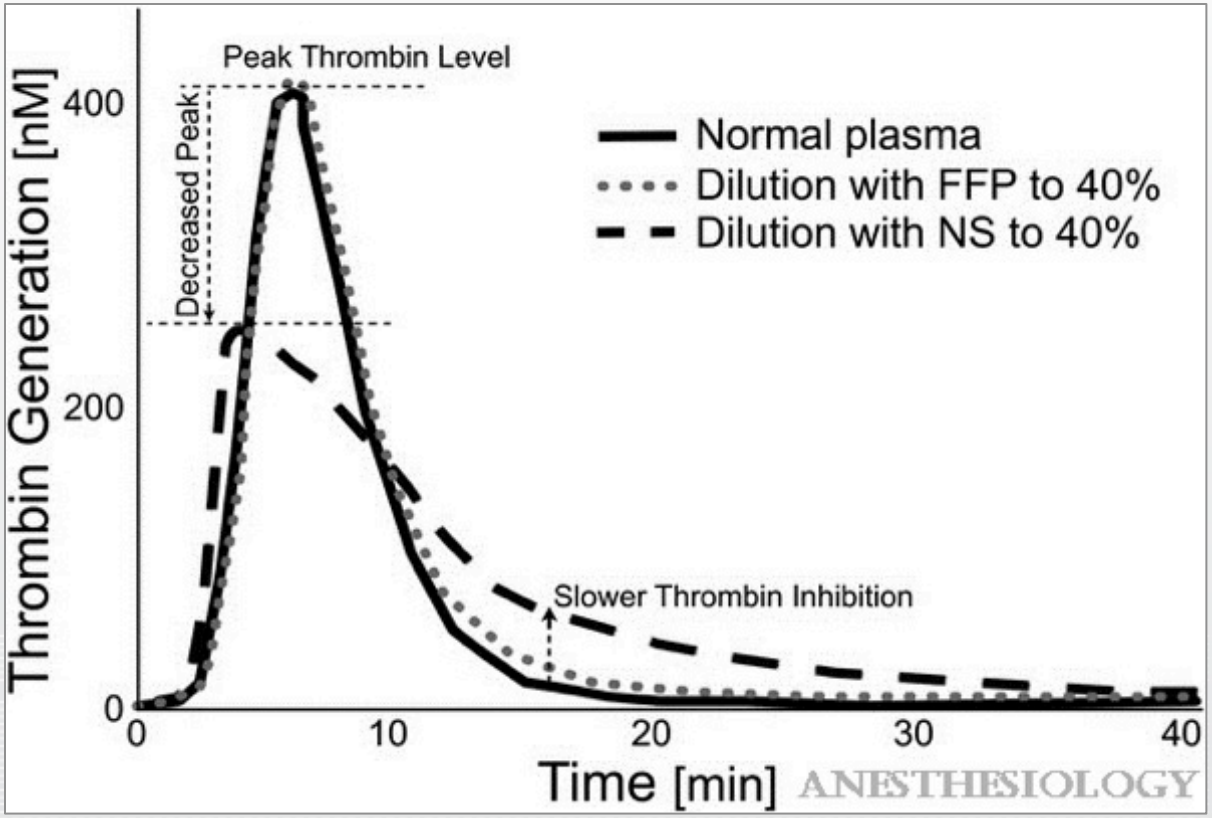
What crystalloid?

- ‘Balanced’ crystalloids cause less hyperchloraemic acidosis
- Less electrolyte disturbances

What are the alternatives?

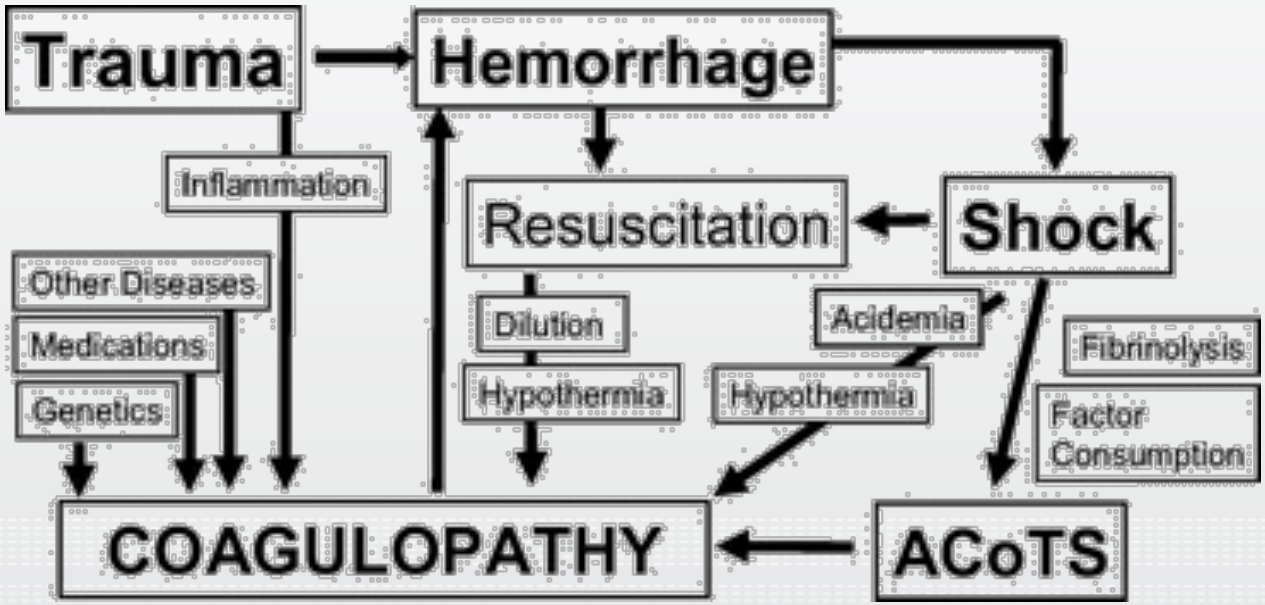
Blood?

PLASMA LYOPHILISE
FRENCH LYOPHILISED PLASMA
N° de lot: 10110235919
EAU POUR PREPARATIONS INJECTABLES
Solution pour préparation injectable
-WATER FOR INJECTIONS -
ATTENTION : SOLUTION HYPOTONIQUE, NE PAS INJECTER
HYPOTONIC SOLUTION, DO NOT INJECT
EAU POUR PREPARATIONS INJECTABLES.....q.s.
Dilution ou dissolution extemporanée de préparations destinées à être administrées par VOIE PARENTERALE.
200/250ML
LOT : 1F124 2
EXP. 03/2016
EAU P.P.I.
NE PAS INJECTER SEULE
NE PAS LAISSER A LA PORTEE DES ENFANTS
REF



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).

Bolliger, D., Görlinger, K., & Tanaka, K. A. (2010). Pathophysiology and treatment of coagulopathy in massive hemorrhage and hemodilution. *Anesthesiology*, *113*(5), 1205–19.



Hess JR et al. The coagulopathy of trauma: a review of mechanisms. *J Trauma.* 2008 Oct;65(4):748-54.

Questions?

LYOVAC
Normal Human Plasma
Dried Normal Human Plasma
IRRADIATED
representing 500 cc. of pooled original plasma
IMPORTANT: Use within 3 hours after restoration.
SHARP & DOHME
PHILADELPHIA, PA.
PLASMA HUMA
CRYO DESSÉCHÉ - 35
à conserver au-dessous de