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Marinejegerkommandoen

RDCR – PRINCIPLES

REMOTE DAMAGE CONTROL RESUSCITATION

- Is the implementation of damage control principles in austere environments

DAMAGE CONTROL RESUSCITATION:

TEMPORARY HEMORRHAGE CONTROL

PERMISSIVE HYPOTENSION

HEMOSTATIC RESUSCITATION

DAMAGE CONTROL SURGERY
(DAMAGE CONTROL RADIOLOGICAL INTERVENTION)

RESTORING ORGAN PERFUSION IN ICU

PERMISSIVE HYPOTENSION: "PRESERVING COAGULATION, REDUCING BLEEDING WHILE SACRIFISING PERFUSION"

PERMISSIVE HYPOTENSION

Goals of Fluid Resuscitation Therapy

- Improved state of consciousness (if no TBI)
- Palpable radial pulse corresponds roughly to systolic blood pressure of 80 mm Hg??
- Avoid over-resuscitation of shock from torso wounds.
- Too much fluid volume may make internal hemorrhage worse by "Popping the Clot."

- Not a treatment
- Necessary evil??
- Evidence????

Bicknell WH, Wall MJ, Pepe PE, Martin RR, Ginger VF, Allen MK, et al. Immediate versus delayed fluid resuscitation for hypotensive patients with penetrating torso injuries. N Engl J Med 1994;331:1105-9

Turner J, Nicholl J, Webber L, Cox H, Dixon S, Yates D. A randomised controlled trial of prehospital intravenous fluid replacement therapy in serious trauma. Health Technology Assessment 2000;4:1-57.

Dutton RP, Mackenzie CF, Scalae TM. Hypotensive resuscitation during active haemorrhage: impact on hospital mortality. J Trauma 2002;52:1141-6.

SAFE Study Investigators; Australian and New Zealand Intensive Care Society Clinical Trials Group; Australian Red Cross Blood Service; George Institute for International Health, Myburgh J, Cooper DJ, et al. Saline or albumin for fluid resuscitation in patients with traumatic brain injury. N Engl J Med 2007;357:874-84

What about delayed evacuation?

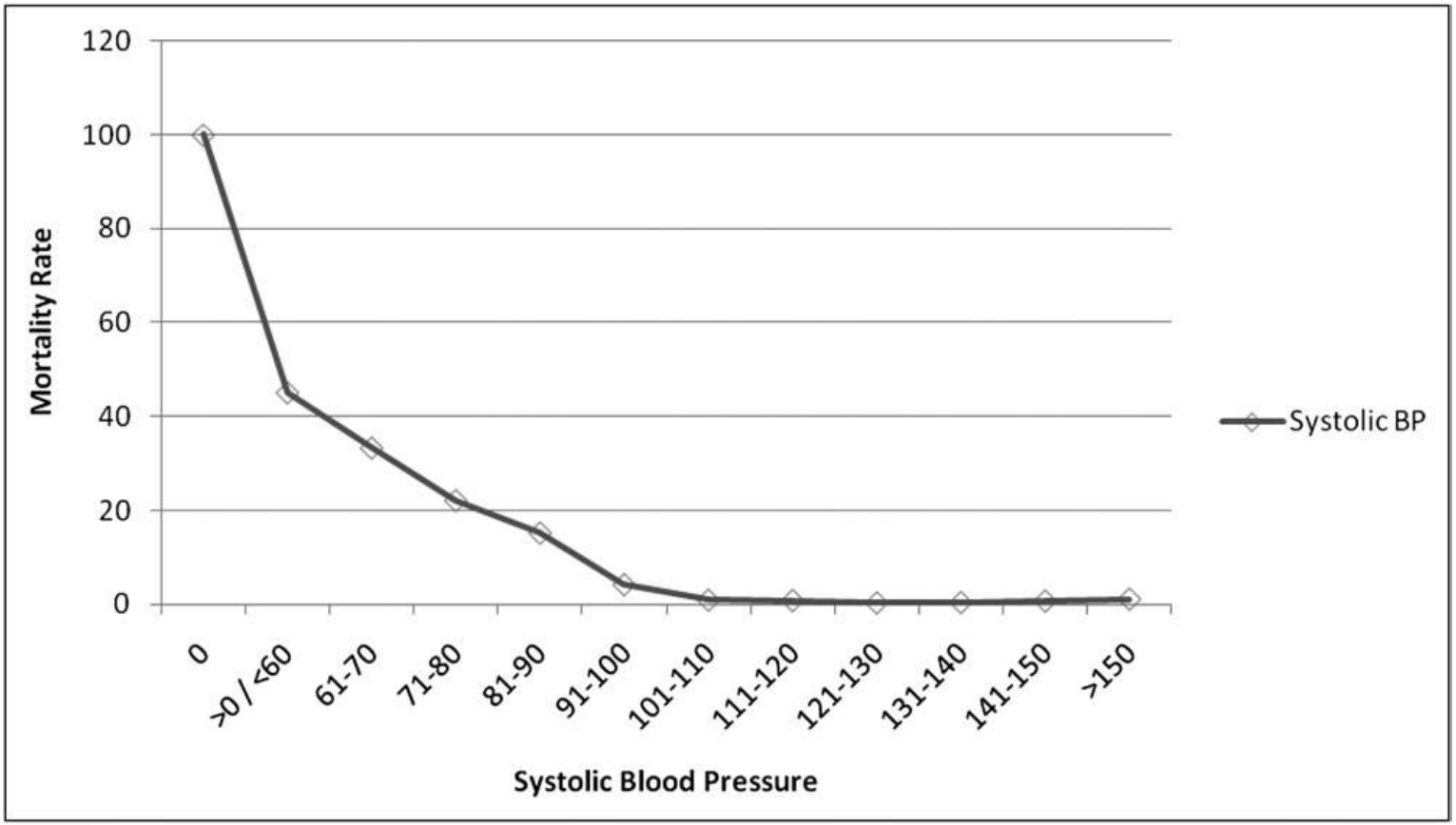
How long in the low-flow state?? Evidence?

- Garner, Jeff, et al. "Prolonged permissive hypotensive resuscitation is associated with poor outcome in primary blast injury with controlled hemorrhage." *Annals of surgery* 251.6 (2010): 1131-1139.
  - 30% Bloodloss – SBP 80mmHg – Mean survival - 2 h
- Doran, Catherine M., et al. "Targeted resuscitation improves coagulation and outcome." *Journal of Trauma and Acute Care Surgery* 72.4 (2012): 835-843.
  - 35% Bloodloss – SBP 80mmHg vs 110mmHg – Mean survival hypotensive group - 3 h
  - Significantly shorter survival in the hypotensive group
- Skarda DE, Mulier KE, George ME, Beilman GJ. Eight hours of hypotensive versus normotensive resuscitation in a porcine model of controlled hemorrhagic shock. Acad Emerg Med 2008;15:845– 52.
  - 35% Bloodloss SBP 65 vs 80 vs 90mmHg
    - Increased mortality and persistent BD and low StO2

What targets?

Hypotension is 100 mm Hg on the battlefield

Brian J. Eastridge, M.D.*, Jose Salinas, Ph.D., Charles E. Wade, Ph.D.,
Lorne H. Blackbourne, M.D.



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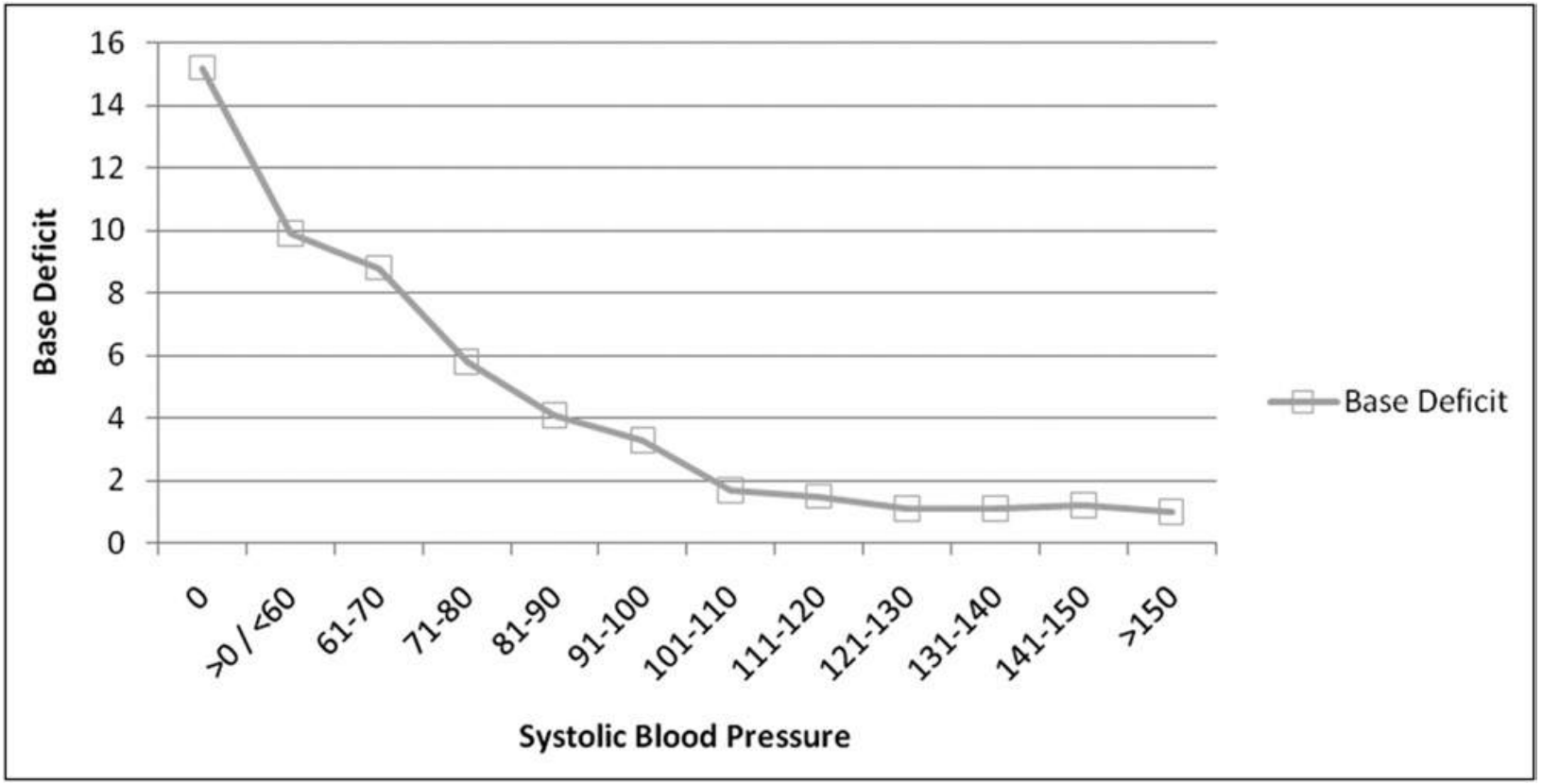
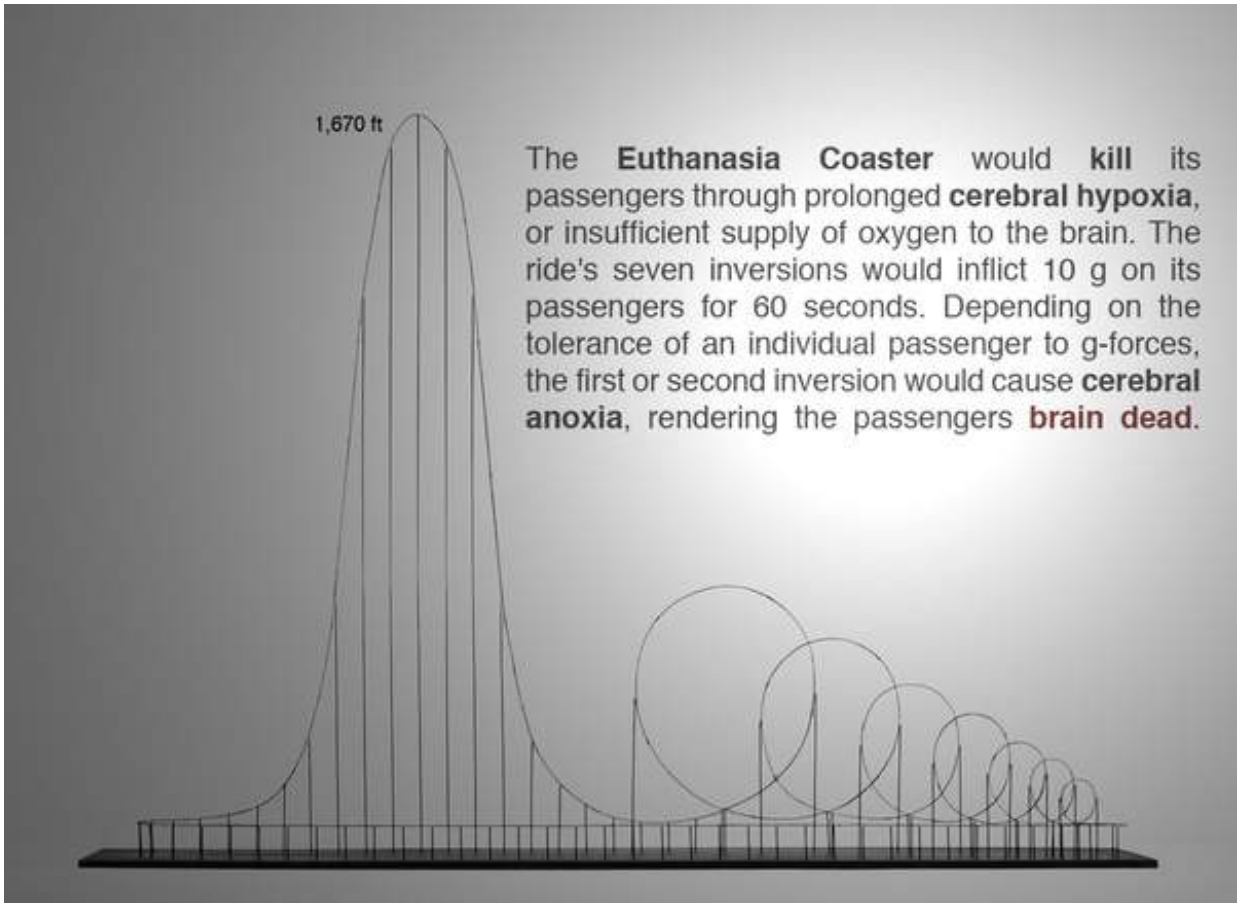


Prolonged permissive hypotension with saline?



Permissive hypotension

$$D0_2 = 1.34 \times Hgb \times Sa0_2 \times CO$$

TCCC on Permissive hypotension:

- "Hypotensive Resuscitation Saves Lives in Non Compressible Hemorrhage!"
  - TRUE: If short evac times, and the only option is crystalloids
  - During long evac permissive hypotension using crystalloids might be dangerous.
  - During long evac and when using blood – we do not know if the permissive approach (systolic 80mmHg) is beneficial.
- "Giving more fluid than necessary may increase bleeding from internal bleeding sites!"
  - SURE: Even worse using saline!
- USE COMMON SENSE!!!

HEMOSTATIC RESUSCITATION

There are four objectives of prehospital fluid resuscitation for casualties in hemorrhagic shock:

1) Enhance the body's ability to form clots at sites of active bleeding

2) Minimize adverse effects (edema and dilution of clotting factors) resulting from iatrogenic resuscitation injury

3) Restore adequate intravascular volume and organ perfusion prior to definitive surgical control of hemorrhage

4) Optimize oxygen carrying capacity

Ideal Resuscitation Fluid

	Volume	Hemostatic	O2 Carrying Capacity
Crystalloid	Y	N	N
Colloid	Y	N	N
Plasma	Y	Y	N
1:1:1	Y	Y	Y
Whole Blood	Y	Y	Y

Why is 1:1:1 therapy probably inferior to whole blood?

DILUTION

Standard Amounts of Anti-coagulants and Additives in Reconstituted Whole Blood vs Whole Blood

Component Therapy per Unit:

6 x RBC	6 x 120 ml = 720ml
6 x FFP	6 x 50 ml = 300ml
1 x aPLT	1 x 35 ml = 35ml

Total =1055ml

Whole Blood per Unit:

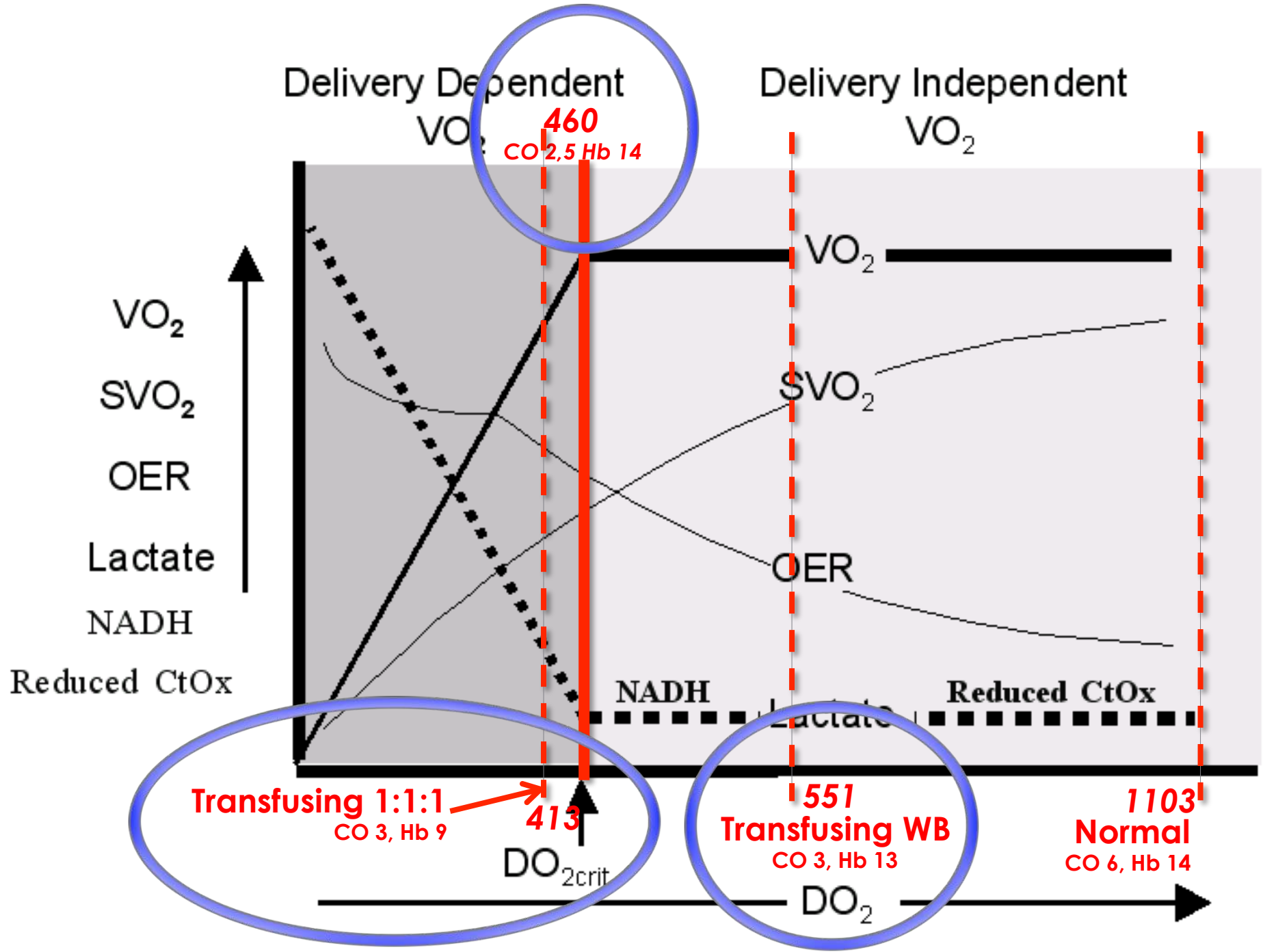
6 x 63ml = 378ml

Total: 378ml

3 times the volume of anticoagulant and additives in 1:1:1 compared to whole blood

Whole blood vs reconstituated whole blood (1:1:1)

- DO_2=13,4 x Hb x SaO2 x CO
- CO 3 L/min in 80 kg Soldier, Sat´s 100%
- What is the DO_2??
  - 1:1:1 gives Hgb 9g/L
  - WB gives Hgb 13/L
- *Normal DO2 (CO = 6, Sat = 98%, Hgb 13) = 1103*
- *Critical DO2 in healthy volunteers (CO = 6, Sat = 98%, Hgb 5) = est. 400*


Delivery Dependent
VO2
460
CO 2,5 Hb 14
Delivery Independent
VO2
VO2
SVO2
OER
Lactate
NADH
Reduced CtOx
VO2
SVO2
OER
NADH
Reduced CtOx
Transfusing 1:1:1
CO 3, Hb 9
413
DO2crit
551
Transfusing WB
CO 3, Hb 13
1103
Normal
CO 6, Hb 14
DO2

Efficacy

- Warm fresh whole blood
- Short term stored cold whole blood

- Better RBC´s??
  - "Storage lesion"
  - NO mediated vasoconstriction

- Cold stored platelets – better?

Spinella, Philip C., and Allan Doctor. "Role of transfused red blood cells for shock and coagulopathy within remote damage control resuscitation." *Shock* 41 (2014): 30-34.

SIMPLICITY???

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Simplicity

TXA – Tranexamic acid

- Non-compressible hemorrhage is the leading cause of preventable death on the battlefield
- Tourniquets and Combat Gauze do not work for *internal* bleeding
- TXA may help

TXA

- TXA does not promote new clot formation
- Prevents forming clots from being broken down by the body
- May support hemostasis
- May helps prevent death from hemorrhage
- Two major studies have shown a small survival benefit from TXA, especially in casualties that require a massive transfusion of blood products

TXA

- Survival benefit greatest when given within 1 hour of injury
- Greatest decrease in blood loss seen when TXA is started early
- Survival benefit still present when given within 3 hours of injury
- Do not give TXA if more than 3 hours have passed since the casualty was injured – survival is decreased by TXA given after this point

TXA

- Possible side effects:
  - Nausea, vomiting, diarrhea
  - Visual disturbances
  - Possible increase in risk of post-injury blood clots
  - Hypotension if given as IV bolus

TXA
Storage and Handling

- Doesn't matter! As long as you don't freeze it!
- Extremely stable drug at a huge variety of temperatures!

TXA Administration – 1st Dose

- Supplied in 1 gram (1000 mg) ampules
- Infuse slowly (a few minutes)
- Rapid IV push may cause hypotension
- If there is a new-onset drop in BP during the infusion – SLOW DOWN the TXA infusion

TXA Administration – 2nd Dose

- Typically given after the casualty arrives at a Role II/ Role III medical facility
- May be given in field if evacuation is delayed

TXA – Bottom line:

- Small survival benefit!
- Does not stop bleeding , but might reduce it!
- Not a gift from GOD!
- Blood transfusion has priority over TXA administration when multitasking
- I would not criticise my medics if they don't give TXA.
- I would be "a bit cross" if they do not resuscitate the shocked casualty early with blood!

Duty Position	Average Fighting Load (lbs)	Average FL % Body Weight	Average Approach March Load (lbs)	Average AML % Body Weight	Average Emergency Approach March Load (lbs)	Average EAML % Body Weight
Combat Medic	54.53 lbs	31.08%	91.72 lbs	51.58%	117.95 lbs	69.88%