

COAGULOPATHY OF TRAUMA & TRANSFUSION
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DESCRIBE
Describe the impact, incidence, and consequences of trauma related hemorrhage

REVIEW
Review the pathophysiology of acute blood loss and massive transfusion

IDENTIFY
Identify the anesthetic implications and interventions for coagulopathy

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TRAUMA

1 in 10 deaths, worldwide
 Leading cause of death in people < 45 y/o

HEMORRHAGE...
 Accounts for most deaths in patients with *potentially survivable injuries*
 Over 90% of *potentially survivable* US combat deaths

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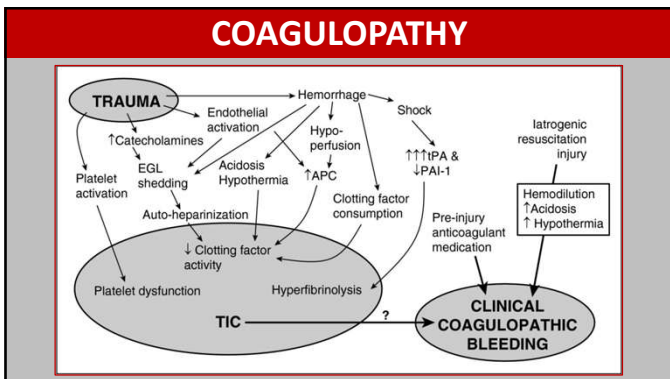
COAGULOPATHY

PRESENT IN ~30% OF TRAUMA PATIENTS IMMEDIATELY AFTER INJURY

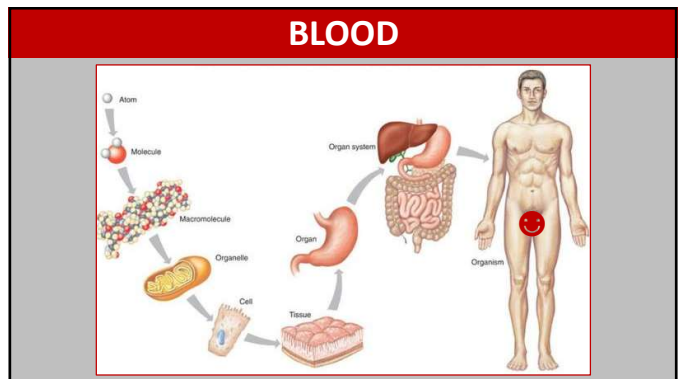
ASSOCIATED WITH ↑ MULTI-ORGAN FAILURE, ↑ ICU ADMISSION, ↑ DEATH

WHEN PRESENT ON ARRIVAL TO E.D., 4 – 6x ↑ MORTALITY

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BLOOD

CARDIOVASCULAR SYSTEM:

PROVIDE O₂ NUTRIENTS TO TISSUES

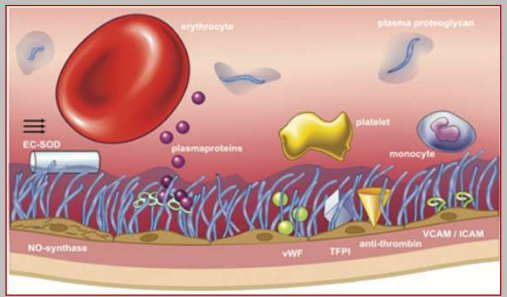
CLEAR WASTE PRODUCTS

PHYSICAL CONDUIT TO CONNECT ORGANS



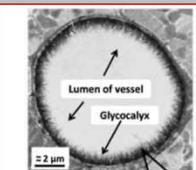
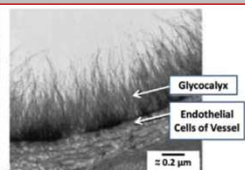
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ORGAN SYSTEM



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ORGAN SYSTEM

Lumen of vessel
Glycocalyx
= 2 μm
= 0.2 μm

Slippery, gel-like network of negatively charged molecules residing on the luminal side of the vascular endothelium.

A carbohydrate-rich layer connected to the endothelium via backbone proteoglycans and glycoproteins. A complex network of plasma- and epithelium-derived soluble molecules is continuously incorporated into the glycocalyx. A **dynamic equilibrium** forms between blood constituents and the glycocalyx—it is not a static structure.

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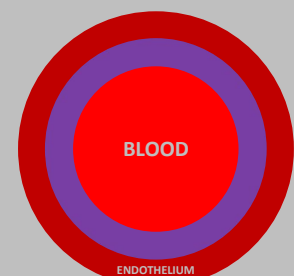
ORGAN SYSTEM



ENDOTHELIUM: 4,000 – 7,000 m²

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ORGAN SYSTEM



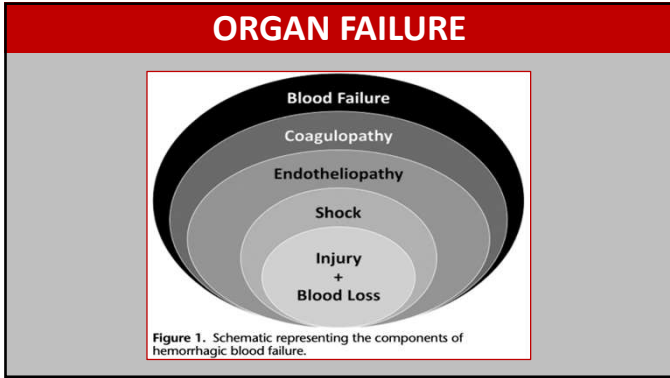
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ORGAN FAILURE

IF IT FUNCTIONS, IT CAN FAIL...

BLOOD FAILURE

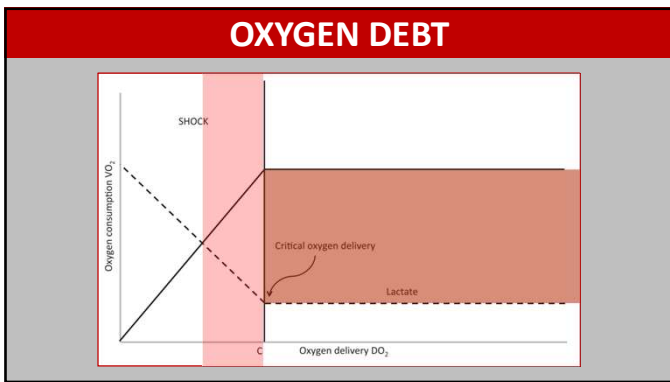
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- ### OXYGEN DEBT
- Mismatch between OXYGEN DEMAND (VO_2) and OXYGEN DELIVERY (DO_2)
 - DO_2 function of CARDIAC OUTPUT, O_2 SATURATION, HGB CONCENTRATION
 - Transition into ANAEROBIC METABOLISM
 - Depth of O_2 debt continues to increase over time
 - ✓ Restoration to baseline VO_2/DO_2 ratio may be insufficient
 - ✓ Ability to physiologically “repay” debt DECREASES OVER TIME
 - Consequences of ACCUMULATED DEBT
 - ✓ Increased reperfusion/inflammation injury
 - ✓ MODS
 - ✓ ENDOTHELIOPATHY → COAGULOPATHY → **BLOOD FAILURE**

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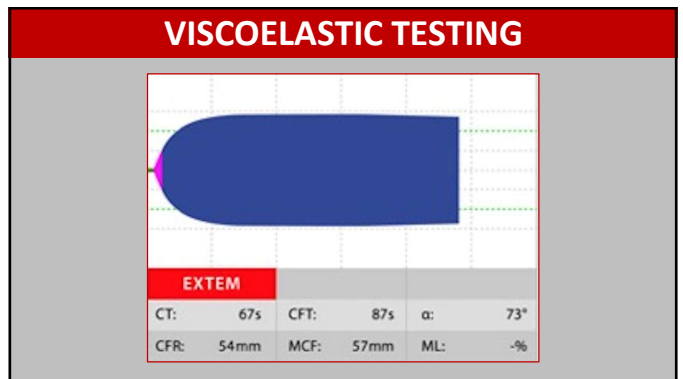
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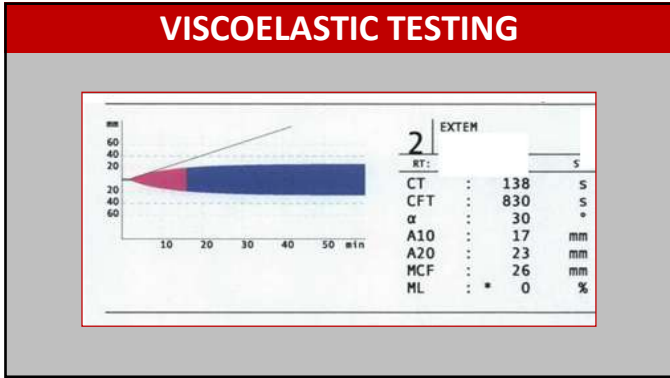
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- ### RECOGNIZING BLOOD FAILURE
- OXYGEN DEBT**
- TACHYCARDIA, ALTERED MENTAL STATUS
BASE DEFICIT
SERUM LACTATE
- COAGULOPATHY**
- CONSPICUOUS BLEEDING
CONVENTIONAL COAGULATION ASSAYS UNRELIABLE!
VISCOELASTIC TESTING (ROTEM, TEG), FIBRINOGEN

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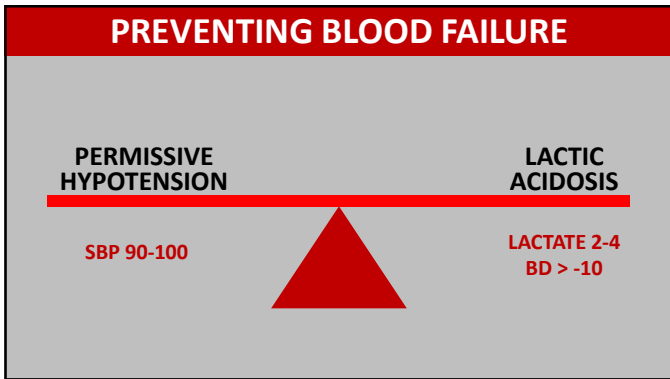
PREVENTING BLOOD FAILURE

$DO_2 = CO + SaO_2 + HGB$

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PREVENTING BLOOD FAILURE


DAMAGE CONTROL RESUSCITATION

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PREVENTING BLOOD FAILURE

PROCEDURES & TECHNIQUES

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) as an Adjunct for Hemorrhagic Shock




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PREVENTING BLOOD FAILURE




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TREATING COAGULOPATHY



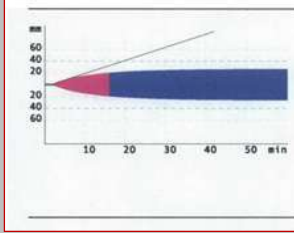
MTP



BETTER?

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TREATING COAGULOPATHY



2 EXTEM			
KT:			S
CT	: 138		S
CFT	: 830		S
α	: 30		°
A10	: 17		mm
A20	: 23		mm
MCF	: 26		mm
ML	: *	0	%

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TREATING COAGULOPATHY

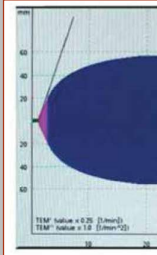
For ROTEM

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    graph TD
      Q1[Is CT prolonged, indicating delayed clot formation?] -- Normal --> Q2[Is MCF too low, indicating weak clot?]
      Q1 -- Yes --> A1[Give FFP or PCC]
      Q2 -- Normal --> Q3[Is LI30 too high, indicating too much lysis?]
      Q2 -- Yes --> B1[Check FIBTEM MCF and ROTEM Platelet if available]
      B1 --> B2[If FIBTEM MCF is low, give cryoprecipitate]
      B1 --> B3[If FIBTEM MCF is normal or ROTEM Platelet is low, give platelets]
      Q3 -- Yes --> A2[Give TXA]
    
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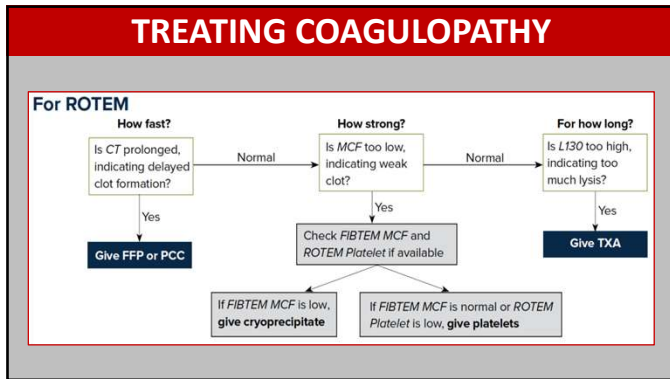
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TREATING COAGULOPATHY



EXTEM		2020-09-24 10:52	
CT	76	s	38-79
CFT	96	s	34-159
α	76	°	63-83
A5	39	mm	34-55
A10	50	mm	43-65
MCF	56	mm	50-72
ML	100	%	<15
LI30	5	%	94-100

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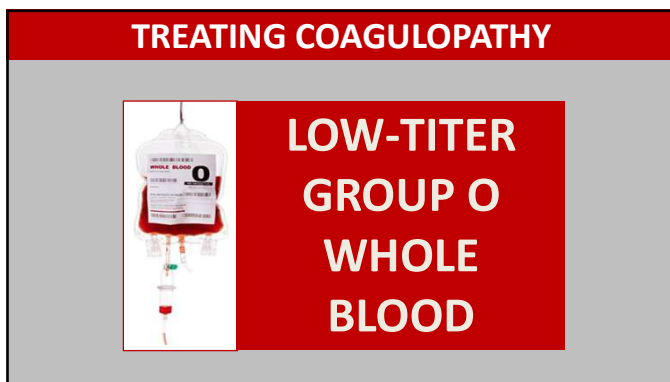
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TREATING COAGULOPATHY

CLINICAL RANDOMISATION OF AN ANTIFIBRINOLYTIC IN SIGNIFICANT HAEMORRHAGE-2

The CRASH-2 trial: a randomised controlled trial and economic evaluation of the effects of tranexamic acid on death, vascular occlusive events and transfusion requirement in bleeding trauma patients

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TREATING COAGULOPATHY

Fresh whole blood use by forward surgical teams in Afghanistan is associated with improved survival compared to component therapy without platelets

Shawm C. Nissen, Brian J. Eastbridge, Daniel Cronk, Robert M. Cook, Kyle Romick, Jason Seery, Arant Shalh, and Phil...

TRANSFUSION 2013;53:1075-1111

Warm Fresh Whole Blood is Independently Associated With Improved Survival for Patients With Combat-Related Traumatic Injuries

Philip C. Swille, MD, James C. Perkins, MD, Kurt W. Grathwohl, MD, Alex C. Rivitz, MD, and John R. Holcomb, MD

J Trauma. 2009;66:568-576.

Comparison of platelet transfusion as fresh whole blood versus apheresis platelets for massively transfused combat trauma patients

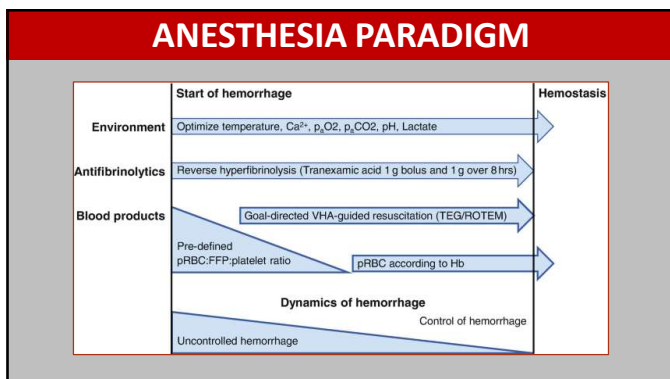
Jeremy G. Perkins, Andrew B. Cook, Kurt W. Grathwohl, Francisco J. Sa...

COMBAT SHOCK, Vol. 41, No. Supplement 1, pp. 62-69, 2014.

WHOLE BLOOD: THE FUTURE OF TRAUMATIC HEMORRHAGIC SHOCK RESUSCITATION

Alan D. Murdock,¹ Ole Berseus,² Tor Hervig,^{1,3} Geir Strandenes,^{1,3} and Turid Helen Lundø¹

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REFERENCES

Bjerkvig C, Strandenes G, Eliassen H et al. "Blood failure" time to view blood as an organ: how oxygen debt contributes to blood failure and its implications for remote damage control resuscitation. *Transfusion*. 2016;56:S182-S189. doi:10.1111/trf.13500

White N, Ward K, Pati S, Strandenes G, Cap A. Hemorrhagic blood failure. *Journal of Trauma and Acute Care Surgery*. 2017;82(6S):S41-S49. doi:10.1097/ta.0000000000001436

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QUESTIONS



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