Early Resuscitation in Hemorrhagic Shock	
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Trauma Management for Rural EMS and Community Hospitals	
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MEDICINE of THE HIGHEST ORDER MEDICINE	

D	isc	losu	ires

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MEDICINE of THE HIGHEST ORDER

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Case

59 y/o male motor vehicle crash

- •Intubated in field for altered mentation
- •Tourniquet placed LLE
- •Initial SBP 50 mmHg; HR 70 bpm
- •Potential causes of hypotension?
- •Now what?

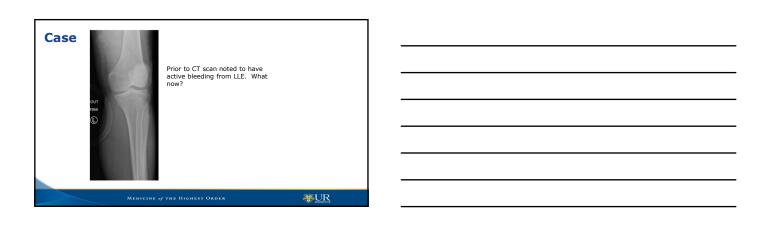


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Case •2 units whole blood/MTP activated •1 gram TXA •TEG sent •Hemostatic dressing applied





Case	
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Case

- •OR for LLE exploration
- •Transected popliteal artery and vein
- •Hemodynamics improve
- •Repaired, fasciotomy performed



Medicine of the Highest Order

Case

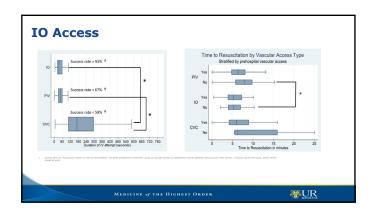
- $\bullet \text{Patient shot himself in leg prior to crash} \\$
- •High spinal cord injury
- •Hypotension related to hemorrhage and neurogenic shock

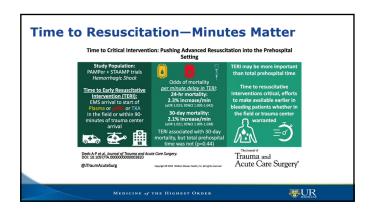


THE HIGHEST ORDER

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Primary Survey: (C)ABCDE	
•Circulation (major external hemorrhage)	
•Airway	
•Breathing	
•Circulation	-
•Disability •Exposure	
Exposure	
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The Hypotensive Patient	
N. C.	
Hypotension = bleeding until proven otherwise	
Bleeding = #1 cause of PREVENTABLE death in	
trauma	
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The Hypotensive Patient	
•Where are the 7 places into which a human can exsanguinate? •Thoracic cavity (x 2)	
• Abdomen	
Pelvis/retroperitoneum	
•Femur (x 2)	
Onto the floor (external hemorrhage)	
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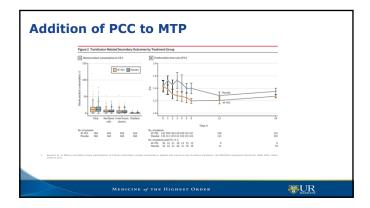
Initial Mechanic	al Control of Hemorrhage in the ED		
Cavit		Adjunct(s)	Comments
Thorax Abdomen	Chest x-ray FAST exam	Thoracostomy tube Aortic balloon occlusion	14 Fr vs larger-bore tube ¹ Nearly 10% risk access
			complications ² Consider OR placement ³ May be useful in "bestile"
			May be useful in "hostile" abdomen? ⁴
Pelvis	Pelvic x-ray	Pelvic binder Aortic balloon occlusion	Mortality remains >30% if hemodynamically unstable ⁵
Femur	Physical exam Femur x-ray	Traction (?) Tourniquet	If concern for vascular injury place tourniquet ⁶
External	Physical exam	Hemostatic dressing	Tourniquets associated with
		Tourniquet	↓ blood usage and ↑ outcomes ⁷ • Evolving concern about
			overutilization of tourniquets ⁸
Normitt IP et al. Management of er Laverty RB et al. Life over brids it	ople and retained hemothorias: a practice management guideline from the Eastern Aco ternal access-related finite sichemic complications in 48-cau MERCA, survivors. J Trisun	occasion for the Swipey of Touris, Am J Surg. 2821 [221 [5] 877-884. No Acute Care Surg. 2022;82(4):722-728. In Taxina Surg Acute Care Cipics. 2015;9(1): e000361. The Sortis. J Touris Acute Care Cipics. 2015;9(1): e000361.	tourniquets
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•Other cause •Tension p •Cardiac ta	otensive Pations of hypotension neumothorax mponade c shock (not spinal sh		
	MEDICINE of THE HIGH	HEST ORDER	#UR
Tourniq	uets		
•Tourniauet	= higher SBP and less	blood products	
. oa. mquet		1.300 p. oddeto	
•No increase	in nerve palsy, infecti	on, amputation, or	fasciotomy
-			
•Delay assoc	iated with higher mort	pidity and mortality	
Scerbo PRI et al. The trauma cent	v it too later: magur limb trauma without a pre-hospital tournsquet has increased deadlesset use in prestoding entiremity trauma: decreased blood transfusions and limb completel with use in prestoding entiremity trauma: decreased blood transfusions and limb comp	h farm hemanhagic shock. J Tawna Acute Care Surg. 2017;83(6):1165-72.	
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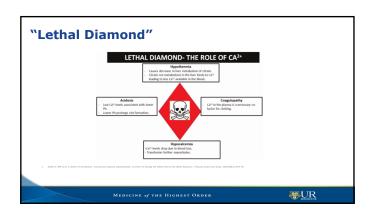






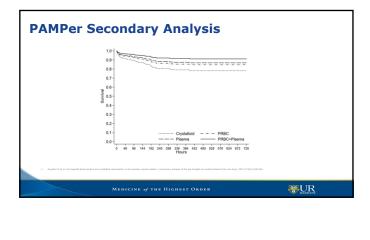
Initial Resuscitation •Early balanced resuscitation •1:1:1 PRBC/Plasma/Platelets and/or whole blood •Cryoprecipitate •TEG-guided resuscitation may improve survival •Pharmaceutical adjuncts •Tranexamic acid (TXA) •Prothrombin complex concentrate

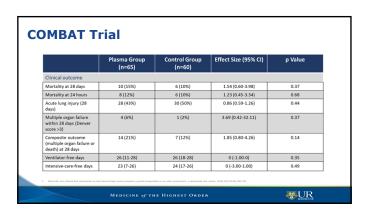




Evolution of Fluid Resuscitation •Whole blood	
•Individual components (around Vietnam)	
•Massive crystalloid resuscitation (1990s)	
•1:1:1 resuscitation	
•Whole blood	
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PROMMTT	
•Prospective cohort study	
•Adults surviving > 30 minutes who received blood	
•Increased plasma:PRBC and platelet:PRBC = better 6 hour mortality	
•<1:2 were 3-4x more likely to die (early) compared with 1:1 or higher	
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PROPPR	
•RCT of patients predicted to require MTP	
•1:1:1 vs 1:1:2 (plasma/platelets/PRBC)	
•Decreased death by exsanguination at 24 hours in 1:1:1	
•No difference in overall survival	
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	Standard Care	Plasma	Odds Ratio (95% CI)	Adjusted p Value
Primary outcome				
Overall 30-day mortality	89/261 (34.1%)	53/220 (24.1%)	0.61 (0.41 to 0.92)	_
Secondary outcomes*				
24-hour mortality	60/271 (22.1%)	32/230 (13.9%)	-8.2 (-14.9 to -1.6)	0.55
In-hospital mortality	88/271 (32.5%)	51/230 (22.2%)	-10.3 (-18.0 to -2.6)	0.33
Median 24-hour volume of blood components, units	4 (2-16)	3 (0-10)	_	0.41
Median PT ratio	1.3 (1.1-1.6)	1.2 (1.1-1.4)	_	<0.001
	S, MOF, nosocomial infec	tions		



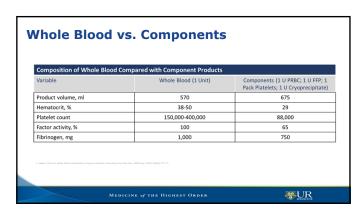


	PRBC + Plasma Group	0.9% Sodium Chloride Group	Adjusted Risk Ratio (95% CI)	Adjusted Average Difference (95% CI)
Primary outcome				
Episode mortality or failure to clear lactate or both	128/199 (64%)	136/210 (65%)	1.01 (0.88-1.17)	-0.025% (-9-9)
Secondary outcomes				
Episode mortality	88/203 (43%)	99/218 (45%)	0.97 (0.78-1.20)	-3% (-12-7)
Failure to clear lactate	98/196 (50%)	113/206 (55%)	0.94 (0.78-1.13)	-5% (-14-5)
Post-intervention fluids	123 (310), 207	160 (389), 221		-34 (-101-32)
Time to ED arrival, minutes				
From 999 call	90 (35)	91 (35)	-	0.60 (-6.14-7.35)
Total blood product up to 2	4 hours after ED arrival			
PRBC	6.34 (7.09), 209	4.41 (6.17), 223	-	1.80 (0.58-3.01)
Plasma	5.04 (5.56), 209	3.37 (5.04), 223	-	1.54 (0.57-2.50)
Death				
Within 3 hours	32/197 (16%)	46/208 (22%)	0.75 (0.50-1.13)	-7% (-15-1)
Within 30 days	86/204 (42%)	99/219 (45%)	0.94 (0.76-1.17)	-4% (-13-6)

1	Whole Blood •Cold-stored (1-6 degrees Celcius)
	•Low titer (<1:200)
	•Type O
	•21-35 day shelf life
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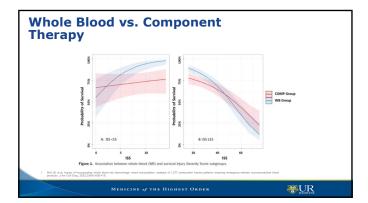


Potential Whole Blood Benefits

- Improved logistics
- •Faster resolution of shock/coagulopathy
- •Decreased infection
- ·Less citrate
- •Less donor exposure
- •Decreased overall transfusion requirements
- •Improved survival?

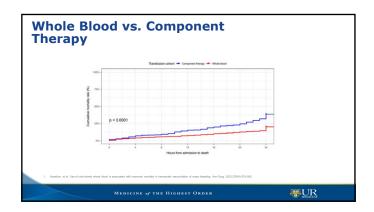
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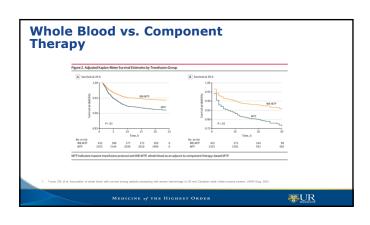
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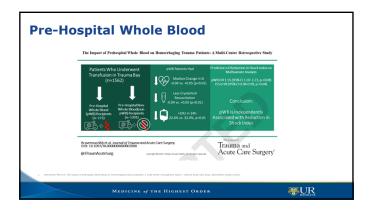


Whole Blood vs. Component Therapy Multivariable Analyses Evaluating the Impact of Low-Titer Group O Whole Blood on 30-Day Survival 30-Day Survival Odds Ratio (95% CI) p Value Odds Ratio (95% CI) WB group Age, per year Male sex ISS, per point 4.10 (2.22-7.45) 0.97 (0.96-0.98) 1.59 (1.28-1.98) 0.99 (0.98-0.99) 0.46 (0.24-0.87) 0.018 0.77 (0.60-0.98) 0.04 0.93 (0.92-0.95) 1.00 (0.99-1.01) 0.286 1.009 (1.006-1.012) 0.89 (0.87-0.92) Arrival lactate, per mmol/L 0.82 (0.76-0.88) **UR**

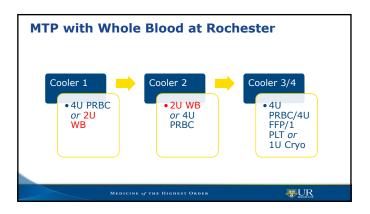
Multivariable Analyses Evaluating the Impact of Low-Titer Group O Whole Blood on 24-Hour Blood Product Use Unweighted Analysis Weighted Analysis				
24-Hour Blood Product Use	Odds Ratio (95% CI)	p Value	Odds Ratio (95% CI)	p Value
VB group	0.38 (0.21-0.70)	0.002	0.93 (0.91-0.96)	<0.001
Age, per year	1.00 (0.99-1.02)	0.602	0.996 (0.995-0.997)	<0.001
Vale sex	1.80 (0.98-3.26)	0.055	1.22 (1.18-1.26)	<0.001
SS, per point	1.07 (1.04-1.09)	<0.001	1.023 (1.022-1.024)	<0.001
icene SBP, per mmHg	0.99 (0.99-1.01)	0.639	0.998 (0.998-0.991)	<0.001
Arrival lactate, per mmol/L	1.12 (1.02-1.25)	0.019	1.038 (1.036-1.039)	< 0.001

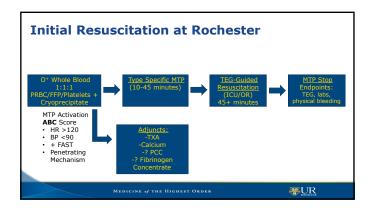


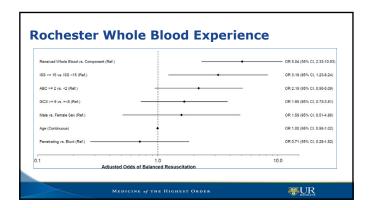


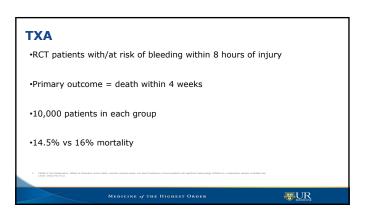


Optimal Crystalloid Volume? -405 patients -About 1/3 received PRBC -About 1/2 received Plasma - Median crystalloid volume was 500 ml - 39.5% of patient received NO crystalloid - 20% died within 24 hours - Volumes between 250-1250 ml associated with lowest early mortality and inflammatory response to injury









	Placebo	TXA	Risk Ratio (95% CI)
rimary outcome			
0-day mortality	45/452 (10%)	36/442 (8.1%)	0.82 (0.53-1.11)
īme from injury, hours			
1	18/238 (7.6%)	10/219 (4.6%)	0.60 (0.44-0.83)
1	27/214 (12.6%)	26/223 (11.7%)	0.92 (0.52-1.64)
hock severity			
achycardia only	21/320 (6.6%)	18/316 (5.7%)	0.87 (0.56-1.34)
BP < 90 mmHg	13/101 (12.6%)	13/99 (13.1%)	1.02 (0.55-1.90)
8P < 70 mmHg	11/31 (35.5%)	5/27 (18.5%)	0.52 (0.34-0.80)
No differences in in-hospital/ omplications	/24-hour mortality, 6 or 24-hour blood trar	nsfusion requirements, or	

XA Dose	30-Day Mortality	Risk Ratio (95% CI)
acebo (reference)	45/452 (10.0%)	-
g bolus	14/150 (9.3%)	0.94 (0.65-1.36)
g bolus/1 g infusion	11/141 (7.8%)	0.78 (0.50-1.24)
g bolus/1 g bolus/1 g infusion	11/151 (7.3%)	0.73 (0.54-0.99)

TXA Summary	
•Reasonable for patients with hemorrhage •Especially if BP <70 and very early from injury	
•? Higher initial dose better (?2 grams)	
•? Base second dose on TEG results	
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Consider MTP with any 2 of the following: Penetrating mechanism SBP < 90mmHg HR >120 bpm Positve FAST exam Think whole blood EARLY and TXA < 15 minutes in trauma bay

Anticoagulant	Reversal Agent(s)
Warfarin	Vitamin K FFP/vitamin K PCC/vitamin K
Dabigatran (direct thrombin inhibitor)	PCC Idarucizumab (Praxbind®)
Rivaroxaban/apixaban (Xa-inhibitors)	PCC Andexanet alfa (Andexxa®)
Antiplatelet agents	DDAVP

Circulation in Summary	
•Humans can exsanguinate into 7 places	
•Whole blood and 1:1:1 better than crystalloid	
•Crystalloid better than nothing?	
•TXA should be considered if concern for major hemorrhage	
•Give calcium (2 grams for every 2-4 units PRBC)	
•Know the tools you have available	
•With blood shortages, increased role for PCC, fibrinogen concentrate?	
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