

High transfusion ratios are
associated with increased
complications in non-extremity
injuries, but not extremity injuries

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Background

- Primary cause of potentially survivable death in combat is hemorrhage
- High energy mechanisms in combat victims
 - Increase number and severity of wounds
- High ratios beneficial in massively transfused



Borgman et al JOT 2007;63
Spinella et al JOT 2008;64S

Definitions

- Massive transfusion
 - More than 10 units PRBC in 24 hours
- Transfusion ratios
 - High ratio
 - Greater than 1:2 ratio of FFP:PRBC



Injury Types

- Compressible
 - Primarily extremity
- Non-compressible
 - Body cavity
 - Unable to control with external measures
 - Surgery required for definitive management



Kelly et al. JOT 2008;64S
Holcomb et al. Annals Surg 2007;245
Champion et al. JOT 2003;54S

Rationale

- High ratios associated with decreased mortality in massive transfusion
 - Concurrent increase in morbidity
 - Survival bias?
- Compressibility affects treatment strategy



Borgman et al JOT 2007;63

Purpose

- Determine effect of transfusion ratios on:
 - Extremity injury (compressible)
 - Non-extremity injury (non-compressible)



Hypothesis

In combat victims with extremity injuries,
high ratio transfusions are associated
with equivalent survival and increased
complications compared to lower ratios



Methods

- Retrospective review
 - IRB approved, Brooke Army Medical Center
 - 2104 injured soldiers
 - Current conflict (March 2003 to June 2008)
 - Required blood transfusion



Methods

Isolated Extremity Injury (EI) [Compressible]

AIS Extremity ≥ 3

AIS Head 0 - 2

AIS Face 0 - 2

AIS Chest 0 - 2

AIS Abdomen 0 - 2

AIS External 0 - 2

Non-extremity Injury (NEI) [Non-compressible]

AIS Extremity < 3

AIS Head any

AIS Face any

AIS Chest any

AIS Abdomen any

AIS External any

AIS = Abbreviated Injury Scale Score



Transfusion Ratios



Low Ratio
< 1:4 of FFP:PRBC



Mid Ratio
1:4 to 1:2 of FFP:PRBC



High Ratio
> 1:2 of FFP:PRBC



= 1 unit FFP



= 1 unit PRBC

Characteristics

	Extremity	Non-Extremity
Age	25.8	25.5
HR	105	92*
SBP	117	110*
ISS	13	21*
GCS	14	10*
Hemoglobin	11.9	12.2*
INR	1.4	1.5*
Base Deficit	5.3	5.6
% MT	35	36
rFVIIa use	17.1%	23.7%*

* $p < 0.05$ – Student's t-test



Massive transfusion

	Extremity Injury (EI)			Non-Extremity Injury (NEI)		
	Low [<1:4]	Mid [1:4 – 1:2]	High [>1:2]	Low [<1:4]	Mid [1:4 – 1:2]	High [>1:2]
<i>n</i>	29	59	159	28	47	129
Mortality (%)	17.2	8.5	6.9	60.7*	27.7	32.8
Complications (%)	20.7	15.3	26.4	3.6*	29.8	32.0

* $p < 0.05$ – χ^2 analysis

EI may have improved survival without more complications

NEI ↑ survival with mid/high ratio MT, but increased complications



MT complications

	Extremity Injury (EI)			Non-Extremity Injury (NEI)		
	Low [<1:4]	Mid [1:4 – 1:2]	High [>1:2]	Low [<1:4]	Mid [1:4 – 1:2]	High [>1:2]
<i>n</i>	29	59	159	28	47	129
% MI	0.0	0.0	0.6	0.0	2.1	3.1
% Stroke	0.0	0.0	0.6	0.0	2.1	2.3
% PE	3.6	5.1	9.4	3.6	4.3	7.8
% DVT	10.3	8.5	13.2	0.0*	12.8	7.8
% Renal failure	13.8*	3.1	3.5	0.0	8.5	7.8
% ARDS	10.3	5.1	5.7	0.0	8.5	9.4
% rFVIIa use	27.6	17.0*	47.2	32.1	36.2	49.6

* $p < 0.05$ – χ^2 analysis



Non massive transfusion

	Extremity Injury (EI)			Non-Extremity Injury (NEI)		
	Low [<1:4]	Mid [1:4 – 1:2]	High [>1:2]	Low [<1:4]	Mid [1:4 – 1:2]	High [>1:2]
<i>n</i>	283	68	105	274	77	264
Mortality (%)	3.9	2.9	4.8	25.6	24.7	21.6
Complications (%)	9.2	8.8	12.4	7.0*	14.5	14.5

* $p < 0.05$ – χ^2 analysis

EI morbidity and mortality not associated with transfusion ratio

Higher transfusion ratios associated with increased complications in NEI



NMT complications

	Extremity Injury (EI)			Non-Extremity Injury (NEI)		
	Low [<1:4]	Mid [1:4 – 1:2]	High [>1:2]	Low [<1:4]	Mid [1:4 – 1:2]	High [>1:2]
<i>n</i>	283	68	105	274	77	264
% MI	0.0	0.0	0.0	0.7	0.0	0.8
% Stroke	0.0	0.0	0.0	0.7	0.0	1.5
% PE	1.4*	6.0	6.7	1.5	4.0	3.0
% DVT	5.3	6.0	2.9	1.5*	10.7*	4.2
% Renal failure	1.4	1.5	1.9	0.4*	4.0	3.0
% ARDS	2.5	3.0	2.9	3.7	1.3	4.6
% rFVIIa use	1.4*	8.8	16.2	6.6*	16.0*	49.6

* $p < 0.05$ – χ^2 analysis



Limitations

- Retrospective
- Missing data points
- TBI victims may confound outcome
- Treatment of extremity injuries unknown
 - Tourniquet, hemostatic dressings, direct pressure



Conclusions

- Compressible hemorrhage
 - Possible survival benefit with high ratio MT
 - No significant increase in overall morbidity
- Non-compressible hemorrhage
 - Improved survival in mid and high ratio massive transfusion
 - Higher complication rate in mid & high ratio transfusion

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