Massive transfusion in trauma

Dr Anne Weaver
Consultant in Emergency Medicine & Pre-Hospital Care
Royal London Hospital
Transfusion in Trauma

- 40% trauma deaths attributed to uncontrolled haemorrhage
- Up to 55% trauma patients are coagulopathic on arrival at hospital
- 9% require transfusion
- 3% require massive transfusion
- Massive transfusion carries mortality 30-60%
Definition - Massive Transfusion

- Replacement of one blood volume in 24 hours
- Transfusion of >10 u RBC in 24 hours
- Loss of 50% of blood volume in 3 hours
- Loss of >150ml / minute
- Requirement to transfuse 4 u RBC immediately with ongoing losses
Aims

• Define massive transfusion
• Describe importance of MT protocols
• Describe acute traumatic coagulopathy
• Share some research findings

• Challenge your current transfusion practice
Massive Transfusion in Trauma

- Baltimore study – 5643 patients
- 68 patients received >20 u RBC (1.2%)
- Massive transfusion group – 50% mortality
- Massive transfusion group used 50% of blood products for centre
- Average age of survivors - 35yrs
Role of MT protocol

- No difference in ISS for survivors vs non-survivors
- Vascular control is key to survival

“an intact coagulation system contributes to haemorrhage control, protocols that minimise coagulopathy should reduce blood usage and improve survival”
Audit of MTP - Denmark

- Established MT protocol
- 39 patients received MT
- 13 inadequately transfused
  - Higher mortality (12/13 vs 13/26)
  - Higher rate of microvascular bleeding
  - Lower platelet count on ICU (40 vs 80)
- Violations
  1) >20PRBC but no FFP
  2) no platelets despite mean 67u PRBC / FFP
- Same RBC requirements but different outcome if not given FFP and platelets

Vox Sanguinis 2005;89:92-96
Transfusion issues in ED

- Prehospital / ED crystalloids
- Uncrossmatched “O” blood – packed cells
- Delay in plasma availability
  - Blood typing / thawing
- Uncertainty as to which products needed
- Traditional transfusion guidelines
- Delay for lab results
Modern transfusion medicine

- Preparation of blood components means not as efficacious as the real thing!
- PRBC do not contain any clotting factors
  - Must replace with FFP early
  - After 12 u PRBC - PT > 1.5 x normal (100%)
- Replacement of total blood volume causes thrombocytopenia
  - Relatively late due to release from sequestration
- Worse outcome if thrombocytopenic
  - Acute bleeding – plt > 50 x 10^9
  - Massive transfusion - plt > 80 x 10^9
Blood products

- **PRBC**
- **FFP** – clotting factors & fibrinogen
- **Platelets** – pooled (ATD) or single units
- **Cryoprecipitate** – Factor VIII, XIII, vWF, fibrinogen
- Some protocols consider **rFVIIa**
Fresh Frozen Plasma Should be Given Earlier to Patients Requiring Massive Transfusion

Ernest A. Gonzalez, MD, Frederick A. Moore, MD, John B. Holcomb, MD, Charles C. Miller, PhD, Rosemary A. Kozar, MD, PhD, S. Rob Todd, MD, Christine S. Cocanour, MD, Bjorn C. Balldin, MD, and Bruce A. McKinley, PhD

**Background:** Acidosis, hypothermia, and coagulopathy were identified more than 20 years ago as a deadly triad for patients presenting with exsanguinating hemorrhage. This led to fundamental changes in initial management of severely injured patients. Despite major advances, hemorrhage remains a leading cause of early death in trauma patients. Recent studies report most severely injured patients to be coagulopathic at admission, before resuscitation interventions, and that traditional massive transfusion practice grossly underestimates needs. The hypothesis for this study is that our pre-intensive care (2003) and resuscitated using our standardized ICU shock resuscitation protocol received MT (≥10 units packed red blood cells [PRBC]) during hospital day 1 (age, 39 ± 2; ISS, 29 ± 1; survival, 70%). All patients required emergency operating room and/or interventional radiology procedures and arrived in the ICU 6.8 ± 0.3 hours after admission. Coagulopathy, present at hospital admission (pre-ICU INR, 1.8 ± 0.2), persisted at ICU admission (initial ICU INR, 1.6 ± 0.1). Pre-ICU resuscitation, 9 ± 1 L crystalloid fluid, 12 ± 1 units PRBC, 5 ± 0.4 1.4 ± 0.03 within 8 hours and remained nearly constant for the remaining 16 hours of ICU resuscitation, indicating moderate coagulopathy. Statistical analysis found severity of coagulopathy (INR) at ICU admission associated with survival outcome (p = 0.02; area under receiver operator curve [ROC] = 0.71.)

**Conclusion:** These data indicate acidosis and hypothermia to be well managed. Coagulopathy was not corrected in the ICU despite adherence to pre-ICU MT and ICU protocols, likely because of inadequate pre-ICU intervention. More aggressive pre-ICU
ED INR: 1.8
ICU INR: 1.6
Acute Traumatic Coagulopathy
ATC
• No difference in volume of fluid given

• 24% patients were coagulopathic on arrival in ED
Mortality

normal: 11%

coagulopathic: 46%
Acute Traumatic Coagulopathy

Karim Brohi, BSc, FRCS, FRCA, Jasmin Singh, MB, BS, BSc, Mischa Heron, MRCP, FFAEM, and Timothy Coats, MD, FRCS, FFAEM

**Background:** Traumatic coagulopathy is thought to be caused primarily by fluid administration and hypothermia.

**Methods:** A retrospective study was performed to determine whether coagulopathy resulting from the injury itself is a clinically important entity in severely injured patients.

**Results:** One thousand eight hundred sixty-seven consecutive trauma patients were reviewed, of whom 1,088 had full data sets. Median Injury Severity Score was 20, and 57.7% had an Injury Severity Score > 15; 24.4% of patients had a significant coagulopathy. Patients with an acute coagulopathy had significantly higher mortality (46.0% vs. 10.9%; $\chi^2, p < 0.001$). The incidence of coagulopathy increased with severity of injury, but was not related to the volume of intravenous fluid administered ($r^2 = 0.25, p < 0.001$).

**Conclusion:** There is a common and clinically important acute traumatic coagulopathy that is not related to fluid administration. This is a marker of injury severity and is related to mortality. A coagulation screen is an important early test in severely injured patients.

**Key Words:** Traumatic coagulopathy, Hypothermia, Fluid administration.

*J Trauma.* 2003;54:1127-1130.
Early Coagulopathy Predicts Mortality in Trauma

Jana B. A. MacLeod, MD, MSc, Mauricio Lynn, MD, Mark G. McKenney, MD, Stephen M. Cohn, MD, and Mary Murtha, RN

Background: Coagulopathy and hemorrhage are known contributors to trauma mortality; however, the actual relationship of prothrombin time (PT) and partial thromboplastin time (PTT) to mortality is unknown. Our objective was to measure the predictive value of the initial coagulopathy profile for trauma-related mortality.

Methods: We reviewed prospectively collected data on trauma patients presenting to a Level I trauma center. A logistic regression analysis was performed of PT, PTT, platelet count, and confounders to determine whether coagulopathy is a predictor of all-cause mortality.

Results: From a trauma registry cohort of 20,103 patients, 14,397 had complete disposition data for initial analysis and 7,638 had complete data for all variables in the final analysis. The total cohort was 76.2% male, the mean age was 35 years (range, 1–108 years), and the median Injury Severity Score was 9. There were 1,276 deaths (all-cause mortality, 8.9%). The prevalence of coagulopathy early in the postinjury period was substantial, with 28% of patients having an abnormal PT (2,994 of 10,790) and 8% of patients having an abnormal PTT (826 of 10,453) on arrival at the trauma bay. In patients with disposition data and a normal PT, 489 of 7,796 died, as compared with 579 of 2,994 with an abnormal PT (6.3% vs. 19.3%; \( \chi^2 = 414.1, p < 0.001 \)). Univariate analysis generated an odds ratio of 3.6 (95% confidence interval [CI], 3.15–4.08; \( p < 0.0001 \)) for death with abnormal PT and 7.81 (95% CI, 6.65–9.17; \( p < 0.001 \)) for deaths with an abnormal PTT. The PT and PTT remained independent predictors of mortality in a multiple regression model, whereas platelet count did not. The model also included the independent risk factors age, Injury Severity Score, scene and trauma-bay blood pressure, hematocrit, base deficit, and head injury. The model generated an adjusted odds ratio of 1.35 for PT (95% CI, 1.11–1.68; \( p < 0.001 \)) and 4.26 for PTT (95% CI, 3.23–5.63; \( p < 0.001 \)).

Conclusion: The incidence of coagulation abnormalities, early after trauma, is high and they are independent predictors of mortality even in the presence of other risk factors. An initial abnormal PT increases the adjusted odds of dying by 35% and an initial abnormal PTT increases the adjusted odds of dying by 326%.

Stab Popliteal Artery
ISS:  6    BD:  13
Stab Popliteal Artery
ISS: 6   BD: 13

Pelvic fracture
ISS: 41   BD: 4
Stab Popliteal Artery
ISS: 6  BD: 13

Pelvic fracture, Shocked
ISS: 50  BD: 15

Pelvic fracture
ISS: 41  BD: 4
Stab Popliteal Artery
ISS: 6 BD: 13
PT: 13 APTT: 23

Pelvic fracture, Shocked
ISS: 50 BD: 15
PT: 18 APTT: 46

Pelvic fracture
ISS: 41 BD: 4
PT: 12 APTT: 23
Stab Popliteal Artery
ISS: 6    BD: 13
PT: 13    APTT: 23
Fib: 2.3   Plt: 272

Pelvic fracture, Shocked
ISS: 50   BD: 15
PT: 18    APTT: 46
Fib: 1.8   Plt: 140

Pelvic fracture
ISS: 41   BD: 4
PT: 12    APTT: 23
Fib: 2.8   Plt: 232
Pelvic fracture
ISS: 41   BD: 4
PT: 12   APTT: 23
Fib: 2.8   Plt: 232

Pelvic #, Shocked
ISS: 50   BD: 15
PT: 18   APTT: 46
Fib: 1.8   Plt: 140

Stab Pop Artery
ISS: 6   BD: 13
PT: 13   APTT: 23
Fib: 2.3   Plt: 272
Pelvic fracture
ISS:  41   BD:  4
PT:  12   APTT:  23
Fib:  2.8   Plt:  232

Pelvic #, shocked
ISS:  50   BD:  15
PT:  18   APTT:  46
Fib:  1.8   Plt:  140

Stab Pop artery
ISS:  6    BD:  13
PT:  13   APTT:  23
Fib:  2.3   Plt:  272
Coagulation Disorders in Combat Casualties:

I. Acute Changes after Wounding
II. Effects of Massive Transfusion
III. Post-Resuscitative Changes

Richard L. Simmons,* Capt., MC, USAR, John A. Collins,** M.D.,
Charles A. Heisterkamp, III, Lt.C., MC, USA, Douglas E. Mills, Sp.4,
Richard Andren, Sp.5, Louise L. Phillips,*** Ph.D.

From the Division of Surgery, Walter Reed Army Institute of Research, Walter Reed
Army Medical Center, Washington, D. C. 20012
Consumption
Acidemia
Hypothermia
Dilution
Hypoperfusion
Trauma

COAGULOPATHY

Shock

ATC

Haemorrhage
How do you diagnose ATC?
PT & PTT

EXPIRED
Can we predict ATC / MT?
Prehospital / admission physiology?
Early predictors for transfusion

- "hypothermia, acidosis, coagulopathy"
- ISS > 25
- pH < 7.1 / Base deficit >6 / Lactate
- Temp < 35°C
- Physiological parameters
  - SBP<90, HR >120, GCS<9
- PT / APTT >1.5x normal

- Trauma Associated Severe Haemorrhage Score (TASH) J Trauma 2006;60:1228-1237
- Emergency Room Transfusion Score (ETS) Transfusion Medicine 2006;16:49-56
Near patient testing?
Pelvic fracture
ISS: 41 BD: 4
PT: 12 APTT: 23
Fib: 2.8 Plt: 232

Pelvic #, Shocked
ISS: 50 BD: 15
PT: 18 APTT: 46
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Stab Pop artery
ISS: 6 BD: 13
PT: 13 APTT: 23
Fib: 2.3 Plt: 272
ATC:
5 minute Clot Amplitude < 37mm
CA5 <37mm (poor clot):

4 vs 1 units PRBCs
37% vs 5% required FFP
80% sensitivity for >10 units PRBC
CA5 >37mm (good clot):

88% NPV any PRBC
95% NPV 6+ PRBC
99% NPV 10+ PRBC
What do the curves mean?

Can ROTEM/TEG guide therapy?
FFP:PRBC ratio
1:2 / 2:3 / 1:1
RLH Protocol 2004

- General common sense approach
- Initial clinical trigger
- Hourly investigations
- 3 FFP, 5 cryo, 1 ATD platelets
- Keep plt >80
- Platelet function / Head injury
- Consider rVIIa
Potential benefits of MT protocol

- Recognise that traditional guidelines based on observation / expert opinion
- Acknowledge early administration of products is beneficial
- Better communication with lab
- Reduce inappropriate blood product use
- Improve haemostasis
- Improve outcome - survival
Potentially fatal errors

- Blood, blood, blood
- Over transfusion
- Hyperkalaemia
- Hypocalcaemia
- Hypothermia

- Transfusion errors – legal requirements
Massive Haemorrhage Protocols
Code Red - RLH

- Blood in resus – after 2 SUIs
- Need for escalated response
- Collaborative pathway
- Evidence based to some extent
- Military – unpublished work
TRAUMA TEAM LEADER MUST DECLARE CODE RED if:
- Systolic BP < 90
- Poor response to initial fluid resuscitation
- Suspected active haemorrhage

Take baseline blood samples prior to transfusion
- Trauma panel including FBC, U&Es, Clotting screen and fibrinogen
- Near patient testing - ABG and FBC

Immediate Blood Transfusion (red cells)
- Use O NEG units in females or O POS units in males
- Take emergency blood from RESUS fridge
- Immediately inform blood bank resus units are being transfused & request restock. Use direct phone line in resus
- Use group specific blood as soon as available

ANTICIPATE COAGULOPHY IN CODE RED PATIENTS
Nominated member of team to call blood bank on direct line.
- State patient’s unique identifier & ‘CODE RED TRAUMA’
- Request: ONE CODE RED PACK A
  (Contains 5 units Red Cells and 4 units FFP)
- Send porter to lab to collect pack immediately

If bleeding continues – request ONE CODE RED PACK B
(contains: 6 units Red Cells, 4 units FFP, 1 unit platelets and 2 pools cryoprecipitate)
- Continue requesting CODE RED PACK B
  (one pack at a time) until bleeding stops

When bleeding is controlled
- REPEAT FBC AND CLOTTING SCREEN
- Administer further products if
  - Platelets <80x10⁹/l - 1 dose platelets (2 doses if plt <30)
  - Fibrinogen <1.0g/l - 2 pools cryoprecipitate
  - APTT / PT ratio >1.5 x normal - 4 units (~1 litre) FFP

If bleeding persists, contact on call Haemophilia Reg (Bleep 1155 or via switchboard out of hours) to consider rVIIa
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Code Red at RLH
Jan 08 – Oct 09

• 124 HEMS pre-alert
• Median PRBC 8 units (0-45)
• Median FFP:PRBCC ratio 0.45
• Median ISS 29
• Median BE -7.7
• Median Hb 11.9 on arrival
• 75 survivors
• General trend to improved ratios
Summary

• Traumatic coagulopathy is commoner than we recognise
• Standard blood tests underestimate the problem
• Early blood product administration can improve survival
• Local protocols need careful implementation and training