Massive Transfusion Initiation & Implication

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Trauma Statistics/Facts

- Each year trauma accounts for 41 million emergency department visits and 2.3 million hospital admissions across the nation.

- **Life Years Lost (2014)**
  - Trauma injury accounts for 30% of all life years lost in the U.S.
  - Cancer accounts for 16%
  - Heart disease accounts for 12%

- **Economic Burden**
  - $671 billion a year, including both health care costs and lost productivity

- **Deaths due to injury (2014)** 192,000

- **Ranking as cause of death**
  - #1 for age group 1-46, or 47% of all deaths in this age range
  - #3 as leading cause of death overall, across all age groups

- Receiving care for a severe injury at a designated/verified trauma center can lower risk of death by 25 percent, yet almost 45 million Americans do not have access to a trauma center within one hour of becoming injured (CDC).
Case 1

- A 28-year-old white male with unknown medical history presented to the emergency room after suffering a gun-shot wound to the right groin.

- Initial vital signs demonstrated a heart rate of 153 beats per minute, oxygen saturation 93%, and a thready pulse with an inability to detect a noninvasive blood pressure.

- The patient was confused and combative, and pertinent physical exam revealed an actively bleeding wound to the right inguinal region.
What are your initial priorities in managing this case?

Is it time to start the massive transfusion protocol?

Central venous access was obtained, Massive Transfusion Protocol (MTP) initiated, and 2 units of un-cross-matched, O-negative blood were hung as the patient was rushed to the Level 1 trauma OR. Lab work had not been obtained prior to transport.

Initial arterial blood gas analysis demonstrated:

**pH 6.622**, **paO₂ 424.6 mm Hg**, **paCO₂ 57.2 mm Hg**, **HCO₃ 6.6 mmol/L**, **base excess –29.3 mEq/L** on 100% FiO₂, and a point of care hemoglobin 12.1 g/dL.

Blood was sent to the laboratory for complete analysis and typing, but those results, as well as cross-matched blood products, were unavailable during the initial resuscitation. When lab results returned, the patient’s coagulation panel demonstrated prothrombin time (PT) **22.4 seconds**, partial thromboplastin time (PTT) **49.6 seconds**, international normalized ratio (INR) **2.0**, and fibrinogen **124 mg/dL**. The patient’s blood type was later determined as O-positive.
Which biochemical values require monitoring in the critically bleeding patient?

- Temperature, Acid-base status, Ionized calcium, Hemoglobin, Platelet count
- PT/INR APTT
- Fibrinogen level

Values indicating critical physiological derangement include:

- Temperature <35
- pH <7.2, base excess >-6, lactate >4mmol/L
- Ionized calcium <1.1mmol/L
- Platelet count <50 x 10/L
- PT > 1.5 X normal
- INR >1.5 X normal
- Fibrinogen level <1 g/L
What is the most common cause of death within the first hour of arrival to a trauma center?

Hemorrhage

What is the definition of Massive Hemorrhage?

Massive hemorrhage can be defined as follows: blood loss exceeding circulating blood volume within a 24-hour period, (ii) blood loss of 50% of circulating blood volume within a 3-hour period, (iii) blood loss exceeding 150 ml/min, or (iv) blood loss that necessitates plasma and platelet transfusion.

What is the deadly triad?

Acidosis, Hypothermia, Coagulopathy
Trauma Mortality and the Golden Hour

Early Mortality

CNS injury & Hemorrhage

Prehospital period 33-56% Hemorrhage

Operating room 80% Hemorrhage

First 24 hours 50% Hemorrhage

Late Mortality & Morbidity

Acidosis/ Base deficit

Multi-organ Failure

Sepsis

[Diagram showing percentage of deaths in prehospital, first 24 hours, and after 24 hours, with categories for Hemorrhage, CNS, and Other.]

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*Prehospital
**Other
Early recognition of major blood loss and effective resuscitation are essential to avoid unnecessary deaths.

Delays to transfusion adversely affects outcome.

Key element is effective communication between all staff involved in patient’s care.
What classification tool can assist you in classifying hemorrhagic shock in the critically bleeding adult patient?

<table>
<thead>
<tr>
<th>Class of haemorrhagic shock</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood loss (mL)</td>
<td>Up to 750</td>
<td>750–1500</td>
<td>1500–2000</td>
<td>&gt; 2000</td>
</tr>
<tr>
<td>Blood loss (% blood volume)</td>
<td>Up to 15</td>
<td>15–30</td>
<td>30–40</td>
<td>&gt; 40</td>
</tr>
<tr>
<td>Pulse rate (per minute)</td>
<td>&lt; 100</td>
<td>100–120</td>
<td>120–140</td>
<td>&gt; 140</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Normal</td>
<td>Normal</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Pulse pressure (mm Hg)</td>
<td>Normal or increased</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Respiratory rate (per minute)</td>
<td>14–20</td>
<td>20–30</td>
<td>30–40</td>
<td>&gt; 35</td>
</tr>
<tr>
<td>Urine output (mL/hour)</td>
<td>&gt; 30</td>
<td>20–30</td>
<td>5–15</td>
<td>Negligible</td>
</tr>
<tr>
<td>Central nervous system/mental status</td>
<td>Slightly anxious</td>
<td>Mildly anxious</td>
<td>Anxious, confused</td>
<td>Confused, lethargic</td>
</tr>
</tbody>
</table>
Stages of Hemorrhage

Stage IV: ATP supply \ll ATP demand
- Anaerobic metabolism
- Membranes leak
- Membranes depolarize
- Entry of Ca\(^{2+}\) into cells
- Membranes rupture
- Cell death

Stage III: ATP supply \lt ATP demand

Stage II: ATP supply = ATP demand
- Recruitment of capillaries

Stage I: ATP supply = ATP demand
- Redistribution of blood flow

O\(_2\) Consumption vs. O\(_2\) Delivery

DO\(_{2}\)crit
15–20% of the resulting deaths which occur within the first 12-24 hours of hospital admission might be preventable.

How?

Prompt and aggressive administration of blood products: Massive transfusion protocols (MTPs)

Resuscitation with damage control

Permissive hypotension
The main mechanisms involved in acute trauma related coagulopathy and transfusion strategy

- Traumatic haemorrhagic shock
- Haemorrhagic shock
  - Fluid resuscitation
  - Hypothermia
  - Hypocalcemia
- Tissue injury
  - Inflammation
  - Excessive activation of the coagulation
  - Fibrinolysis
- Hemodilution
  - Decrease of activity of coagulation factors and platelet function
- Beside coagulation monitoring
- Tranexamic acid
- Low volume resuscitation
  - $80 \leq \text{SAP} \leq 90 \text{ mmHg}$
  - Early administration of vasopressor
- Normothermia
  - Ionised Ca$^{++} = 1.1-1.3 \text{ mmol/l}$
- Avoid delays in the delivery
  - Massive transfusion protocol
  - RBCs:FFP $\leq 2:1$
  - Early administration of FFP
  - Fibrinogen $\geq 1.5-2 \text{ g.L}^{-1}$

Acute Traumatic Coagulopathy
Flowchart of initial management of trauma related hemorrhagic shock

- **Primary goal**: Stop the bleeding

**Hemodynamic management**
- Fluid resuscitation
  - Goals of AP
    - Without TBI: 80 ≤ SAP ≤ 90 mmHg
    - With TBI (GCS ≤8): SAP ≥ 120 mmHg
  - Failure to obtain goals of AP
    - Early administration of vasopressor (norepinephrine)
      - Start at 0.1 μg/kg/min
  - Titration of fluid resuscitation
    - Indices of preload responsiveness
      - Cardiac output
      - Markers of tissue oxygenation

**Coagulation management**
- Tranexamic acid
  - 1g IV followed by IV infusion of 1g over 8 h
- Transfusion Coagulation targets
  - Without TBI (Hb 7-9 g.dL⁻¹)
    - PT/APTT < 1.5 x normal
    - Platelets > 50.10⁹ L⁻¹
    - Fibrinogen ≥ 1.5-2 g.L⁻¹
  - With TBI (GCS ≤8) (Hb > 10 g.dL⁻¹)
    - PT/APTT < 1.5 x normal
    - Platelets > 100.10⁹ L⁻¹
    - Fibrinogen ≥ 1.5-2 g.L⁻¹

**Surgical and/or angiographic embolization bleeding control**
What is Damage Control Resuscitation (DCR)?

- Patients die from a triad of **coagulopathy, hypothermia and metabolic acidosis**. Once this metabolic failure has become established it is extremely difficult to control hemorrhage and correct the derangements.

- If the patient is to survive, the operation must be foreshortened so that they can be transferred to a critical care facility where they can be warmed and the hypothermia and acidosis is corrected. Once this is achieved the definitive surgical procedure can be carried out as necessary - the 'staged procedure'.

- RBC and plasma should be delivered by a rapid transfuser and through a blood warmer

- Restore perfusion and permissive hypotension
(a) Classical damage control resuscitation–damage control surgery sequence (b) Integrated damage control resuscitation – damage control surgery sequencing.
What is permissive hypotension?

Systolic blood pressures of 80-100 mm Hg are tolerated while bleeding is being controlled (without TBI).

No need to normalize the blood pressure!
Back to our case!
Is it time to start the massive transfusion protocol?

- A 28-year-old gun-shot wound
- Initial vital signs: HR 153 beats per minute, oxygen saturation 93%, an inability to detect a noninvasive blood pressure.
- The patient was confused and combative, and pertinent physical exam revealed an actively bleeding wound to the right inguinal region.
Triggers for Initiating MT Prediction Tools

Predicting the need for MT

- The Assessment of Blood Consumption (ABC) score
- The Emergency Transfusion Score (ETS)
- The Trauma Associated Severe Hemorrhage (TASH) score
The Assessment of Blood Consumption (ABC) score

Assign a value of 0 or 1 to the presence of:

- Penetrating trauma
- Positive focused abdominal sonography in trauma (FAST)
- Systolic blood pressure (SBP) < 90 mm Hg
- Heart rate (HR) > 120 bpm
Criteria to trigger the activation of MTP include one or more of following:

- ABC score 2 or more
- Persistent hemodynamic instability
- Active bleeding requiring operation or embolization
- Blood transfusion in the trauma bay
MTP triggers met, what do you do?

- Activate MTP
- Order MTP
- Begin universal blood product infusion rather than crystalloid or colloid solutions
- Transfuse universal RBC and plasma in a ratio of 1:1 Universally compatible RBC (O Rh negative) and thawed plasma (AB plasma or low titer A plasma)
- Transfuse one Single Donor Platelet (SDP) or random donor platelet pool for each 6 units of RBC
- Blood products should be sent by the Blood Bank (BB) in established ratios
- Subsequent coolers should be delivered at 15-minutes intervals until MTP has been terminated
- The goal is to keep at least one MTP cooler ahead for the duration of the MTP activation
Precondition TICs System before each use:

To Precondition: Place TICs System panels flat in a -18°C freezer (or colder) for a minimum of 12 hours, until frozen hard. Before loading product/payload, let panels stand at room temperature for 25 minutes or until surface frost melts.

Optional Storage Method: After TIC System preconditioning, it may be refrigerated up to 48 hours before needing to be reconditioned.

For full loading instructions please reference user guide. For additional product information call (877) 537-8800 or visit CredoThermal.com

MUST Stay in the Cooler
Return to Blood Bank

Credo Cube™
SERIES 4 8240R

TIC Size
6.5X11
Route and Rate of Fluid Administration

- Standard, large (14- to 16-gauge) peripheral IV catheters are adequate for most fluid resuscitation.
- With an infusion pump, they typically allow infusion of 1 unit of packed RBCs in 20 min.
- For patients at risk of exsanguination, a large (8.5 French) central venous catheter provides more rapid infusion rates; a pressure infusion device can infuse 1 unit of packed RBCs in < 5 min.
Notify the blood bank, when patient is transferred from ER to OR, or interventional radiology.

Once major bleeding has been controlled and the rate of transfusion has slowed it is appropriate to switch to a laboratory-or Point Of Care (POCT)-based transfusion.

For the performance improvement purposes the of ratio of blood product transfusion should be accessed at the time of bleeding cessation.
Criteria and process for termination the MTP

- Anatomical (control of bleeding) and physiological (normalizing hemodynamic status) criteria
- Further resuscitation is futile
Ant fibrinolytic medications (Tranexamic acid TXA or Aminocaproic acid)

Prothrombin Complex Concentrates

Recombinant activated factor 7
Review cases of MTP with the following complications:

- Coagulopathy
- Thrombotic complications
- ARDS
- Other transfusion reactions: TACO, TRALI, and HTR
- Inappropriate FFP: RBC ratio
- Death
Performance Indicators for the process of MTP

- Time from calling MTP to infusion of first unit RBC
- Time from calling MTP to infusion of first unit of Plasma
- Adherence to predetermined ratio
- Informing the BB that MTP has been terminated within one hour of termination
- Wastage rate for blood products
Case 2

- 31-year-old male was rock-climbing with two friends at a national park 14 miles away from the nearest hospital when he suddenly lost his footing and fell 18 feet to the ground.

- Med-evac located and evacuated the man. A large-bore IV was placed in each arm in-flight, and normal saline fluid was administered intravenously. The patient became increasingly disoriented during the flight, reaching the emergency room about 40 minutes after the fall.
The patient was lethargic but responsive to shouting and sternal pinch.

He had multiple abrasions over his chin, neck, anterior thorax, and abdomen. A six-inch-long, half-inch deep laceration was noted in the right inguinal region, extending into the right, upper thigh. The tourniquet placed in this area was soaked with blood.

Vital signs were as follows: HR = 112 (supine) and 128 (sitting), BP = 108 / 60 (supine) and 92 / 52 (sitting), RR = 32, rectal temp = 99.4°F. Skin was cold and clammy.
Laboratory Studies

- Hematocrit = 46%
- Hemoglobin = 15.0 gm / dl
- Blood pH = 7.28
- Urinary output in first 60 minutes in ER was 20 ml
- ECG revealed normal sinus rhythm with slight ST-depression in most leads.
What is this patient's primary problem?

- This patient has lost a significant volume of blood due to a laceration of his right femoral artery. He is in danger of developing hemorrhagic shock.
List all of the evidence you can that supports your answer to #1

- The history of a fall and the appearance of a blood-soaked, right thigh tourniquet overlying the laceration in the right groin suggest that this patient lacerated his right femoral artery.
Is this patient's urinary output normal? Why is it important to monitor this patient's urinary output?

- This patient's urinary output is 20 ml per hour, which is below normal range of 30-50 ml per hour.
- Severe hemorrhagic shock can reduce blood flow to the kidneys
- Acute renal failure
What is the ABC Score?

- Do you activate MTP?
- How do you activate MTP?
MTP Ordering Process

Massive Transfusion Criteria & Consequences

MTP Declared by authorized MD and/or resident (Team Leader)

Call the Blood Bank (BB) x 26344 or Use Red Phone in Trauma Room to: Inform of the activation of the MTP

“Sunrise” → ‘MTP1 order set’:
= 4 RBC + 4 FFP + 1 PLA
& Type and Screen + CBC,
& ABG & electrolytes,
& PT/PTT, Fibrinogen level,
& TXA-tranexamic acid (Pharmacy)
MTP order set 2 : 6 RBC+6 FFP+1PLA+ CRAYO

Pre-Identify Team Lead:
• Know the criteria
• Assign roles
• Ensure basic knowledge
• Track progress (way-points)

Provide to Blood Bank:
• Team leader name pager #
• Patient’s information
• Name, MR#, Gender, Age
• Limited Clinical History

Track progress:
• Know where you are
• Keep up with plasma
• Order labs as you go
Suggested points for residents from blood bank techs!

1. **Confirmatory specimens:**
   a. There is no point in drawing a confirmatory specimen at the same time as the TNS. Tell them we KNOW they are doing this and it needs to stop! The patient must be “re-identified” before drawing the confirmatory sample.

   b. If a patient has a name (not Trauma name), they can call blood bank to see if a confirmatory is needed or not. (Even if a patient was born here and we have a type, it counts! and we do not need a confirmatory ever!)

2. **Phlebotomist ID:**
   First initial, Last name and Lawson number of the Phlebotomist (person who identifies the patient) must be LEGIBLE and on all specimens Submitted to the blood bank. If the required info is missing or illegible you will have to redraw the patient.
3. **MTP vs ala carte product ordering:**

   Please stress that you do not need to have an MTP, in order to get urgent blood products. If you know a patient will probably need blood, even a relatively large amount (not massive), this can be ordered ahead of time (for example: order 4 plasma and 4 RBC if there is a possibility it may be required).

4. **Uncrossmatched vs Crossmatched blood:**

   a. O negative, which is usually given for uncrossmatched blood is a very rare commodity and must be used judiciously (I like that word). Only approximately 7.5% of the population is this type.

   b. Crossmatched blood means that a sample of the donor unit is tested with the patients serum in a test tube to observe for any incompatibility. You do not have this assurance with uncrossmatched blood.

   c. Blood Bank is NOT WALMART. The staff does not just take the item out of the refrigerator and CHECK it out. RBC must be crossmatched. Plasma must be thawed. Orders must be accepted and filled and issued in the computer. All while assuring the safe transfusion for your patient.
5. **ALLOCATED in the computer means “ready to be picked up”**

   a. You should not have to call the blood bank to see if blood is ready.

   b. The blood bank does not have to be notified that you are coming/sending someone to pick up blood products.

   c. A pick up slip with patients full name and MR# is always required.

      Also remind them when the patient expired please let us know so units reserved on the patient can be made available.

      Also…no CABD is not a reason to order uncrossmatched blood!