FLUID THERAPY IN TRAUMA

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Early signs of hemorrhagic shock

- Visible blood loss or long-bone fracture
- Anxiety, lethargy, coma
- Pallor, diaphoresis, decreased skin turgor
- Hypotension (with narrowed pulse pressure)
- Tachycardia
- Nonfunctioning pulse oximeter
- Decreased ETCO2
## Estimation of blood volume deficit in trauma

<table>
<thead>
<tr>
<th>Condition</th>
<th>Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral hemothorax</td>
<td>3000</td>
</tr>
<tr>
<td>Hemoperitoneum</td>
<td>2000 – 5000</td>
</tr>
<tr>
<td>Pelvic fracture</td>
<td>1500 – 2000</td>
</tr>
<tr>
<td>Femur fracture</td>
<td>800 – 1200</td>
</tr>
<tr>
<td>Tibia fracture</td>
<td>350 – 650</td>
</tr>
<tr>
<td>Small fracture sites</td>
<td>100 – 500</td>
</tr>
</tbody>
</table>
Most common regions of bleeding in hemorrhagic shock

<table>
<thead>
<tr>
<th>Location</th>
<th>Cause</th>
<th>Diagnostic Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest</td>
<td>Pulmonary injury, Intercostal arteries, Great vessels</td>
<td>physical examination, chest RTG, CT, chest tube output</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Solid organ injury, Mesentery</td>
<td>FAST, CT, DPL</td>
</tr>
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# Most common regions of bleeding in hemorrhagic shock

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<th>Location</th>
<th>Cause</th>
<th>Diagnostic Approach</th>
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<tr>
<td>Retoperitoneum</td>
<td>Post.pelvic fracture; Renal aortic, vena, Caval injury</td>
<td>pelvic instability, pelvic RTG, CT</td>
</tr>
<tr>
<td>Thights</td>
<td>Femur fracture</td>
<td>physical examin., direct RTG</td>
</tr>
<tr>
<td>“The street”</td>
<td>Scalp fracture, Open fracture, Massive soft tissue wounds</td>
<td>physical examin.</td>
</tr>
</tbody>
</table>
## Classification of hypovolemic shock based on response to fluid bolus

<table>
<thead>
<tr>
<th>Response to 500ml crystalloids</th>
<th>Clinical implication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responder</strong> increased and sustained improvement BP</td>
<td>not actively bleeding, do not require transfusion</td>
</tr>
<tr>
<td><strong>Transient responder</strong> increased BP but recurrent hypotension</td>
<td>actively bleeding, consider early transfusion</td>
</tr>
<tr>
<td><strong>Nonresponder</strong> no improvement</td>
<td>likely active bleeding, severe hypoperfusion, rule out: - tension pneumothorax, - cardiac tamponade, - spinal cord injury, immediate transfusion (early plasma and platelets)</td>
</tr>
</tbody>
</table>
Supply exceeds demand

Demand exceeds supply

Oxygen Delivery

+

- compensated shock

resuscitation

hemostasis achieved

A
Hemodynamic balance in hemorrhagic trauma

Hypotension

Hemorrhage
Analgesia
Sedation
PPV

Hypertension

Pain
Anxiety
Fluid
Blood products
Routine Monitoring of Severely Injured

- ECG
- CVP (central venous catheter)
- IBP (arterial line)
- Stroke Volume (hemodynamic monitoring)
- Pulse Oximetry
- Capnography
- Central Temperature
- Urine Output
- POC (laboratory studies: ABG, Hgb, Ht, Electrolytes, Coagulation parameters, serum lactate)
Future monitoring of hemorrhagic shock

- Mixed venous oxygen saturation
- Gastric tonometry (?)
- Sublingual CO2 concentration
- Infra-red tissue oximetry
Priority in Trauma Management

- *restore and maintain* organ perfusion
- *restore and maintain* oxygenation above critical level

best achieved by

- *stopping the bleeding*
- *repleting intravascular volume*
Rapid crystalloid infusion in active hemorrhage?

vigorous fluid resuscitation → hemodilution, increased bleeding

recurrent hypotension
Immediate fluid resuscitation?

Disadvantages

- Decreased blood viscosity
- Blowout of hemostatic plug
- Dilution of coagulation factors
- Increased blood loss
- Delayed transport to definitive care
Delayed fluid resuscitation?

**Benefits**

- Faster transfer to hospital facilities
- Avoidance of recurrent bleeding and hypotension
## Fluid Options for Trauma Hemorrhage

### Isotonic Crystalloids

<table>
<thead>
<tr>
<th>Fluid Type</th>
<th>pro</th>
<th>contra</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9% saline</td>
<td>compatible with blood</td>
<td>dilutes blood components, hyperchloremic metabolic acidosis</td>
</tr>
<tr>
<td>Lactate Ringer’s</td>
<td>physiologic electrolyte mix</td>
<td>dilutes blood composition, may clot blood (contains calcium)</td>
</tr>
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</table>
## Fluid Options for Trauma Hemorrhage

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<th>Colloids</th>
<th>pro</th>
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<tr>
<td><strong>5% Albumin</strong></td>
<td>rapid volume expansion</td>
<td>may result endothelial swelling, no proved benefit</td>
</tr>
<tr>
<td><strong>High MW Hetastarch</strong></td>
<td>rapid volume expansion</td>
<td>coagulopathy, platelet dysfunction</td>
</tr>
<tr>
<td><strong>Low MW Hetastarch</strong></td>
<td>rapid volume expansion, less</td>
<td>no proved benefit</td>
</tr>
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Fluid Options for Trauma Hemorrhage

**Hypertonic saline**

**pro**
- rapid volume expansion,
- restores intravascular volume,
- decreases ICP,
- improved outcomes in TBI

**contra**
- rapid increase BP may exacerbate bleeding, dilutes blood composition
# Fluid Options for Trauma Hemorrhage

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<td><strong>Red blood cells</strong></td>
<td>rapid volume expansion, increased oxygen delivery</td>
<td>limited resource, cross-matching requ., viral transmission</td>
</tr>
<tr>
<td><strong>Plasma</strong></td>
<td>rapid volume expansion, clotting factor replacement</td>
<td>limited resource, cross-matching requ., viral transmission</td>
</tr>
<tr>
<td><strong>Fresh whole blood</strong></td>
<td>rapid volume expansion, increased oxygen delivery, includes factors and platelets,</td>
<td>limited resource, cross-matching requ., long time for viral testing</td>
</tr>
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</table>
**Donation**

**Fresh Whole Blood 500ml:**
- Hematocrit 45%
- Factor activity 100%
- Platelets 250,000/mcl

**Transfusion**

**660ml:**
- Hematocrit 29%
- Factor activity 65%
- Platelets 88,000/mcl

**RBC: 355ml**
- Hematocrit 55%

**Plasma: 275ml**
- Factor activity 80%

**Platelets: 50ml**
- 5.5x10^10
**Fluid Resuscitation Strategy**

**Asap**
- before the point of uncompensated shock

**Possible Immediate**
- localization and correction source of bleeding

**Continuous**
- support patient’s physiology
  - (not normalization)
**Fluid Resuscitation Strategy**

*slow crystalloid infusion*

*controlled hypotension (SBP 90mmHg)*

*preserve blood composition*

*as soon as deficits identified: O neg. RBC, plasma, platelets*
**Fluid Resuscitation Strategy**

*actively bleeding transient responder in ED*

- **Fresh Whole Blood**
- **Massive Transfusion Protocol:**
  - red blood cells, thawed fresh plasma, platelet pool
  - “jump start” to coagulation: cryoprecipitate, Factor VII a, bicarbonate, calcium

*avoid*

- hypothermia, hypocalcemia, hyperkalemia, hyperglycemia

*The Best Course - RAPID HEMOSTASIS*
Thank you for your attention