Applying ROTEM to the Management of Bleeding in Trauma

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Disclosure

NONE
ROTEM for the management of trauma

ROTEM

Growing evidence usefulness
Cardiac surgery, liver transplant, etc

Incipient in trauma

Why care about a lab test?
Introduction

1. Trauma is common
2. 1st cause mortality (*young*)
3. Bleed a lot (1st hospital death; 90% cryo; 50% FFP)

Sauaia et al J Trauma 1995;38:185
Two types of bleeding:

**Mechanical** - surgery

**Coagulopathic** - blood
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Coagulopathy 21st Century

Until 2003 (Brohi)

- Bleeding
- Dilution

Coagulopathy

Hypothermia

Acidosis

Etc; etc

After 2003

- Endogenous
- Within minutes
- 25% patients
- Shock
- Tissue damage
- 3x mortality
Mechanism 1 – Anticoagulation

- Trauma
- Shock
- Thrombin generation
  - (-)
  - Clot formation anticoagulated

Endothelial damage

- TM + Thrombin
- TM + Thrombin

- PC
- APC
- FV
Mechanism 2 – Hyper fibrinolysis

- APC
- PAI-1
- tPA

Fibrinolysis

Clot lysis fibrinolysis

(-) fibrinogen
Mechanism 3 – Hypo fibrinogemia

Fibrinogen = CRITICAL

- $1^{\text{ary}}$ & $2^{\text{ary}}$ hemostasis
- $1^{\text{st}}$ to drop ($140\% - \text{plat } 230\%$)
- Consumption
- Dilution
- Small reserves ($10g$)
- Hyperfibrinolysis = 86% mortal.
Mechanism 4 – Other

Hypothermia & acidosis = CRITICAL

- Decrease thrombin generation
- Fibrinogen synthesis
- Fibrinogen degradation
- Clot factors (enzymes)

Mechanism 5 DIC = no evidence
Pathophysiology

- Unique & early
- Shock + tissue destruction
- Complex (multiple defects)

a. Anticoagulation = APC
b. Hyper fibrinolysis = tPA
c. Imbalances
d. Low fibrinogen
e. Hypothermia, acidosis
Management

How did the 21\textsuperscript{st} century change the resuscitation of bleeding trauma patients
Management

1. **Lab-guided**
   - time to results – POC limitations
   - “catch up”
   - no evidence

Chandler *(Transfusion 2010)*
Rapid bleed panel <20min *(10-15min verbal)*
Management

2. Formula “one size fits all”
DCR or 1:1:1

everyone is (or will be) coagulopathic
everyone needs plasma (± platelet)
start plasma as early as possible
no lab required
limit use crystalloids
Management

2. **Formula “one size fits all”**
   
   DCR or 1:1:1
   
   TRFL study **CMAJ 2013;185(12)**
   
   inappropriate transfusion
   wastage
   increase complications *(ARDS, sepsis)*
   
   ?? mortality
Ideal Resuscitation

Dr McCoy (Star Trek) tricorder

**Ideal**: instant results

Multiple coagulopathies

Individualized care
ROTEM

Advantages over conventional tests:

1. Differentiate mechanical vs. coagulopathic
2. Guide transfusion

3. Hypo coagulation: A5 or MCF
   A5<35mm  77% massive transfusion

4. Hyper fibrinolysis: ML or LY30
   Death sentence  65-100% literature
   75% Toronto
ROTEM for Surgeons (Idiots)

- A5 < 35 give platelets
- LY30 < 95% give tranexamic acid
- CT > 100 give 4 FFP
- MCF < 7 give 10 cryo
### Real Life – arrival

#### A. Blood Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Result</th>
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</thead>
<tbody>
<tr>
<td>Hemoglobin (g/L)</td>
<td>50</td>
</tr>
<tr>
<td>Platelets (10^9/L)</td>
<td>55</td>
</tr>
<tr>
<td>INR</td>
<td>2.4</td>
</tr>
<tr>
<td>PTT (seconds)</td>
<td>&gt; 150</td>
</tr>
<tr>
<td>D-dimers (ng/mL)</td>
<td>7750</td>
</tr>
</tbody>
</table>

#### B. TEG Results

![TEG Results Graph]
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30’ 4h 28h

24h

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Real Life

60yo M – pedestrian hit by car

**Pre-hospital:**
GCS 5, intubated at the scene
Hypotensive, given 4L crystalloid
Right chest tube ~ 500 mL

**Trauma Room:**
BP 110/50; HR 83
CT chest = multiple rib fractures
CT abd = complex pelvic fracture
# Lab & Clinical Progress

<table>
<thead>
<tr>
<th></th>
<th>0h</th>
<th>4h later</th>
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<tbody>
<tr>
<td>Hg</td>
<td>78</td>
<td>53</td>
</tr>
<tr>
<td>Plat</td>
<td>195</td>
<td>118</td>
</tr>
<tr>
<td>INR</td>
<td>1.47</td>
<td>1.47</td>
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<tr>
<td>PTT</td>
<td>3.5</td>
<td>29</td>
</tr>
<tr>
<td>Lactate</td>
<td>3.5</td>
<td>4.8</td>
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</tbody>
</table>

1st hour
3U RBC + 4U FFP

4h later = crash
Hypotensive
Taken to angio
Embolization pelvis

7.14/65/311/21 100%

Fibrinogen = 1 (normal ≥2g/L)
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**EXTEM**
- CT: 57 (38-79)
- α-angle: 63 (63-88)
- A5: 31 (>35)
- MCF: 53 (50-72)
- ML: 9% (<15%)

**FIBTEM**
- A56
- A10: 6 (7-23)
- MCF: 8 (9-25)

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Lethal triad coagulopathy = \textit{INR} 1.47
acidotic = \textit{lactate} 3.5/pH 7.14
bled/bleeding = \textit{Hg} 78

\textbf{ROTEM} low = A5 & fibtem MCF

4U FFP = INR not corrected (difficult correct INR 1.47)
Tranexamic acid NOT given

Coagulopathic = “crash” later (\textit{no active bleeding on CT})
? more aggressive – correct fibrinogen, platelet?

Best treatment \textbf{customized}
examination + lab (INR, lactate) + ROTEM
Management

Guess the outcome!
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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Range</th>
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<tbody>
<tr>
<td>CT</td>
<td>86</td>
<td>(38-79)</td>
</tr>
<tr>
<td>CFT</td>
<td>133</td>
<td>(34-159)</td>
</tr>
<tr>
<td>α-angle</td>
<td>70</td>
<td>(63-88)</td>
</tr>
<tr>
<td>A5</td>
<td>29</td>
<td>(&gt;35)</td>
</tr>
<tr>
<td>A10</td>
<td>5</td>
<td>(43-66)</td>
</tr>
<tr>
<td>MCF</td>
<td>28</td>
<td>(50-72)</td>
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<tr>
<td>LI30</td>
<td>12</td>
<td>(94-100)</td>
</tr>
<tr>
<td>ML</td>
<td>100%</td>
<td>(&lt;15%)</td>
</tr>
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</table>

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<thead>
<tr>
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<th>Value</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>A10</td>
<td>2</td>
<td>(7-23)</td>
</tr>
<tr>
<td>A20</td>
<td>1</td>
<td>(8-24)</td>
</tr>
<tr>
<td>MCF</td>
<td>8</td>
<td>(9-25)</td>
</tr>
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</table>
ROTEM for the management of trauma

Thank you