ROTEM/TEG

“Circulation in trauma: From roadside to bedside”

A/Prof David Roxby
SA Pathology Transfusion Service
South Australia

Joint Trauma & ACCUTE SIG Meeting
Disclosures

- CSL
- National Blood Authority
- NovoNordisk
- TEM Innovations
- HaemoView Diagnostics
- Ortho Clinical Diagnostics
- Terumo
- Amgen

- Haemonetics
- NATA
- RCPA
- Grifols
- Australian Red Cross Blood Service
- Caridian BCT
- Standards Australia

- ROTEM user
GOOD THINGS

✓ Retrieval
✓ Triage
✓ Hypotensive resuscitation
✓ Trauma management teams
✓ Diagnosis
  ✓ Imaging
  ✓ Invasive
✓ Damage control surgery versus definitively "fixing" the problem
✓ Organ supportive therapy

BAD THINGS

❖ Pre-existing disorders
❖ Increasing Shock
❖ Trauma to vital organs
❖ Trauma ⇒ Coagulopathy
❖ SIR ⇒ MOF
❖ Sepsis
❖ Blood storage lesion
❖ Compounding medical disorders (Myocardial, Respiratory, Renal)
Trauma, Haemorrhage & Transfusion

- Tissue trauma is massive & uncontrolled
- Initiation of transfusion may be late
- Hypovolemia & shock are present
- Temperature is not controlled => hypothermia
- Monitoring of haemostasis is late
- Coagulopathy occurs early
Coagulopathy of Trauma

Pro-thrombotic State
DVT / PE

Haemorrhagic State
Bleeding
Ongoing hypotension

Coagulopathy of trauma is dynamic
**Haemorrhage**

- Leading cause of death in first hour of arrival\(^1\)
- Responsible for more than 80% of OT deaths\(^2\)
- Accounts for nearly 50% of deaths in first 24 h\(^2\)
- *Control commonly thwarted by coagulopathy [25-30%]*\(^3, 4\)

Challenges inherent to the management of critical bleeding

- Represents a significant clinical challenge
  - trauma, surgical, medical & obstetric scenarios
- High mortality
- Poor planning
- Poor communication
- Infrequent or inappropriate laboratory monitoring
- Massive transfusion
  - Inappropriate use of blood products
- Significant delay in ordering/administering plasma/fgn
- Failure to prevent hypothermia & low use of fluid warmers
**Therapeutic Goals**

- Judicious use of blood components to correct coagulopathy
  - Treat early
  - Treat adequately
  - ‘Too little, Too late’
  - ‘Not too wet nor too dry’

- Early goal-directed coagulation management
  - Surgical bleeding ↔ coagulopathy

- Goal
  - Prevent/minimize coagulopathy
  - Avoid unnecessary transfusions
  - Minimize end organ dysfunction
Importance of Coagulation Monitoring

- Diagnose potential causes of haemorrhage
- Predict risk of bleeding
- *Guide appropriate haemostatic therapy*
  - Blood products associated with increased
    - LOS
    - Infections & sepsis
    - MOF
    - Morbidity & mortality
    - TRALI
    - TACO
- Standard coagulation assays
  - Often provide a specific biochemical diagnosis
  - No assurance that this correlates to the clinical picture
What’s the Problem?

- Constant changes in treatment recommendations
- Variation in clinical practice
- Lack of good evidence to guide practice
  - Lack of randomised controlled trials
- Assumptions
  - Abnormalities of PT/INR correlate with risk of bleeding from procedure
  - FFP use can correct abnormal PT/INR & reduce or eliminate risk of bleeding
- Inappropriate use of labile blood components
  - Exposing patients to risk with poor evidence for benefit
  - Inappropriate use of FFP to normalise INR
**Haemostatic Resuscitation**

- Remains controversial when and in what dose plasma/cryo/RCs/plts should be transfused to massively bleeding patients
- Optimal ratio of FFP:RC:Plts remains to be established
  - FFP:RC ratio >1:2 is associated with improved survival compared to <1:2
    
    Maegele M. Vox Sang 2008;95:112

- **Goal directed management**
**Alternatives in Bleeding Management**

- **Blind therapy**
  - According to estimated blood loss
  - 1:1:1 formula driven (RC:FFP:Plts)

- **Individualised therapy**
  - Routine lab results directed therapy [time delays]
  - PoC directed therapy – algorithm based
    - Specific coagulation factor concentrates
Rational Haemostatic Function & End Points

Identify Cause & Stop The Bleeding
- Surgery
- Physical measures
- Embolisation
- Minimise delay in receiving products

Adequate Haemostatic Function
- Std coags or PoCT (ROTEM/TEG)
- Correct blood products in appropriate volumes
- Anti-fibrinolytics
Management of severe perioperative bleeding

Guidelines from the European Society of Anaesthesiology
Kozek-Langenecker S et al

- Target therapy according to cell-based model of coagulation
- Use PoCT
- Restrictive use of allogeneic blood products
Point of Care Devices for Assessing Bleeding and Coagulation in the Trauma Patient

Oliver M. Theusinger, MD\textsuperscript{a,*}, Jerrold H. Levy, MD, FAHA, FCCM\textsuperscript{b}
Anesthesiology Clin 2013;31:55-65

KEY POINTS

- Routine coagulation tests in the laboratory only reflect the initiation phase of hemostasis and cannot be used to monitor coagulopathy.
- Viscoelastic devices (such as thromboelastography or rotation thromboelastometry) measure clot formation and dissolution in whole blood and thus should be used to monitor trauma patients.
- Hypocoagulable results in viscoelastic devices predict the need for massive transfusion and correlate with increased rate of mortality; hence, therapy aiming at restoring clot strength is recommendable.
**Viscoelastic Coagulation Methods**

- Growing evidence that rotational thromboelastometry (ROTEM) or thromboelastography (TEG) are superior to conventional assays
- Real-time measurement of visco-elastic properties of clot kinetics
- Potential to guide coagulation therapy according to actual needs
  - Reduce risk of over or under transfusion – algorithm guided replacement
  - Cohort studies
    - Reduced transfusion requirements
    - Reduced transfusion related adverse events
    - Improved outcomes
- Used in various clinical settings – liver transplant, cardiac surgery, obstetrics & trauma
- High negative predictive value
  - normal results → bleeding highly unlikely due to significant coagulopathy
Viscoelastometry

- Functional assay
- Global assessment (from initiation of coagulation through clot lysis)
- Multiple end-points
- Reflect ability to monitor thrombin burst
- Functional fibrinogen
  - Function
  - How much used in clot
- Factor Deficiencies
- Platelet Function
- Clot Strength
- Fibrinolysis
PoCT: ROTEM/TEG – Functional Assays

- Management of major blood loss should be guided by ROTEM/TEG Johansson. Acta Anaesthesiol Scand 2010
- ROTEM/TEG is advantageous in managing massive haemorrhage Bollinger. Anaesthesiology 2010
**Why Don’t We Just Stick With The Traditional Coag Profiles?**

<table>
<thead>
<tr>
<th></th>
<th>Theatre</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ROTEM (median [IQR])</td>
<td>Non ROTEM (median [IQR])</td>
</tr>
<tr>
<td>Specimen Delivery</td>
<td>2 min</td>
<td>12 mins [9-16]</td>
</tr>
<tr>
<td>Specimen Processing</td>
<td>3 mins</td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>60 secs [60-77]</td>
<td></td>
</tr>
<tr>
<td>CFT</td>
<td>152 secs [126-197]</td>
<td></td>
</tr>
<tr>
<td>A10</td>
<td>10 mins</td>
<td></td>
</tr>
<tr>
<td>MCF</td>
<td>Not measured</td>
<td></td>
</tr>
<tr>
<td>Coagulation Screen</td>
<td></td>
<td>42 mins [35-54]</td>
</tr>
<tr>
<td>FBE</td>
<td></td>
<td>22 mins [14-34]</td>
</tr>
</tbody>
</table>
Standard Coagulation Tests

- Stop measuring at first stage of coagulation, when the clot first forms
- Platelet poor plasma tests - measures plasma haemostasis not patient haemostasis, which is in whole blood
- Important role of RCs, plts and phospholipids in coagulation not taken into account
Why Don’t We Just Stick With The Traditional Coag Profiles?

3. ROTEM/TEG - whole blood (not plasma)
   - Information regarding overall haemostasis which may be adequate despite an abnormality in one component (e.g. low platelet count compensated by a high fibrinogen level)

4. INR & aPTT
   - Never intended for use in assessing the multifactorial coagulopathies in major haemorrhage or surgery
   - Poor predictive value for bleeding or transfusion requirements
     - Designed to assess the effect of coumadins and heparin / haemophilia
     - Indirect correlation with clinical picture
   - Plt poor plasma

5. Fgn (Clauss Method)
   - May be over estimated by up to 30% in presence of colloids
Viscoelastometric Technology

TEG

ROTEM
Viscoelastometry
TEG

Whole blood – test within 2-4 minutes
Citrate – stabilise 10-20 mins
Sensitive to vibrations & mechanical shocks
2 channels
Kaolin, heparinise & rapid TEG

Assay Time = 15-20 mins

• Developed by Hartert, 1948
• Traditional choice in USA
# TEG Result Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clotting time</strong></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td></td>
<td>Time to start of clot onset. Similar to clotting time</td>
</tr>
<tr>
<td><strong>Clot kinetics</strong></td>
<td><strong>K</strong></td>
</tr>
<tr>
<td></td>
<td>A measure of the speed to reach a specific level of clot strength. Time from the onset of clotting to an amplitude of 20mm. Represents clot kinetics</td>
</tr>
<tr>
<td><strong>Alpha/Angle</strong></td>
<td><strong>K</strong></td>
</tr>
<tr>
<td></td>
<td>Measures the rapidity of fibrin build-up and cross-linking (clot strengthening). Represents fibrinogen level</td>
</tr>
<tr>
<td><strong>Clot strength</strong></td>
<td><strong>MA</strong></td>
</tr>
<tr>
<td></td>
<td>A direct function of the maximum dynamic properties of fibrin and platelet bonding via GPIIb/IIIa and represents the ultimate strength of the fibrin clot.</td>
</tr>
<tr>
<td><strong>Hemostasis profile</strong></td>
<td><strong>CI</strong></td>
</tr>
<tr>
<td></td>
<td>Coagulation Index, which is a linear combination of the above parameters. CLx = 100 x (A30/MA)</td>
</tr>
<tr>
<td><strong>Clot stability</strong></td>
<td><strong>LY30</strong></td>
</tr>
<tr>
<td></td>
<td>Measures the rate of clot breakdown by measuring the rate of amplitude reduction 30 minutes after MA.</td>
</tr>
</tbody>
</table>
Thromboelastography – Point of Care Use in the Acutely Bleeding Patient

Hemorrhage and traumatic coagulopathy are major causes of early death in multiply injured patients. Thrombelastography (TEG) seems to be a fast and accurate coagulation test in trauma care…to detect an acute traumatic coagulopathy and especially primary fibrinolysis…
Principle of Rotational Thromboelastometry [ROTEM]

Use more prevalent in Europe

Citrated whole blood – test within 4 hours
4 channels

Assay Time = 5-10 mins
ROTEM Result Parameters

- Different activators & additives
  - rTF, ellagic acid, cytochalasin D

- Detect & differentiate specific haemostatic defects
  - Assess broader picture of haemostasis
  - Identify mechanisms of blood loss & trauma (associated coagulopathy)
    - Hyperfibrinolysis
    - Heparin & protamine effects
    - Hypofibrinogenemia
    - Fibrin polymerisation disorders
    - Coagulation factor deficiency & thrombocytopenia
# Tests

<table>
<thead>
<tr>
<th>ASSAY</th>
<th>Activator Inhibitor</th>
<th>Information provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTEM</td>
<td>Tissue factor activation</td>
<td>Assessment of clot formation, fibrin polymerisation and fibrinolysis via the extrinsic pathway (rTF)</td>
</tr>
<tr>
<td>INTEM</td>
<td>Contact activation</td>
<td>Assessment of clot formation, fibrin polymerisation and fibrinolysis via the intrinsic pathway (ellagic acid)</td>
</tr>
<tr>
<td>FIBTEM</td>
<td>Tissue factor activation and platelet inhibition</td>
<td>Analysis without platelets (cytochalasin D): Qualitative assessment of fibrinogen status</td>
</tr>
</tbody>
</table>
**fibTEM**

**Clotformation**

- Cytochalasin D (a strong inhibitor of the platelet cytoskeleton)
- Thromboplastin (exTEM) as activator

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**fib-TEM® MCF vs. Fibrinogen (Clauss)**

- $r = 0.931$
## Tests

<table>
<thead>
<tr>
<th>ASSAY</th>
<th>Activator Inhibitor</th>
<th>Information provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>APTEM</td>
<td>Tissue factor activation + Aprotinin</td>
<td>In-vitro fibrinolysis inhibition: Fast detection of lysis when compared to EXTEM</td>
</tr>
<tr>
<td>HEPTEM</td>
<td>Contact activation + Heparinase</td>
<td>Analysis without heparin influence: Specific detection of heparin (compared to INTEM), assessment of clot formation in heparinised patients</td>
</tr>
</tbody>
</table>
**apTEM Test**

Activation as in EXTEM with addition of aprotinin

Signs of hyperfibrinolysis (APTEM compared to EXTEM)

- Shortening of CT
- Shortening of CFT
- Improved MCF

Hyperfibrinolysis
hepTEM

Activation as in INTEM with the addition of heparinase

When HEPTEM CT is shorter than INTEM CT, this indicates heparin influence
# TEG/ROTEM Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TEG</th>
<th>ROTEM</th>
<th>Interpretation</th>
<th>Main Determinants</th>
<th>Corrective Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clotting time</td>
<td>R time</td>
<td>CT</td>
<td>Initiation of clot</td>
<td>Activity of coagulation factors</td>
<td>FFP</td>
</tr>
<tr>
<td>Clot formation time</td>
<td>K time</td>
<td>CFT</td>
<td>Clot amplification</td>
<td>Plts &amp; fibrinogen</td>
<td>Plts/fibrinogen</td>
</tr>
<tr>
<td>Rate of clot polymerization</td>
<td>α angle</td>
<td>α angle</td>
<td>Thrombin burst</td>
<td>Plts &amp; fibrinogen</td>
<td>Plts/fibrinogen</td>
</tr>
<tr>
<td>Amplitude</td>
<td>Ax</td>
<td></td>
<td>Clot strength</td>
<td>Plts &amp; fibrinogen</td>
<td>Plts/fibrinogen</td>
</tr>
<tr>
<td>Maximum clot firmness</td>
<td>MA (maximum amplitude)</td>
<td>MCF</td>
<td>Ultimate clot strength</td>
<td>Plts, fibrinogen &amp; FXIII</td>
<td>Plts/fibrinogen/FXIII</td>
</tr>
<tr>
<td>Clot lysis at 30 &amp; 60 minutes</td>
<td>Ly30, Ly60</td>
<td>LI30, LI60</td>
<td>Degree of fibrinolysis</td>
<td>Activity of fibrinolytic factors</td>
<td>TXA</td>
</tr>
</tbody>
</table>
How Do I Interpret the Results?

- Results should not be interpreted in isolation; the clinical condition must always be considered.

- Pattern recognition plays an important role.

- The shape of the curve may provide more information than the measured values.

- Important for labs: response to treatment should be monitored.

- Minimise waste (FFP & cryo).

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**Normal trace**
- Short CT (stem)
- Wide MCF (body)

**Coagulopathic trace**
- Long CT (stem)
- Narrow MCF (body)

**Hyperfibrinolysis trace**
- Wide MCF initially with narrowing

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**CuTT Opin Crit Care 2013; 19:605-612**
How Do I Interpret the Results?

In most cases you need to ask 5 simple questions

1. Is the patient still bleeding (or at high risk of recurrent or concealed bleeding)?
2. Is there evidence of fibrinolysis?
3. Should I replace fibrinogen?
4. Should I replace clotting factors?
5. Should I give platelets?

Do not forget:

- Hypothermia
- Acidosis
- Ionised Ca
- >Hb 70g/L
Interpretation of ROTEM/TEG Parameters

- **↑ CT/R time**
  - Coag factor deficiency or anticoagulants
  - ↑ CT EXTEM >80s correlates with ↓ FII, FVII & FX to <35% of normal

- **MCF/MA**
  - Strong fibrin polymerization can compensate for decrease in platelet contribution to clot firmness
  - ↓ MCF/MA: decreased plts ± function or ↓ fgn ± fibrin polymerisation disorders or ↓ FXIII
  - Mechanically weak clot represents severe bleeding risk
  - ↑ MCF & A10/MA: Hypercoagulable

- **FIBTEM MCF correlates well with fgn level**
  - <7mm correlates with fgn <1.5g/L
INTEM
Prolonged CT low amplitude

HEPTEM
Normal CT normal amplitude

Suggests: heparin influence

INTEM
- 2004-09-27 13.22
- 2: 2543
- CT: 1501s
- CFT: 442s
- α: 32°
- A10: 25mm
- MCF:* 41mm
- ML: - %

HEPTEM
- 2004-09-27 13.23
- 2: 2543
- CT: 138s
- CFT: 71s
- α: 77°
- A10: 49mm
- MCF: 53mm
- ML:* 14%
Hypercoagulation
Use & Utility of PoC Guided Algorithms

- Time efficient
- Clinically efficacious
- Cost effective
- Pathophysiology driven therapy
- Guiding selective blood component/anti-fibrinolytic use
- Reduce inappropriate transfusions
- *Decreases variability in treatment*
Algorithms – reduce blood products

Transfusion in trauma: why and how should we change our current practice?

“algorithm incorporates information obtained from the patient’s history, clinical presentation and routine coagulation laboratory and bedside viscoelastic coagulation tests.”

“in the first 6 months after implementation of the algorithm, the use of FFP dropped by approximately 50% and RCs as well as platelet administration decreased by approximately 20% each.”
Recommendations from Current EAS Guidelines

- We recommend the application of transfusion algorithms incorporating predefined intervention triggers based on point-of-care (POC) coagulation monitoring assays to guide haemostatic intervention during cardiovascular surgery. 1C

- Implementation of transfusion and coagulation management algorithms (based on ROTEM/TEG) can reduce transfusion-associated costs in trauma, cardiac surgery and liver transplantation. B
**Physiological Targets:**
- Temp >36 °C
- pH >7.2
- iCa >1 mmol/L
- Hb >70 g/L

**Normal Ranges**

**EXTEM**
- CT: 38-79 sec
- CFT: 34-159 sec
- A10: 43-65 mm
- MCF: 50-72 mm
- ML: 0-15%

**INTEM**
- CT: 100-240 sec
- CFT: 30-110 sec
- A10: 44-66 mm
- MCF: 50-72 mm
- ML: 0-15%

**FIBTEM**
- A10: 7-23 mm
- MCF: 9-25 mm

**Testing Panel**
- FIBTEM
- EXTEM
- INTEM
- APTEM
- HEPTEM

**Blood collection:**
- Blue top Citrate
- Fill to the line
- Labelled with: URNO, Full name

**EXTREM / FIBTEM Comparative Analysis (Platelets or Fibrinogen?)**
- EXTEM: Amplitude (A10) LOW
- FIBTEM: Amplitude normal → fibrinogen level OK → platelet deficiency or function defect

**INTEM / HEPTEM Comparative Analysis (Heparin Effect?)**
- INTEM: CT long
- HEPTEM: CT also long → No heparin effect → In protamine overdose, protamine becomes anti-anticoagulant itself → Potential factor deficiency (factor deficiency is only detected when approximately <30% factors are left)

**EXTREM / APTEM Comparative Analysis (Hyperfibrinolysis)**
- EXTEM: clear hyperfibrinolysis (ML 100%)
- APTEM: fibrinolysis inhibited (ML <15%) → Confirms fulminant hyperfibrinolysis

**Repeat ROTEM tests 10 mins after therapy**
**MCF Vs A**

- Takes 30-40 mins to obtain MCF
- Until then, most algorithms involving ROTEM values used MCF values to guide decision making
MCF & $A_{10}$ Parameters [Liver Transplant]

- Close correlation: $A_{10}$ allows 20-25 min shorter decision time
- $A_{5}$ & 10 accurately predict MCF for EXTEM & FIBTEM

$R^2 = 0.735, p < 0.001$

$R^2 = 0.982, p < 0.001$
Obstetric Haemorrhage

FibTEM A5 vs MCF

R=0.963, p<0.0001

Liverpool Women’s, UK
No fibrinogen
Trauma
ROTEM® Measurement module

Preparation | 4-TEM | Screenshot | Standard overlay | Patient overlay | Help | Quit

ST: 14:01:02  RT: 00:37:30

CT: 920 s [0043 - 0075]
CFT: —
α: —
A10: 3 mm [0007 - 0023]
A20: 3 mm [0008 - 0024]
MCF: 3 mm [0009 - 0025]
ML: * 13%

Patient data | Print | Stop channel 4 | Clear channel 4

EXTEM

INTEM

APTEM

FIBTEM

ST: 13:58:18  RT: 00:40:08
CT: 284 s [0038 - 0079]
CFT: —
α: —
A10: 1 mm [0043 - 0065]

ST: 13:59:48  RT: 00:38:40
CT: 384 s [0100 - 0240]
CFT: —
α: —
A10: 6 mm [0044 - 0066]

ST: 14:26:33  RT: 00:11:57
CT: * 386 s
CFT: —
α: —
A10: —

ST: 14:01:02  RT: 00:37:30
CT: 920 s [0043 - 0075]
CFT: —
α: —
A10: 3 mm [0007 - 0023]

2011-01-04T14:38:40  User: admin  Channel status: ok  Temperature: 37.0°C
Strategies

What should we put in the box?

- Empiric therapy
  - According to estimated blood loss
  - 1:1:1 formula-driven

- Individualised therapy – one size doesn’t fit all
  - Routine lab-directed therapy
  - PoC directed therapy
**MASSIVE TRANSFUSION PROTOCOL**

**STOP THE BLEEDING**
- Identify source
- Initial measures
  - Compression
  - Tourniquet (max 2hrs)
- Fluid Resuscitation
  - Avoid hypothermia, actively warm patient and fluid
  - Avoid excessive crystalloid
  - Tolerate permissive hypotension (10-30mmHg) until bleeding controlled

**CELL SALVAGE**
- Consider where appropriate

**FOUNDATION RATIO** of components

**HAEMORRHAGE AND HAEMODYNAMIC INSTABILITY** OR KNOWN COAGULOPATHY

**SEND BASELINE BLOOD TESTS**
- Use red "STAFF" bag and pre-printed request
- Full blood count
- Coagulation profile (PT, aPTT, TAT)
- Biochemistry
- Blood gas
- ROTEM where available (blue citrate tube to transfusion service)

**MONITOR**
- ROTEM: 10 minutes post blood components
  - Every 30-60 minutes:
    - Full blood count
    - Coagulation profile
    - Arterial blood gas

**INFORM BLOOD BANK** of patient's clinical condition and order 2 units 0 negative group specific BCs

**ACTIVATE MASSIVE TRANSFUSION PROTOCOL** and inform if ROTEM sample sent

If continued uncontrolled bleeding a senior clinician should notify Transfusion Service (****) to...

**NO ROTEM**

**MTP**
- 5 RBCs
- 4 FFP
- Cryoprecipitate if fibrinogen < 1g/L, (5 ampoules or 10 whole blood units)
- 1 adult dose platelets every second pack

**ROTEN – targeted replacement therapy**

**MTP**
- 4 RBCs
- Blood components as per ROTEM algorithm
- Consultant/Registrar to coordinate ROTEM targeted therapy

**CONTINUE UNTIL BLEEDING CONTROLLED & PATIENT HAEMODYNAMICALLY STABLE**

**NOTIFY TRANSFUSION SERVICE TO STOP MASSIVE TRANSFUSION PROTOCOL**

**TARGETS**
- Temperature > 35°C
- pH > 7.2
- Base excess > 6
- Lactate < 4mmol/L
- Ca > 1.1 mmol/L
- Hb > 70g/L
- Platelet > 50 x 10^9/L
- PT/INR < 1.5 x normal
- NR < 5.5
- INR > 1.9

**ADDITIONAL THERAPIES**
- Transaminase
  - Within 6 hours of trauma
  - >1g over 16 hours then
  - >1g over 8 hours
- Calcium
- FFP
- Consult with Transfusion Medicine
- Recommended dose 20-30mg/kg or 1-2mg/kg if transaminase acid already administered

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**foundation ratio**

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Platelet

Fibrin

Platelet-fibrin clot

PoCT
**Point of Care Coagulation Monitoring - Conclusion**

- Useful tool for global assessment of haemostasis to
  - one test – whole blood clot measurement - fast
  - analyse perioperative & acute trauma induced coagulation disorders
  - guide more targeted coagulation therapy (FFP, PCCs, Fgn, plts) in these settings
  - detect a hyper-fibrinolytic state
- Can be used in lab or clinical setting
- Results rapidly available to lab & clinical area & interpreted within minutes
- Potential cost savings

![Venn Diagram](image-url)