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Thromboelastographic Goal-Directed Blood Component Therapy for Severe Hemorrhage

By Mark Walsh, MD, Manar Jbara, MBChB, Adam Miller, BS, Jeremy Lawson, MS, Memorial Hospital Trauma Center and Indiana University School of Medicine – South Bend at the Notre Dame Campus, South Bend, Ind., and the Scientific Publications Committee, America's Blood Centers

Point-of-Care, Goal-Directed Blood Component Therapy: Defining the Need

Hemostasis is a complex physiologic process involving many constituents that act in symphony to form a clot. Conventional coagulation tests, such as prothrombin time (PT), international normalized ratio (INR), activated partial thromboplastin time (aPTT), fibrinogen concentration, and platelet count, measure only a fraction of this process. Moreover, these tests sometimes lack accuracy in trauma settings, which has led to investigations of point-of-care viscoelastic tests (VETs), such as thromboelastography (TEG) and rotational thromboelastometry (ROTEM).[1] The use of VETs has been shown to optimize (and often reduce) blood use when treating severely bleeding trauma patients who require damage control resuscitation (DCR).[1-4]

DCR, which in part aims to reproduce whole blood resuscitation via the use of approximately 1:1:1 ratios of red blood cells (RBCs), plasma, and platelets, has become the standard of care for the transfusion management of patients with severe hemorrhage.[1-6] This approach, however, comes with a potential cost: the use (at least, up-front) of greater quantities of plasma and platelets. This is just one more reason why the application of VETs during severe hemorrhage has become an important topic of discussion.[1-6]

The following section focuses on the use of TEG during the management of severe bleeding, though very similar principles and practical considerations also apply to the use of ROTEM.

VET-Guided Reduction in Blood Product Usage and the Mechanics of TEG

Data from European and US combat and civilian trauma studies have demonstrated the utility of VETs in assisting clinicians with their efforts to provide blood component therapy (BCT) in a goal-directed fashion that often enhances patient outcomes while sparing blood products.[1-4,7]

Key Points about TEG and ROTEM

- Describe the body's ability to form a clot with tracings that demonstrate adequacy of coagulation factors, fibrinogen/fibrin, clot strength, initial platelet function and fibrinolysis
- More useful than conventional coagulation tests because they offer nearer to real-time assessments for guiding blood component therapy and can be used as a tool to assist with the management of massive transfusions
- Can alleviate the strain on the blood bank in damage control resuscitation by more accurately guiding the delivery of required blood products

TEG assesses the degree of hemostatic integrity and measures the ability of whole blood samples to form a clot. Specifically, TEG depicts the following four stages of clot formation: (1) initiation, (2) amplification, (3) propagation, and (4) termination through fibrinolysis. This is accomplished by placing a 0.36 mL aliquot of citrated whole blood sample into a Kaolin coated ("standard") TEG cup that has been pre-warmed to 37°C. A pin, attached by a wire to a transducer, is then suspended into the sample. The cup rotates around the pin within the TEG autoanalyzer at an angle of 4.45 degrees every 10 seconds. As the clot forms, the pin and the cup are ultimately joined by the formation of the fibrin and platelet clot. This causes the pin and the cup to rotate together, with the resultant change in tension detected by the transducer. A graphical output is then plotted as a change in tension (measured in millimeters on the y axis) versus time (measured in minutes on the x-axis).[2,3,7,8]

The four key parameters of the TEG tracing are the: (1) r value (reaction time to clot formation), (2) α (alpha)

angle – rate of clot formation, (3) MA (maximum amplitude – maximum strength of clot), and (4) LY30 (percent clot lysis 30 minutes after the MA).[2,3,8] Together, these create an image that somewhat resembles a shovel (see Figure 1). The "handle" of the shovel, represented by r, is the interval that begins with initiation of the reaction and ends when the clot first manifests. The r value reflects the PT/INR and aPTT, or enzymatic phase, of coagulation. The α angle, which defines the curve of the shovel's blade, is equal to the slope of the curve and corresponds to fibrin and fibrinogen activity. The MA indicates the ability of the fibrin/platelet clot to contract and reflects clot strength. Finally, the subsequent tapering of the curve toward the baseline represents the effect of fibrinolysis on the clot. This percentage reduction of the MA, when measured at 30 minutes, is called the LY30.[2,3,8]

We have developed a helpful analogy for understanding the TEG whereby we associate shovels with grave digging. It should be the goal of healthcare providers to prevent the patient's tracing from taking on the appearance of a perfect shovel (i.e., one that could be used to "dig the patient's grave"). Rather, the ideal shovel (TEG tracing) should appear *non-functional*, with a tiny handle and an overly wide blade, correlating to a short r, a large α angle and MA, and a small LY30 that does not taper too rapidly. Refer to Figure 1.

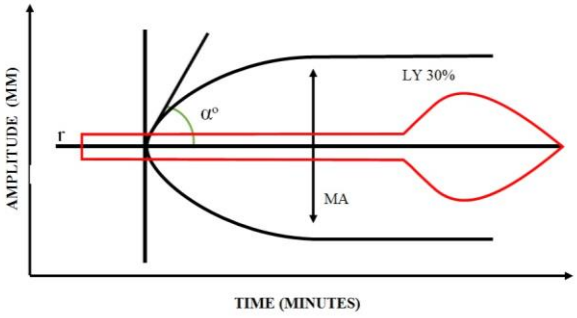

Figure 1. Normal TEG tracing (in black) resembles a wide flat (non-functional) shovel with a short handle. The superimposed "shovel" (in red) demonstrates a tracing with a prolonged r, flat α angle, small MA, and increased LY 30, indicative of a systemic coagulopathy with fibrinolysis.

Recommendations Based on Abnormal TEG Tracing[1,7]	
Significant Finding on "Standard" TEG Tracing	**Potential Therapeutic Intervention**
Prolonged r-value (> 7 minutes)	Plasma and/or prothrombin complex concentrate
Low or flat α angle (< 45°)	Cryoprecipitate
Narrow MA (< 48 mm)	Platelets +/- DDAVP +/- Cryoprecipitate
Increased LY30 (> 7.5%)	Anti-fibrinolytic agent

Evidence of the Efficacy of VET-guided BCT for Trauma Resuscitation

The use of VETs can be especially helpful when managing the transfusion needs of massively bleeding trauma patients (defined as adult patients who require ≥ 10 units of RBCs within 6 or 24 hours[4-9]), as it allows clinicians to determine more exactly who will require BCT support above and beyond the aforementioned ratios of RBCs/plasma/platelets. It also can assist with the diagnosis of disseminated intravascular coagulation. Large clinical trials have been designed and are underway to determine the ideal physiologic ratios of blood products guided by VETs that can be given to the trauma population.[9]

A limiting factor in the performance of VETs is the lack of universal standardization and quality assurance (QA) protocols. Participation of the entire trauma team in their hospital's transfusion committee QA programs, along with the designation of well trained and committed operators, will ensure proper utilization of VETs in the setting of severe hemorrhage.[1,-4,6-8]

References

1. Holcomb JB, Minei KM, Scerbo ML, et al. Admission rapid thromboelastography can replace conventional coagulation tests in the emergency department: experience with 1974 consecutive trauma patients. Ann Surg. 2012 Sep; 256(3):476-86.
2. Kashuk JL, Moore EE, Sawyer M, et al. Postinjury coagulopathy management: goal directed resuscitation via POC thromboelastography. Ann Surg. 2010 Apr; 251(4):604-14.
3. Schöchl H, Voelckel W, Grassetto A, Schlimp CJ. Practical application of point-of-care coagulation testing to guide treatment decisions in trauma. J Trauma Acute Care Surg. 2013 Jun; 74(6):1587-98.
4. Spahn DR, Bouillon B, Cerny V, et al. Management of bleeding and coagulopathy following major trauma: an updated European guideline. Crit Care. 2013;17:R76.
5. Frith D, Goslings JC, Gaarder C, et al. Definition and drivers of acute traumatic coagulopathy: clinical and experimental investigations. J Thromb Haemost. 2010 Sep; 8(9):1919-25.
6. Weiskopf RB. Reconstructing deconstructed blood for trauma. Anesthesiology. 2012 Mar; 116(3):518-21.
7. Tapia N, Chang A, Norman M et al. TEG-guided resuscitation is superior to standardized MTP resuscitation in massively transfused penetrating trauma patients.J of Trauma and Acute Care Surgery. 2013 Feb; 74(2):378-386.
8. MacDonald SG, Luddington RJ. Critical factors contributing to the thromboelastography trace. Semin Thromb Hemost. 2010 Oct; 36(7):712-22.
9. Holcomb J., Pragmatic, Randomized Optimal Platelets and Plasma Ratios (PROPPR) Study. Updated 2013 Dec. http://clinicaltrials.gov/show/NCT01545232.

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