“Diagnostic testing is an essential component of Patient Blood Management. The accurate assessment of the true causes of bleeding dysfunction facilitates the employment of evidence based, goal directed therapy to rapidly prevent and treat excess blood loss.”

Sherri Ozawa RN, Clinical Director, Institute of Patient Blood Management, Englewood Hospital Medical Center, Englewood, NJ
What Is the Issue?

Blood transfusion is the most common procedure performed in US hospitals.¹

- Every year, approximately 14 million units of packed red blood cells are used.²
- One in ten hospitalized patients who undergoes an invasive procedure is transfused.³
- It is estimated that 40-60% of transfusions are administered without appropriate clinical justification.⁴

Modifiable risks that can reduce patient exposure to blood products.⁵

94% of transfusions in surgical patients can be attributed to modifiable events.

- Low preoperative hemoglobin levels
- Excessive surgical blood loss
- Inappropriate transfusion practices

What Factors Impact Bleeding Related Complications?

Evolving technology in health care can predispose patients to bleeding complications.⁶

- Progressive widespread use of anticoagulant and antiplatelet therapeutics
- Technological advances that enable complex and lengthy surgical procedures
- Advancing age of the general population with associated comorbidities that predispose to bleeding related complications

Why Should I Care?

Unanticipated surgical bleeding is expensive and associated with poor outcomes.⁷

- Rate of bleeding-related complications was almost 30% in commonly performed operating procedures
- Incremental length of stay associated with bleeding-related complications or transfusions was 6 days
- Incremental cost per hospitalization associated with bleeding-related complications and adjusted for covariates was $2,805 to $17,279 depending on type of surgery

"Achieving hemostasis in surgical patients is finding that fine balance between perioperative bleeding and pathological thrombosis; the two extremes of preventing a patient from bleeding to death while also preventing them from clotting to death." - SHERRI OZAWA RN
Goals of Diagnostic Testing in Patient Blood Management

Rapid diagnosis and arresting blood loss by accurately assessing true causes of bleeding dysfunction

- Use both quantitative and qualitative measures to assess true coagulation status
- Recognize the major mechanism of a developing coagulopathy
- Use goal directed diagnostic testing to direct and establish treatment goals

Conventional Coagulation Testing - What Do We See?

Blood tested almost one hour after it is drawn

Blood is drawn. It’s transported to the laboratory. It’s centrifuged. The cells are removed. Calcium and activators are added. Clot initiation (ATT and PTT) is measured.

Routine plasma coagulation tests only reflect 1-2% of the entire coagulation process

- Only 5% of total thrombin has been generated when the coagulometer stops
- Only plasma is analyzed
  - Interaction of platelets (or any other cells) are not assessed
  - Interaction with the coagulation system, fibrinolysis or FXIII is not assessed
Mildly abnormal test results are associated with hemostatically adequate coagulation factor concentrations\textsuperscript{10}

Below is a graph comparing the percentage of available clotting factors with INR values.

- 25-30\% of factors are required to produce a clot (INR \(\approx\) 1.7)
- INR may be elevated, but patient is still able to clot

New Insights: Viscoelastic Diagnostic Testing

Basic principles of rotational thromboelastometry (ROTEM\textsuperscript{®})\textsuperscript{11}

A citrated blood sample is placed in a stationary cup with calcium chloride and a coagulation activator. The rotating pin is lowered into the blood. Clot formation changes the torque between the pin and the cup.

\begin{itemize}
  \item CT \hspace{1cm} Clotting time
  \item CFT \hspace{1cm} Clot forming time
  \item Alpha \hspace{1cm} Alpha angle
  \item A10 \hspace{1cm} Amplitude 10 min after CT
  \item MCF \hspace{1cm} Maximum clot firmness
  \item ML\% \hspace{1cm} Maximum Lysis
\end{itemize}
Measurements include coagulation time (CT; sec), clot formation time (CFT; sec), angle (degrees), amplitude at 10 minutes after CT (A10; mm), maximum clot firmness (MCF; mm), and maximum lysis (ML; % decrease decrease 60 min after MCF).

Morphology and clot formation changes are dependent on clotting defect.

Below are examples of ROTEM® traces using the EXTEM® test.
Allows assessment of clotting defect and replenishment of what is needed without additional blood components

Below is an algorithm using the results of viscoelastic testing and a summary of therapeutic options.

Viscoelastic POC Testing (TEG®) guided therapy was superior to conventional coagulation tests in trauma patients\textsuperscript{12}

Holcomb (2012) evaluated a series of 1974 trauma patients, 25\% of whom presented in shock and 28\% of whom were transfused. The authors found that TEG\textsuperscript{®} (Haemonetics\textsuperscript{®}) predicted RBC transfusion and massive transfusion better than PT or PTT. TEG\textsuperscript{®} was superior to fibrinogen in predicting plasma transfusion, and superior to platelet count in predicting platelet transfusion.
Advantages compared to conventional coagulation testing\textsuperscript{11,13}

- Conventional coagulation testing only provides limited information on the underlying coagulation disorder
- Whole-blood viscoelastic tests such as rotational thromboelastometry (ROTEM\textsuperscript{®}) or thrombelastography (TEG\textsuperscript{®}) offer a more comprehensive insight into the coagulation process in trauma
- Results are available within minutes and they provide information about:
  - Initiation of coagulation, the speed of clot formation, and the quality and stability of the clot
- Viscoelastic tests have the potential to guide coagulation therapy according to actual needs of each patient and reducing the risks of over or under transfusion
  - Goal-directed therapy with specific hemostatic drugs, coagulation factor concentrates, and blood components
- In several cohort studies, this POC-based management was associated with:
  - Reduced transfusion requirements
  - Reduced incidence of transfusion associated adverse events
  - Improved patient outcomes

Summary

The superior information obtained with viscoelastic testing is critical to better direct effective therapeutic interventions in patients with coagulation issues. Optimizing coagulation is a fundamental principle of Patient Blood Management and along with other evidence based interventions, can positively impact patient outcome. Implementing organized PBM programs, which incorporate advanced capabilities such as viscoelastic testing result in better clinical decision making, cost savings, and optimal patient care.

What is Patient Blood Management?

“The timely application of evidence based medical and surgical concepts designed to manage anemia, optimize hemostasis, and minimize blood loss in order to improve patient outcomes.” - Society for the Advancement of Blood Management (SABM.org)
References


