t 2 a.m., all was quiet at Center City Hospital. Dan Dire, MT(ASCP) was about to take a break. Or so he thought. Over the loudspeaker, three short but alarming bells rang to signify a trauma entered the emergency department (ED). Dire had to grab the massive transfusion protocol (MTP) cooler and rush to the ED.

As he ran to the ED, he was relieved Center City Hospital recently implemented an MTP and that he received training in the last month. Although the night might be busy, he felt in control and ready to participate in the multidisciplinary team focused on providing the best medical care to the trauma patient.

Continuous improvement is key to successful management of patients requiring blood products. Because new technologies and study results may change how medicine is practiced, it is important to continuously review current processes and make necessary changes resulting in improved patient care. Managing the massively transfused patient is no exception.

This article will define massive transfusion, discuss massive transfusion protocols, describe blood recipients’ physiology after massive transfusion and review potential use of recombinant factor VIIa after conventional treatment has failed to stop the patient’s bleeding.

Massive Transfusion
When Good Patients Go Bad

By Ricci Jo Ackley, MT(ASCP)SBB; and Karen M Byrne, MDE, MT(ASCP)SBB, CQA(ASQ)

At 2 a.m., all was quiet at Center City Hospital. Dan Dire, MT(ASCP) was about to take a break. Or so he thought. Over the loudspeaker, three short but alarming bells rang to signify a trauma entered the emergency department (ED). Dire had to grab the massive transfusion protocol (MTP) cooler and rush to the ED.

As he ran to the ED, he was relieved Center City Hospital recently implemented an MTP and that he received training in the last month. Although the night might be busy, he felt in control and ready to participate in the multidisciplinary team focused on providing the best medical care to the trauma patient.

Continuous improvement is key to successful management of patients requiring blood products. Because new technologies and study results may change how medicine is practiced, it is important to continuously review current processes and make necessary changes resulting in improved patient care. Managing the massively transfused patient is no exception.

This article will define massive transfusion, discuss massive transfusion protocols, describe blood recipients’ physiology after massive transfusion and review potential use of recombinant factor VIIa after conventional treatment has failed to stop the patient’s bleeding.

Massive Transfusion
Definitions of massive transfusion can vary, but most incorporate a specific volume of blood transfused within a specific amount of time; either the replacement of one blood volume in a period of 24 hours or ≥4 units packed red blood cells within 1 hour.2,3 If bleeding rate is addressed, then loss of 50 percent of blood volume in 3 hours defines a massively bleeding patient.3

Regardless of definition used, the frank description is a lot of blood is transfused to one patient in a short period. The main goals of massive transfusion are simple: establish rapid control of bleeding and restore systemic oxygen delivery.

Events of massive transfusion can be grouped into three categories: action, impact and consequences (Figure).

Action
The majority of those who receive massive transfusions are either trauma or elective surgery patients.2 The main difference between these two groups is the amount of control one has over the initial presentation of the patient and subsequent management of the situation. With trauma patients, the time between hemorrhage and treatment is varied and sequelae such as hypovolemia, shock, hypothermia and the possible development of disseminated intravascular coagulation can occur. It should be understood only 5 percent of trauma patients are recipients of massive transfusions.2 The patient undergoing elective surgery is observed in a controlled manner, hemostasis stabilization is ongoing and treatment is usually much simpler than for the trauma patient.

A third population that may be massively transfused is women with postpartum hemorrhage. Hemorrhage may be caused from uterine atony, pathologic placental implantation, retained products of conception, uterine rupture, birth trauma and existing or acquired coagulopathy.4 Again, regardless of recipient, therapeutic goals are to maintain tissue perfusion and oxygenation by restoring blood volume and hemoglobin, and to stop bleeding by treating any traumatic, surgical or obstetric source.5

Impact
To prevent a patient from bleeding to death (exsanguinating hemorrhage), blood and blood products need to be transfused quickly.

Selection, preparation and distribution of blood products all take time, and often time is of the essence during trauma situations. Planning and coordination is important, hence the MTP. This is a multidisciplinary process whereby
blood and blood products are obtained rapidly for a bleeding patient. An MTP is the result of a team of experts working together to decide the best course of action to be taken in cases including, but not limited to: 1) life-threatening trauma presenting to the emergency department; 2) unexpected surgical blood emergencies; 3) surgeries expected to require massive transfusion; and 4) patients who require transfusion of more than one blood volume within a 24-hour period.

The protocol should address a process of notification so staff can activate procedures. Communication systems can include telephone contact, laboratory-based alarms or other means. A facility providing massive transfusions must have a blood bank with adequate in-house inventory and a method to quickly acquire additional components to replenish inventory when necessary. The protocol may define a specific number of RBC units, fresh frozen plasma and platelets to be prepared and readied for delivery. In addition to the blood bank, other laboratories are involved to monitor the hemostatic state of the transfused patient. The hematology laboratory will be called upon to provide STAT complete blood counts including platelet counts. The coagulation laboratory will provide prothrombin time (PT)/partial thromboplastin time (PTT) and possibly fibrinogen results. Sodium, potassium and ionized calcium levels will be monitored by the chemistry laboratory.

Orchestration of all of these events by a transfusion service physician can ensure the clinical team transfusion support is being maintained and monitored.

Specifics for the initial set of orders for blood products may vary and should be agreed upon when the MTP is being developed. Blood products common to all orders include red blood cells (RBC), fresh frozen plasma (FFP) and platelets (either apheresis or platelet concentrates [PC]).

Examples of transfusion packages include:

- five RBC units, five FFP and two PC pooled from four donors.
- for every four RBC, transfuse two FFP; after every eighth RBC, also transfuse a pool of six random platelets; by the sixteenth RBC, add a ten-pack of cryoprecipitate (CRYO).
- ten RBC, one unit of apheresis platelets and two FFP.

Laboratory results should be carefully monitored to adjust transfusion of proper blood components. Special consideration should be taken to address combat-related trauma and hypocoagulable trauma patients who require massive transfusion. An article written by Borgman et al concluded a 1:1 ratio of plasma to RBC may be beneficial and practical.

Component replacement guidelines suggest the following:

- Platelet concentrates (one whole-blood-derived platelet concentrate per 10 kg of body weight) if the platelet count decreases below 50,000/µL.
- FFP, liquid plasma, plasma frozen within 24 hours after phlebotomy, or thawed plasma (12mL/kg of body weight) if the PT or PTT is higher than 1.5 times control levels.
- Cryoprecipitate (1 to 1.5 units per 10 kg of body weight) if the fibrinogen level is less than 0.8 g/L.

The MTP may refer to specific standard operating procedures in the transfusion service which address ABO-compatible components and a policy for regarding compatibility testing (Table 1).

Group O RBCs are often used for emergency transfusion before completion of compatibility tests and when the patient’s type is unknown. ABO-specific components may be able to be given once an accurate ABO is determined. Rh-negative RBCs should be used for pre-menopausal females to avoid possible immunization to the D antigen which could cause hemolytic disease of the newborn in the future.

Providing antigen-negative RBCs to a patient who has unexpected antibodies can present quite a problem. Antibody identification and patient history are important and communication with the clinical team is essential to managing such patients. A full crossmatch (antiglobulin-phase) is labor intensive and time consuming and an abbreviated crossmatch (immediate spin or electronic) may need to be addressed in procedures regarding massive transfusions to expedite RBC provision. In rare cases where an alloantibody is detected, a plan must be designed that will minimize risk to patients without obstructing rapid provision of red cells. One such strategy is to retain 8-10 antigen-negative units to be given when the condition has stabilized.

The drug, recombinant factor VIIa (rFVIIa), is licensed for use in

<table>
<thead>
<tr>
<th>TABLE 1: MASSIVE TRANSFUSION PROTOCOL CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ABO/Rh of Blood Products in MTP</strong></td>
</tr>
<tr>
<td>RBCs</td>
</tr>
<tr>
<td>FFP</td>
</tr>
<tr>
<td><strong>Specimen Collection</strong></td>
</tr>
<tr>
<td>two independent patient identifiers, date of collection and mechanism to identify who drew specimen</td>
</tr>
<tr>
<td><strong>Types of Compatibility Testing</strong></td>
</tr>
<tr>
<td>Antiglobulin crossmatch</td>
</tr>
<tr>
<td>Immediate spin crossmatch</td>
</tr>
<tr>
<td>Computer crossmatch</td>
</tr>
</tbody>
</table>

**FIGURE: PROGRESSIVE EVENTS OF MASSIVE TRANSFUSION**

- **Action**: massive transfusion
- **Impact**: MTP is used for communication and preparation
- **Consequences**: immediate and delayed
hemophiliacs with inhibitors to treat active bleeding or as prophylaxis for surgery.9

The use of rtFVIIa has been investigated as a “last ditch” treatment for patients with massive hemorrhage. Although the conclusion was rtFVIIa did not rescue patients who were resistant to conventional treatment, it poses the possibility higher doses or shorter infusion intervals may be associated with improved outcomes.9 Although this hemostatic agent has been reported anecdotally to dramatically reduce blood loss following administration, sound evidence from controlled trials is limited and this drug should only be used with a local protocol and with proper consultation.10

Consequences
For a patient undergoing massive transfusion, there are both immediate and delayed effects. Initially, the patient faces challenges from the trauma itself. The body must compensate for blood loss, trying to preserve intravascular volume and maintain tissue perfusion. This is achieved by an increase in heart rate, vasoconstriction of the blood vessels, and activation of cytokines, hormones and clotting factors.2 In addition to blood loss, the patient faces a need to maintain body temperature in order for enzymes, clotting factors and platelets to function properly. Maintaining body temperature also combats metabolic acidosis, which is caused by inadequate perfusion of tissues. A minimal drop of core temperature to 35°C triggers dysfunction of coagulation.2 The cascade of events leading from blood loss to acidosis and hypothermia may result in coagulopathy with potentially fatal results. Temperature drops quickly as the patient is being tended by medical personnel. This occurs first by being soaked in blood and being examined for medical assessment then by infusion of crystalloid and colloid fluids followed by blood products that are cold and rapidly infused.

Risks
Once the infusion of blood components and volume expanders begin, the patient faces a whole set of new challenges.

Blood Components
The first risk faced is being given the wrong blood. This risk is increased in emergency situations where several unidentified patients may present at the same time and transfusion of wrong blood could potentially lead to an acute hemolytic transfusion reaction.5 Accurate patient identification and proper specimen collection are critical to the safety of blood administration (Table 1). The odds of other acute hemolytic transfusion reactions including transfusion-related acute lung injury increase with each transfusion, especially with transfusion of plasma containing components such as platelets and FFP. The switch to FFP prepared only from male donors may decrease this risk by avoiding transfusion of plasma collected from multiparous women who may have formed antibodies to HLA class I antigens.11

All potential transfusion reactions should be evaluated and treated immediately. This should be followed by documentation and reporting of suspected transfusion-related adverse events as required by the AABB Standards for Blood Banks and Transfusion Services.12 Fatalities related to blood transfusion shall be reported to outside agencies as required.13

Citrate Toxicity
As the infusion of stored blood continues, the patient is affected by the physical properties inherent to the components infused (Table 2). Due to anti-coagulant preservative solutions, citrate toxicity becomes a real danger to the massively transfused patient. The citrate in the preservative solution causes a decrease in calcium and magnesium which can cause a reduction in myocardial contractility and may increase the risk of arrhythmias.3 Citrate is usually cleared by the liver, but as the number of components and the rate of infusion increases, the liver can be overwhelmed with the volume of citrate. Monitoring the patient for ionized calcium is critical and the replacement of calcium can correct any deficiencies.

Potassium
In addition to citrate, stored blood can have an increase in extracellular potassium. At low temperatures, the function of ion pumps in the red cell membrane are impaired and cause the movement of potassium to the extracellular fluid compartment.3 Additionally, potassium increases due to lysis of stored RBCs causing elevation in extracellular potassium and plasma hemoglobin. The kidneys are the mechanism of clearance for any extracellular potassium. This clearance can be reduced in patients with renal failure and hypotension, as well as neonates and children. Potassium should be closely monitored and patients with renal insufficiency may require special products such as freshly collected (<7 days) RBC or washed blood.

2,3 DPG
Another attribute of stored blood that may affect the massively transfused patient is a reduction in levels of 2,3 DPG. By day 14 of storage, the level of 2,3 DPG is zero.3 The decrease in 2,3 DPG levels causes the red cell to hold on to any oxygen it carries instead of releasing it to oxygen starved tissues. This causes a shift in the oxygen dissociation curve to the left. Therefore, as the red cells circulate, their full ability to carry and release oxygen as needed is decreased until 2,3 DPG repletion takes place. Severely depleted red cells are able to regenerate half their 2,3 DPG levels in 12 hours and complete restoration and normal hemoglobin function in 24 hours.8 Although stored blood with reduced 2,3 DPG levels can potentially impair oxygen delivery to tissue in massively transfused patients, patients can usually compensate.
Nitric Oxide

One study concluded nitric oxide bioactivity is depleted in banked blood. This would impair RBC vasodilation, which would then compromise blood flow. It was suggested renitrosylation of banked blood during storage may improve transfusion efficacy.

Dilutional Coagulopathy

If massively transfused patients continue to bleed and to use excessive amounts of blood components, they become at risk for dilutional coagulopathy and volume overload. Packed red cells in additive solutions such as AS-1 have very low levels of plasma. The reduction of plasma levels means there is no replacement of coagulation factors or platelets. This makes it critical to transfuse plasma to patients with a prothrombin time value greater than 1.5 (1.3 for central nervous system or retinal hemorrhage) of the control.

Although, initially, transfusion with packed red blood cells forces the available platelets to the periphery of vessels bringing them in contact with damaged endothelium, platelets are reduced by consumption and dilution with no subsequent replacement with red cell transfusion. Transfusion of platelets becomes necessary to offset these effects. Additionally, fibrinogen levels need to be monitored and replaced with cryoprecipitate upon depletion. Although rare, signs of disseminated intravascular coagulation (DIC) should be monitored. Signs of DIC include a hemorrhagic diathesis characterized by generalized oozing or uncontrolled bleeding, and can be monitored by fibrinogen levels, platelet count and fibrin split products.

Delayed Consequences

If the bleeding is stopped and the patient is stabilized, the patient may still be subject to delayed consequences of massive transfusion. Hemolysis due to a delayed hemolytic transfusion reaction is possible, as well as development of new antibodies that could cause problems in future transfusions. Additionally, transfusion-transmitted diseases after exposure to multiple donors are a risk. Although current testing for transfusion-transmitted diseases has advanced, diseases such as Hepatitis C or HIV are still not 100 percent detectable. Bacterial transmission can also have dire consequences for a massively transfused patient. Yersinia enteroxocolitica followed by coagulase negative Staphylococci are the most commonly acquired bacterial infections from transfusions. Antibiotics may be given to minimize this risk. Although not often considered, the risk of transmission of parasites through the transfusion of blood components is of increasing interest. New donor screening questions requiring massive transfusion of Trypanosoma cruzi.

Blood Bank Challenges

Not only is the patient faced with challenges, but the blood bank/transfusion service also faces immediate and delayed consequences of a massive transfusion. Upon initiation, communication is the key. One member of the clinical team should act as coordinator in order to organize, communicate and document interactions with the blood bank. Multiple calls from multiple clinical team members causes confusion and takes blood bank staff away from getting components ready. Early communication also helps the blood bank assess inventory, rearrange staff and call in any extra staff that is needed. Good communication reduces panic and provides for a smooth execution of the protocol.

If the patient continues to need blood components, inventory can become critical. Not only does the available inventory decrease for the massively transfused patient, but the other patients in the hospital may be affected. Depending on supplier location and the amount of traffic in the area, obtaining additional blood components can be difficult. All these factors must be considered in maintaining sufficient blood inventory for the entire hospital.

Eventually, the supplier itself may run low on blood products for other area hospitals. So, a massively transfused patient may affect the ability of the blood bank to supply products for other patients in the hospital, and if severe enough, may also affect the needs of patients in an entire city or region.

MTP Review

At the conclusion of any massive transfusion protocol, records of the event should be reviewed and assessed for any difficulties. Using techniques such as root cause analysis may help to identify the cause of any problems encountered and lead to solutions for those problems.

Each situation is unique and provides a learning opportunity. Therefore, the MTP should be continually modified and updated to make the process better.

Conclusion

Massive transfusion is a challenge with far reaching consequences. Communication should be the ultimate goal of all those involved to make the process as smooth as possible. Studies show those patients who require massive transfusion of > 50 units have a survival rate of 43 percent. These statistics show it is worth it to continue with aggressive transfusion therapy.

Everyone benefits from having a well written protocol to improve patient care and patient safety. A well-executed massive transfusion protocol can be the one thing giving a patient the chance to survive. It is for this reason the protocol should be a living document that grows and changes with each experience.

Ricci Jo Ackley is technical specialist, Transfusion Services, George Washington University Hospital (GWLH), Washington, DC. Karen M. Byrne is education coordinator, Transfusion Services Laboratory Department of Transfusion Medicine, Clinical Center, National Institutes of Health (NIH), Bethesda, MD. This article represents the authors’ personal views and not necessarily the views of NIH or GWLH.
Questions

1. The best definition for massive transfusion is:
   a. < 5 RBC units in 5 hours.
   b. one blood volume replaced within 24 hours.
   c. three platelet doses over 3 hours.
   d. one dose of rFVIIa given within 48 hours.

2. Massive transfusion goals include all of the following, except:
   a. maintain tissue perfusion and oxygenation.
   b. restore blood volume.
   c. maintain patient’s hemoglobin > 15 g/dL.
   d. stop bleeding.

3. Choose the blood components common in massive transfusion packages:
   a. RBC, CRYO and PC.
   b. CRYO, FFP and RBC.
   c. RBC, FFP and PC.
   d. PC, CRYO and FFP.

4. What blood component is indicated given the laboratory values: H/H = 12g/dL and 37 percent; PT/PTT = 24/56; and platelet count = 150,000/µL?
   a. RBC
   b. FFP
   c. CRYO and platelets

5. True or false: rFVIIa is licensed for use in hemophiliacs with inhibitors to treat active bleeding or as prophylaxis for surgery?
   a. true
   b. false

6. One strategy to avoid the transfusion reaction known as TRALI is to:
   a. transfuse only irradiated products.
   b. make and transfuse FFP collected only from male donors.
   c. avoid transfusion of plasma products.
   d. none of the above.

7. What items must be included on specimens drawn for type and screen/crossmatch?
   a. collection date
   b. two independent patient identifiers
   c. mechanism to identify individual who drew specimen
   d. all of the above

8. True or false: All trauma patients who present in the emergency department receive blood products?
   a. true
   b. false

9. What ABO type of RBC units would be given to a trauma patient who has a blood donor card indicating she is group A, Rh positive, when a current sample has not been taken for ABO/Rh determination and compatibility testing?
   a. group A
   b. group B
   c. group AB
   d. group O

10. Hypothermia leads to:
    a. decreased acidosis.
    b. increased factor levels.
    c. decreased platelet function.
    d. increased intracellular K⁺.

11. Anti-coagulant preservative containing citrate causes:
    a. increased potassium.
    b. decreased calcium.
    c. decreased magnesium.
    d. both B and C.

12. True or false: Clearance of citrate takes place in the kidneys?
    a. true
    b. false

13. Stored blood has an:
    a. increased intracellular CO₂.
    b. increased intracellular K⁺.
    c. increased 2,3 DPG.
    d. increased extracellular K⁺.

14. The best RBC product for a hypotensive patient with renal failure may be:
    a. irradiated.
    b. < 7 day old RBC.
    c. CMV-negative.
    d. leukoreduced.

15. Reduced levels of 2,3 DPG result in:
    a. decreased release of O₂, shift to the right.
    b. decreased release of O₂, shift to the left.
    c. increased release of O₂, shift to the right.
    d. increased release of O₂, shift to the left.

16. Levels of 2,3 DPG:
    a. are 0 by day 12 of storage.
    b. are replaced within 24 hours.
    c. cause a shift to the right.
    d. are depleted within 72 hours.

17. True or false: DIC is common among massively transfused patients?
    a. true
    b. false

18. True or false: Yersinia enterocolitica and Streptococci are the most commonly acquired bacterial infections from blood transfusions?
    a. true
    b. false

19. Hemolysis immediately following massive blood transfusion can indicate:
    a. ABO incompatibility.
    b. acute hemolytic transfusion reaction.
    c. delayed hemolytic transfusion reaction.
    d. both A and B.

20. Which of the following laboratory values would help to monitor DIC?
    a. platelet count
    b. fibrinogen
    c. fibrin split products
    d. all of the above
## Answers

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>2.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>3.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>4.</td>
<td>A</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>A</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>7.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>8.</td>
<td>A</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>10.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>11.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>12.</td>
<td>A</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>14.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>15.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>16.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>17.</td>
<td>A</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>A</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>20.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

## Survey

1. To what extent were the objectives stated at the beginning of the article met?
   a. completely
   b. some
   c. a little
   d. not met

2. How long did it take you to complete both the reading and the quiz?
   ___ minutes

3. How much of this article can you apply in practice?
   a. all
   b. some
   c. very little
   d. none

4. This program is used to meet CE requirements for:
   a. state license.
   b. NCA.
   c. employment.
   d. other.

5. How would you rank the quality of this article?
   a. superior
   b. good
   c. fair
   d. poor

6. How many years have you been a laboratory professional?
   a. less than 5
   b. 5-10
   c. 10-20
   d. more than 20

7. What topics would you like to see covered in future Learning Scope articles?

---

### ADVANCE for Medical Laboratory Professionals

**“Massive Transfusion: When Good Patients Go Bad”**

April 7, 2008

---

To earn continuing education credit:

1. Complete the form below,
2. Answer the questions and
3. Mail a copy of this form and $15 for ASCLS members or $20 for non-members to:

American Society for Clinical Laboratory Science
P.O. Box 79154
Baltimore, MD 21279-0154
or fax to 301-657-2909

Make checks or money orders payable to ASCLS or send credit card number and expiration date along with this form.

- Please send ASCLS membership information
- Please send information on other sources of ASCLS continuing education

A certificate and credit will be awarded to participants who achieve a passing grade of 70 percent or better. P.A.C.E. credits are accepted for continuing education requirements for maintaining certification by NCA and for maintaining the licensure of laboratory professionals in the states of CA, FL, LA, MT, NV, ND, RI and TN. Tests may be submitted to the ASCLS up to 2 years after publication in ADVANCE.

The Learning Scope is copyrighted and is intended to be used only in conjunction with the ASCLS P.A.C.E. program. It may not be reproduced in part or in whole without permission of Merion Publications and the ASCLS.

This offering expires April 7, 2010