



Approved October 2005
Revised January 2013
Revised April 9, 2018

Guidelines for Best Practices for Massive Transfusion of the Surgical Patient

Introduction

The following Guidelines for Best Practices were researched and authored by the AST Education and Professional Standards Committee, and are AST approved.

AST developed the Guidelines to support healthcare delivery organization's (HDO) reinforce best practices in *massive transfusion* as related to the role and duties of the Certified Surgical Technologist (CST®), the credential conferred by the National Board of Surgical Technology and Surgical Assisting. The purpose of the Guidelines is to provide information OR supervisors, risk management, and surgical team members can use in the development and implementation of policies and procedures for massive transfusion in the surgery department. The Guidelines are presented with the understanding that it is the responsibility of the HDO to develop, approve, and establish policies and procedures for the surgery department regarding massive transfusion practices per HDO protocols.

Rationale

Hemorrhage is a leading cause of death following traumatic injury; more than 80% of deaths in the operating room (OR) and approximately 50% of deaths in the first 24 hours after injury are caused by coagulopathy and exsanguination.^{1,2} The mortality rate is due to the hemorrhagic shock that is a result of the "lethal triad" of acidosis, coagulopathy and hypothermia.³ Causes of massive transfusion include gastrointestinal hemorrhage and major surgeries, such as cardiac and liver, and organ transplants.⁴ Obstetrical hemorrhage is another common cause of massive transfusion that causes shock in the patient and is the primary cause of material mortality worldwide.⁵

Four common definitions for massive transfusion in adults are:⁶⁻⁸

- Transfusion of ≥ 10 *packed red blood cell* (PRBC) units, which is approximately equal to the total body volume (TBV) of an average adult patient within 24 hours;
- Transfusion of >20 units of PRBC units in 24 hours;
- Transfusion of >4 PRBC units in one hour with anticipation of the continued need for blood product support;
- Replacement of $>50\%$ of the TBV by blood products within three hours.

The definitions that use the 24-hour period are not useful during an active surgical procedure and the surgeon activate the *massive transfusion protocol* (MTP). Therefore, the definitions that address rapid blood transfusions apply to the surgical patient.

Pediatric patients require a separate definition due to age and weight:⁷

- transfusion of >100% TBV within 24 hours;
- transfusion support to replace ongoing hemorrhaging of >10% TBV per minute;
- replacement of 50% TBV by blood products within 3 hours.

Blood loss can be categorized as follows:⁴

- Category 1: 15% of the TBV has been lost; no treatment required;
- Category 2: 15% - 30% of TBV has been lost; usually requires IV fluid. Patient signs and symptoms include fatigue, lightheadedness, paleness;
- Category 3: 30% - 40% of TBV has been lost; IV fluid and blood transfusion required. Patient signs and symptoms include irritability, confused, weak, fatigue, paleness;
- Category 4: More than 40% loss of TBV. Requires aggressive emergency treatment with IV fluids and blood transfusion. This is a life-threatening condition in which treatment must be immediately started to replace blood and fluids, as well as stop the hemorrhaging.

A patient that experiences a moderate to catastrophic loss of blood will be in hemorrhagic shock. Based upon the above categories, 20% of blood-volume loss produces mild shock; 20-40% blood-volume loss produces moderate shock; and 40% blood-volume loss produces severe shock.

Therefore, not only is fluid and/or blood replacement a priority in treating the patient, but the accompanying lethal triad of hemorrhagic shock must also be treated.⁵ Early intervention with the implementation of a MTP has been shown to significantly improve the survival rate of the patient.⁹⁻¹⁴ The improvement in mortality is credited to the reduced time of activating the MTP to the first transfusion of blood products to begin treating the underlying complication of coagulopathy.¹⁵ Riskin et al. reported that a HDO that has an established MTP improves communication among departments, improves the availability of blood products, decreases the delay in obtaining the blood products from the blood bank and starting the first infusion, and increases the patient outcomes for survival.¹⁰ Additionally, the improved patient outcomes are also a direct result of decreasing the use of un-crossmatched blood that studies have shown to be an indicator of mortality.¹⁶

Based upon several studies, the standard for both military and civilian medicine for MTP is a 1:1:1 ratio of PRBC to frozen fresh plasma (FFP) and platelets.^{9-11,13,17-22}

The only contraindication that could possibly prohibit blood or blood-product transfusion is due to religious affiliation. However, the following are complications that are associated with massive transfusion.²³

- Hypothermia;
- Coagulopathies;
- Transfusion reactions;
- Decreased calcium level;
- Pulmonary insufficiency;
- Disseminated intravascular coagulation.

Evidence-based Research and Key Terms

The research of articles, letters, nonrandomized trials, and randomized prospective studies is conducted using the Cochrane Database of Systematic Reviews and MEDLINE®, the U.S. National Library of Medicine® database of indexed citations and abstracts to medical and healthcare journal articles.

The key terms used for the research of the Guidelines include: blood products protocol; colloid solution; crystalloid solution; fibrinogen; massive transfusion; massive transfusion protocol; packed red blood cells; partial prothrombin time; universal donor; whole blood. Key terms used in the Guidelines are italicized and included in the glossary.

Guideline I

The surgery department should have an established MTP for the surgery department that is accessible to the staff who should be familiar with the procedures.

1. Approximately 3% - 5% of the civilian trauma patients will undergo massive transfusion, but the patients will exhaust up to 70% of the blood at the trauma center.^{1,4} Massive transfusions are unplanned, thus requiring the rapid transfusion of large amounts of blood and blood products which requires detailed preplanning, training, and coordination between the emergency department, OR, blood bank and laboratory. HDOs that have an up-to-date, active MTP in place are shown to have improved patient and facility outcomes as compared to HDOs that rely upon a physician and lab driven resuscitation.^{1,9,10,13,14}
 - A. Holcomb et al. retrospectively reviewed 466 MTP trauma patients treated for one year at Level 1 trauma centers. They identified the outcomes were best among trauma centers with an active MTP in place.¹¹
 - B. O’Keefe et al. completed a prospective study of patients for two years after MTP was in place as compared to patients from the year prior to when the MTP was activated.⁹ It was reported that the times to first transfusion were much improved, the MTP patients received fewer blood products in the first 24 hours and comparison of costs showed a savings of \$200,000 for the MTP group, partially due to a decrease in blood product wastage.
 - C. Riskin et al. also reviewed their history of two years prior to and post-MTP implementation.¹⁰ They noted an increase in patient survival in the MTP group as well as improved communication with the blood bank leading to an improvement in the time from MTP activation to first transfusion.
 - D. To promote knowledge of the procedures and establish a multidepartment/multidisciplinary level of coordination, initial training and routine drills are recommended for healthcare personnel (HCP) to maintain competency.¹
 - E. The MTP should be based on the principles of damage-control resuscitation that includes the process for immediately obtaining and transfusing PRBC, FFP and platelets.¹ A key factor is reduced time from when the surgeon activates the MTP to the first transfusion. The MTPs should address the following:¹

- 1) Standardized assessment of coagulopathy that includes assessment and treatment of acidosis, hypocalcemia and hypothermia;
 - 2) Triggers for the physician to activate massive transfusion in trauma patients The four triggers are active bleeding requiring operation; blood transfusion in the emergency department; persistent hemodynamic instability; and Assessment of Blood Consumption (ABC). The ABC score consists of four variables: pulse >120; systolic blood pressure <90; positive focused assessment with sonography with trauma (FAST – rapid, bedside ultrasound examination used as a screening tool for blood around the heart or abdominal organs of a trauma patient); penetrating torso. Each variable is assigned one point and a FAST score of two or more will prompt the physician to activate the MTP.
 - 3) Resuscitation in the emergency department;
 - 4) Continuing MTP in the OR;
 - 5) Processes for the rapid delivery of blood and blood-products to the patient;
 - 6) Transfusion targets;
 - 7) Use of adjunct agents;
 - 8) Equipment, e.g. fast flow fluid warmer, warming blanket;
 - 9) Termination of the MTP and return of remaining blood products to the blood bank;¹
 - 10) Performance improvement review (PIR) and evaluation after a MTP incident. The PIR should include evaluating the following outcomes:¹
 - a) Time from activating MTP to the first transfusion of a unit of PRBCs;
 - b) Time from activating MTP to the first transfusion of a unit of plasma;
 - c) Adherence to predetermined ratio one to two hours after activation of the MTP;
 - d) Wastage rates of blood and blood products.
2. The physician(s), and as directly applied to the OR, the anesthesia provider and surgeon, agree to implement the MTP, and confirm with the other members of the surgical team which includes implementing the HDO's *blood products protocol*.
(Adopted from *Massive Transfusion Protocol. Lancaster General Hospital, Lancaster, PA, 2005.*)
- A. CSTs in the assistant circulator role or RN circulator notifies the surgery department supervisor of the physician order to activate the MTP.
 - B. The blood bank is immediately notified of the activation of the MTP and surgeon's orders are confirmed as to what is needed, i.e. *whole blood* or PRBC, FFP, and/or platelets, and the number of units. The blood bank should confirm that the MTP has been activated as well as confirm the inventory of blood and blood products.

3. Timely, precise, and frequent communication between the emergency department, OR, blood bank and laboratory regarding availability, need for and delivery of blood and blood products cannot be overemphasized as to contributing to the success of massive transfusion.
 - A. When the trauma patient is transported from the emergency department to the OR it is extremely important that this is communicated to the blood bank so there is no interruption in the delivery of the blood and blood products.¹
 - B. Surgery personnel are assigned to coordinate the communication between the surgery team and blood bank, serve as transporters (informally referred to as “runners”) to obtain blood and/or blood-products from the blood bank for delivery to the OR, deliver blood samples to the lab, and if necessary, directly communicate lab values to the OR. (*Adopted from Massive Transfusion Protocol. Lancaster General Hospital, Lancaster, PA, 2005.*)
 - 1) CSTs and RNs can serve in the various roles to coordinate the communication between the various HDO departments and the surgery department.
4. The blood-warming unit(s) must be obtained and set up.
 - A. CSTs in the assistant circulator role should know the location of the blood-warming unit and how set it up for use. The anesthesia provider may request the set-up of more than one blood-warming unit.
5. Lab values are obtained after each five units of whole blood or PRBCs are transfused, or hourly, or as requested by surgeon and/or anesthesia provider. Recommended lab tests include CBC, platelet count, *partial prothrombin time (PTT)*, *fibrinogen*, and ionized calcium. (*Adopted from Massive Transfusion Protocol. Lancaster General Hospital, Lancaster, PA, 2005.*)
 - A. CSTs in the assistant circulator role should know the protocol for delivering blood samples to the laboratory department and if necessary, directly communicating the blood test results to the OR.
6. Documentation is completed according to the blood products protocol. CSTs should be familiar with and experienced in assisting with completing patient documents.
 - A. CSTs in the assistant circulator role should assist with completing the documentation in the various patient records such as the clinical record, intake/output (I/O) record, and patient’s chart.^{24,25}
7. The surgeon is responsible for notifying the surgical team that the massive transfusion status of the patient is discontinued.
 - A. When major bleeding has been controlled in the OR and the rate of transfusion has slowed, the surgeon(s) are responsible for making the decision to switch to a laboratory or point-of-care (POCT) based transfusion, and communicating this to the surgical team.
 - 1) American College of Surgeons (ACS) recommends that the surgeon should declare hemorrhage control/hemostasis when both of the following have been met:¹
 - a) The surgeon declares absence of bleeding requiring intervention in the surgical field or resolution of blush after

angioembolization (“blush” is the active extravasation of the contrast solution);

- b) The surgeon and/or anesthesia provider agree that the patient is adequately resuscitated based on the following criteria: stable or increasing blood pressure, or; stable or decreasing heart rate, or; stable or increasing urine output, or; decreasing requirement for vasopressors to maintain a stable blood pressure.
- 2) CSTs in the circulator role or RN circulator notify the surgery department supervisor that the massive transfusion status has been discontinued. This information is also communicated to other surgery department personnel, blood bank and laboratory department within one hour of notification by the surgeon(s).

Guideline II

CSTs in the assistant circulator role should be familiar with the blood and blood products, medications and equipment used during massive transfusion to be an effective member of the surgical team assisting the anesthesia provider and circulator.

1. CSTs must be knowledgeable of the blood and blood products that are used during a massive transfusion to be able to competently confirm the type of product and information on the label of the bag with the blood bank technician, and deliver to the OR to repeat and verify the information with the anesthesia provider.
 - A. Universally compatible donor blood, O Rh-negative and O Rh-positive, and thawed plasma should be immediately available.¹ While waiting for the type and crossmatch to be completed, the transfusion of type-specific blood is appropriate to avoid delay of treating the patient.⁴ If the recipient’s blood type is not known and the transfusion must be started prior to confirming blood type, type O Rh-negative blood should be obtained. In this instance, PRBCs should be transfused instead of whole blood to minimize the transfer of anti-A and anti-B antibodies.²⁶
 - 1) HDOs that have used thawed plasma early in resuscitation efforts have realized a decrease in blood product use and wastage, overall transfusion requirement and mortality.^{1,23,27} However, HDOs should take into consideration that it can take approximately 20 minutes to thaw frozen plasma and thawed plasma can only be kept for five days by facilities that keep it in-stock (this also applies to platelets that can only be stored up to five days).²³

Since most patients arrive with unknown blood type, the *universal donor* AB plasma is transfused. However, AB plasma is rare with only 4% of the population having group AB, presenting a challenge to HDOs to keep an inventory of AB plasma.^{4, 23} Therefore, the patient may initially be transfused with group A plasma while the trauma or surgical team wait on the type-and-crossmatch results.²⁸ A retrospective study by Chhibber et al.

examined the outcomes associated with transfusing group A plasma versus group AB plasma in an emergency setting. Twenty-three patients with blood group AB or B experienced no hemolytic or other adverse reactions.²⁹ Therefore, transfusing group A plasma is considered a practical approach in massive transfusion practice.

- 2) PRBCs and plasma should be delivered through a fast flow fluid warmer.¹ However, platelets and cryoprecipitate should **not** be administered through a fluid warmer.
 - 3) When MTP is activated, universal blood product should be infused rather than *colloid* or *crystalloid solutions*.¹ As previously stated, the ratio of PRBC to FFP to platelets is 1:1:1; the blood bank should automatically send the blood and blood products according to this established ratio.¹
2. CSTs must be knowledgeable of other medications that may be used during a massive transfusion to obtain them for the anesthesia provider.
- A. As mentioned in the suggested protocol for massive transfusion, the calcium level of the patient should be monitored. The reason is that the citrate in banked blood will bind the circulating calcium. CSTs in the assistant circulator role or RN circulator should confirm with the anesthesia provider that calcium chloride is available to administer to the patient. However, calcium administration is only recommended in adults who are receiving a large volume of blood products that are being rapidly transfused.³⁰
 - B. Acidosis is treated through the infusion of fluids to normalize the arterial pH and correct the underlying hypoperfusion.¹⁵ However, if the pH level persists below 7.0, sodium bicarbonate may be administered.³¹ The determination is made based upon the continual laboratory measurement of blood-gas levels from the patient's blood samples.³⁰
 - C. Tranexamic acid (TXA) is an antifibrinolytic agent that has been shown to decrease the need for blood transfusions in elective surgery and reduce mortality in bleeding patients.^{32,33}
 - 1) In 2010, the results of the Clinical Randomization of an Antifibrinolytic in Significant Hemorrhage 2 (CRASH-2) that was conducted in 274 hospitals in forty countries involving 20,211 patients were published. It was a randomized placebo-controlled trial involving adult trauma patients with, or at risk of, significant bleeding who were within eight hours of injury. Patients received either 1 gram of TXA over ten minutes followed by an IV infusion of 1 gram over eight hours or a placebo.

The TXA group had a significantly lower mortality at 28 days than the placebo group. The conclusion of the researchers was early administration of TXA safely reduced the risk of death in bleeding trauma patients and is highly cost-effective.³⁴ However, to be effective the researchers also concluded that TXA must be given as early as possible within one to three hours after injury; after three hours TXA is ineffective.³⁴

- D. April 2013 the FDA approved the use of a four-clotting factor prothrombin complex concentrate (PCC); however, it is only approved for correction of warfarin-induced coagulopathy in bleeding patients.³⁵ FDA The American College of Chest Physicians recommends use of PCC over FFP for reversing warfarin in the case of major bleeding.³⁶
3. Hypothermia is a common pathophysiologic complication of severe injury and serious hemorrhage.³⁷ CSTs in the assistant circulator role should be knowledgeable of the rewarming strategies including set-up and operation of the equipment (rewarming strategies pertaining to CSTs in the first scrub role are discussed in Guideline VI).
- A. It is estimated that approximately 66% of trauma patients arrive in the emergency department with hypothermia.³⁸ Gregory et al. reported that hypothermia developed in 57% of the trauma patients that were studied.³⁹ Adverse effects of hypothermia include cardiac dysrhythmias and decreased cardiac output.¹⁵ However, the most significant hypothermic effect on the body is coagulopathic bleeding due to dysfunctional platelets and fibrinolysis.^{40,41}
- B. Rewarming strategies that are begun in the OR should be continued in the intensive care unit (ICU). The strategies are divided into passive external rewarming, active external rewarming and core rewarming.¹⁵
- 1) Passive external rewarming methods include increasing the OR temperature and limiting traffic in-and-out of the OR to decrease the flow of air over the patient. Additionally, providing the anesthesia care provider with a towel to cover the head is crucial since vasoconstriction does not occur in the vessels of the scalp and up to 50% of the radiant heat loss occurs from the neck up.²²
 - 2) Active external rewarming methods include fluid/air circulating blanket and overhead radiant warmer. Conductive rewarming with a fluid or air circulating blanket that is placed on the OR table and is underneath the patient is not effective as other available methods such as placing the blanket over the patient; however, when the OR team has limited time in preparing for a trauma patient it may be the optimal choice due to quick set-up time, and obviously delivering some level of rewarming to the patient.¹⁵

The use of overhead radiant warmers is probably not effective for use on adult patients and should be reserved for use on infants and toddlers.
 - 3) The hypothermic trauma patient greatly benefits from core rewarming as compared to any other method of rewarming. Use of warm IV fluids is the easiest, fastest and most efficient method of providing heat to the body core of patients undergoing massive transfusion resuscitation.¹⁵ Fast flow fluid warmers that allow rapid infusion of large volumes of fluid warmed 35° C to 41° C (95° F – 105.8 F), the current standard established by the American Association of Blood Banks, should be used.⁴²

CSTs in the first scrub role must remember the exact amounts of fluids, such as irrigation solution, that are administered to the patient for the anesthesia provider and surgeon to estimate blood loss (EBL), and to provide information that assists with postoperative care if blood and/or blood products were not used. The irrigating fluid must be warm to assist with core rewarming of the patient.

Airway warming by the anesthesia provider can be achieved with the use of humidified ventilator circuits that can be warmed to 41° C (105.8° F).

Guideline III

CSTs should be knowledgeable of the various considerations and issues regarding cultural diversity, and understand that a patient's religious and/or cultural beliefs may not allow the use of certain blood replenishment products.

1. There are specific religions that prohibit the transfusion of blood and blood products, such as Jehovah's Witness.⁴³ The CST should be familiar with the IV fluids that can be given to adults in lieu of transfusing blood or blood products. The following list is not all inclusive of the IV products that are available on the market.
 - A. Crystalloid solutions, such as Ringer's lactate, can be given. However, the surgeon and anesthesia provider will closely monitor the amount infused to prevent hemodilution.
 - B. Gelofusine is a modified fluid gelatin that is also a blood plasma replacement product that assists in increasing blood flow, blood volume, cardiac output and oxygen transport.
 - C. Hetastarch is a plasma volume expander that restores blood plasma due to severe hemorrhaging.
 - D. IV ferritin (iron) products are available in the effort to stabilize the hematocrit level in patients experiencing severe hemorrhaging.
2. The surgical personnel should be familiar with the state and federal laws regarding transfusing blood and blood products in infants and children (age group 0 – 12), and minors (age group 13 – 17).⁴³⁻⁵⁹
 - A. The surgeon and/or anesthesia provider have the responsibility for making the sole decisions regarding transfusing blood and/or blood products for these age groups based upon consultation with legal counsel.

Guideline IV

CSTs in the first scrub role should know the measures taken to implement the MTP to be an effective team member assisting the surgeon.

1. CSTs should have a comprehensive understanding of hemostatic methods to proficiently assist the surgeon in controlling hemorrhaging at the surgical field.
 - A. CSTs should be knowledgeable of the thermal and mechanical methods of hemostasis, and make those available according to the preferences of the surgeon.
 - 1) Electrocautery is used during most surgical procedures and therefore, should be immediately available for use by the surgeon. If the primary surgeon is being assisted by another surgeon, the CST should set up a second electrocautery.
 - 2) Upon activation of the MTP, the CST should immediately request additional mosquito and Crile hemostats, ties of various sizes, and medium and large hemoclip appliers and clips of various sizes.
 - B. CSTs should be knowledgeable of the chemical and topical hemostatic agents that are in the inventory of the surgery department, and how to quickly prepare the agents for use.
 - 1) The CST should request that the chemical and topical hemostatic agents be available in the OR.
 - 2) If the thermal and mechanical methods of hemostasis do not fully achieve the results the surgeon desires, the CST should confirm with the surgeon if he/she wants to also use chemical and/or topical hemostatic agents, and provide the agents that are available in the OR according to the surgeon's preference.⁶⁰
3. During any patient emergency incident in the OR, CSTs are still relied upon by the surgical team to maintain the sterile field and account for all sharps, sponges and instruments to prevent retained surgical items (RSI) in the surgical wound.
 - A. The CST must remain calm, but respond efficiently and swiftly while employing critical thinking skills to anticipate the needs of the surgeon.
 - B. As sharps, sponges and instruments are added to the sterile field the CST and circulator may not have the time to perform counts. However, the CST must still make every effort to keep track of all items to prevent RSI.
 - 1) Once the patient is stabilized and the surgical procedure completed, the surgeon may request x-rays to be taken in the OR at the end of the procedure or in ICU to confirm there are no retained items.²⁴
 - 2) The circulator should document in the patient's surgical record that counts were not able to be performed, the reason why, x-rays were performed and the results of the x-rays; along with the circulators initials, the CST should also initial the record.²⁴
4. During a laparotomy, the CST should assist the surgeon in covering the exposed bowel and any other organs of the peritoneal cavity with dry towels or sponges, or plastic bags. The use of wet towels or sponges can increase the evaporative heat loss by nearly 250%.³⁷

Guideline V**The surgery department should review the MTPs on an annual basis.**

1. The MTPs should be developed by a multidisciplinary committee that includes anesthesia providers, blood bank personnel, emergency department personnel, risk management, surgery department personnel and trauma service personnel.^{1,4} The surgery department should be represented on the committee by CSTs, surgeons, and RNs.
 - A. The committee should document when the MTPs were developed, reviewed and revised, and who participated in the process.
2. CSTs should be familiar with the MTPs for the surgical patient. The orientation of new employees should include reviewing the MTPs and participating in drills.

Guideline VI**CSTs should complete continuing education to remain current in their knowledge of MTPs for the surgical patient.⁶¹**

1. The continuing education should be based upon the concepts of adult learning, referred to as andragogy. Adults learn best when the information is relevant to their work experience; the information is practical, rather than academic; and the learner is actively involved in the learning process.⁶²
2. It is recommended surgery departments use various methods of instruction to facilitate the learning process of CSTs.
 - A. If the education is primarily lecture, methods to engage learners include presentation of case studies for discussion, and audience discussion providing suggestions for reinforcing massive transfusion for the surgical patient.
 - B. Other proven educational methods include interactive training videos, and computerized training modules and teleconferences.
 - C. The continuing education should be delivered over short periods of time such as in modules, and not in a one-time lengthy educational session.
3. Continuing education programs should be periodically evaluated for effectiveness including receiving feedback from surgery department personnel.
4. The surgery department should maintain education records for a minimum of three years that include dates of education; names and job titles of employees that completed the continuing education; synopsis of each continuing education session provided; names, credentials, and experience of instructors.

Competency Statements

Competency Statements	Measurable Criteria
<p>1. CSTs can obtain blood and/or blood-products from the blood bank including verifying with blood bank personnel the patient information on the bags of blood or blood-product for delivery to the OR.</p> <p>2. CSTs can serve as “runners” to deliver blood samples to the lab and communicate blood sample lab results to the OR</p> <p>3. CSTs are qualified to obtain and set-up a blood warming unit.</p> <p>5. CSTs can assist in the documentation, such as the clinical record and patient’s chart.</p> <p>6. CSTs are qualified to participate on HDO and/or surgery department committees that establish the MTPs including protocols that address religious and/or cultural beliefs.</p>	<p>1. Educational standards as established by the <i>Core Curriculum for Surgical Technology</i>.²⁵</p> <p>2. The didactic subject of massive transfusion is included in a CAAHEP accredited surgical technology program.</p> <p>3. As practitioners, CSTs perform patient care duties by assisting the surgeon and anesthesia provider during routine and emergency transfusions.</p> <p>4. CSTs complete continuing education to remain current in their knowledge of hemorrhage, transfusion of the surgical patient, and patient care duties as related to transfusion, including following the policies of the surgery department in completing annual in-service requirements.⁶¹</p>

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Glossary

Blood products protocol: Standardized protocols for the administration of blood and blood products during massive transfusion of a trauma patient.

Colloid solution: Type of intravenous fluid that contains large molecules that are dispersed throughout a liquid medium that do not pass through a semipermeable membrane; when infused, the molecules expand the intravascular circulatory system.

Crystalloid solution: Type of intravenous fluid that contains solutes that are mixed into and dissolve in a solution. The solutes are molecules that can pass through semipermeable membranes, thus, they can transfer from the circulation into cells and body tissues. Types of crystalloid solutions are normal saline and lactated ringers.

Fibrinogen: A naturally occurring protein in the blood plasma that is converted into fibrin (Factor I) when it comes into contact with thrombin during the clotting mechanism. Commercial preparations of human fibrinogen are used to restore blood fibrinogen levels to normal during major bleeding.

Massive transfusion: Massive transfusion in the adult is defined as either replacement of >1 blood volume in 24 hours, or >50% of blood volume in four hours; pediatric patients defined as transfusion of >40 mL/kg.

Massive transfusion protocol: The procedures for instituting the rapid replacement of blood and blood components through transfusion.

Packed red blood cells: Concentrated preparation of red blood cells that are obtained from whole blood through the removal of plasma; used for purposes of transfusion.

Partial prothrombin time: Laboratory blood test that measures the length of time it takes for blood to clot.

Universal donor: An individual who is blood group O whose blood can be transfused to patients of any blood group.

Whole blood: Blood that contains all the components including plasma and platelets.

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