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Guidelines for Best Practices for Treatment of Disseminated Intravascular Coagulation

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 organizations (HDO) reinforce best practices in treating *disseminated intravascular coagulation* (DIC) in the surgical patient 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 treating DIC 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 DIC treatment practices per HDO protocols.

Rationale

DIC is a complicated acquired, systemic disorder of the body's hemostatic process that involves a combination of hemorrhaging and microvascular *coagulation*. The International Society of Thrombosis and Haemostasis (ISTH) DIC subcommittee defines DIC as "an acquired syndrome characterized by intravascular activation of coagulation with the loss of localization arising from different causes. It can originate from and cause damage to the microvasculature, which, if sufficiently severe, can produce organ dysfunction."[1] There are two forms, chronic and acute; this document will focus on the acute form that is characterized by a massive, excessive activation of coagulation that eventually overwhelms the anticoagulant and fibrinolytic systems.[2-4] It is most often referred to in terms of being a hemorrhagic disorder, due to the difficulties associated with bleeding; however, the complications that occur with the microvascular clotting must be also be recognized as being associated with true DIC.[5] DIC is not in itself a primary disease, but occurs as a complication from or response to an underlying condition.[6] Physicians consider the possibility of DIC only when there is severe and uncontrollable hemorrhaging from multiple sites.[7]

The two key agents responsible for DIC are circulating plasmin and thrombin.[2,8] DIC is a repeating cycle of clot formation and *fibrinolysis* of the clot, leading to the depletion of platelets and coagulation factors, including the constant release of anticoagulants.[5,8] As the level of the platelets decreases, systemic microvascular coagulation occurs in the bloodstream creating clots that prevent the circulation of blood cutting off the normal blood supply to vital organs that can lead to major damage to the

organs.[9,10] At the same time, the depletion of the platelets and coagulation proteins results in the inducement of severe bleeding. Patients with DIC exhibiting a decreased level of platelet and coagulation factors can be at risk for serious bleeding when undergoing an invasive surgical procedure. Additionally, *antithrombin*, the most important inhibitor of the action of thrombin, is decreased due to its continuous consumption by the ongoing activation of coagulation; the excess thrombin adversely effects the vascular endothelium to make it weaker and cause leaking leading to vasogenic edema and as such, putting a stop to the effects of thrombin is critical towards resolving DIC.[11,12] Low levels of antithrombin in DIC are associated with an increase in mortality and organ dysfunction.[13,14] In summary, the unobstructed production of plasmin and thrombin leads to the following complications:[2]

- Generalized systemic bleeding.
- Overproduction of fibrin degradation products including *D-dimers*.
- Depletion of anticoagulant proteins including antithrombin and *protein C*.
- Activation and depletion of platelets, coagulation factors, fibrinogen and fibrin.
- *Schistocytes* form as the red blood cells are *cleaved* (severed) as they flow through the fibrin strands.
- Formation of microthrombi that block blood vessels preventing blood and oxygen from suppling tissue and organs leading to tissue ischemia and possible multi-organ dysfunction syndrome (MODS); however, large thrombi may also form in cancer patients.[3,8]

DIC occurs in a variety of clinical conditions. (see Table 1) DIC occurs at all ages and in all races, and does not exhibit a preference for males or females.[11] It is estimated that 1% of hospitalized patients develop DIC, and 20% of patients with acute respiratory distress syndrome (ARDS) develop DIC.[6] Sepsis is the most common clinical cause of DIC; approximately 35% of patients who have *sepsis* are affected by DIC.[10,15] A study published in 2008 reported that the mortality rate was significantly higher in sepsis patients than trauma patients.[16] Most microorganisms can cause DIC, but bacterial infection is most frequent. Contrary to popular belief and information, DIC seems to occur as often in patients with Gram-positive sepsis as in those with Gram-negative sepsis.[11,15] Approximately 10%-20% of patients with Gram-negative bacteremia display evidence of DIC.[2,17]

Another clinical occurrence commonly associated with the development of DIC is severe trauma, particularly trauma to the brain tissue. In cases of major trauma, studies have shown DIC approximately doubles the mortality rate and is an independent predictor of mortality in patients.[6,11,17]

DIC is a common complication associated with abruptio placentae and amniotic fluid embolism, occurring in more than 50% of patients who experience these obstetrical conditions.[17-19]

Table 1: Conditions Associated with the Cause of DIC[3,4,11]

* Cancer
  - > Leukemia
  - > Solid tumors

* Obstetrical complications
  - > Retained fetus
  - > Abruptio placentae
  - > Amniotic fluid embolism
  - > Preeclampsia/eclampsia

* Vascular conditions
  - > Aortic aneurysm
  - > Giant hemangioma

***** Pancreatitis

* Immunologic syndromes
  - > Transplant rejection
  - > Anaphylactic reaction
  - > Hemolytic transfusion reaction

* Trauma
  - > Burns
  - > Brain injury
  - > Fat embolism
  - > Massive transfusion

* Gram-positive or Gram-negative sepsis

* Liver disease

* Miscellaneous
  - > ARDS
  - > Near drowning
  - > Venomous snake bites

The diagnosis of DIC is based on both clinical symptoms and laboratory information.[6,20,21] There is no single laboratory test that can be used for diagnosing or ruling-out the diagnosis of DIC.[3,6,18] The goals of the tests are to identify DIC, evaluate the severity and monitor its effects over time.[3] A combination of tests is frequently performed at intervals to closely monitor the patient for clinical improvement or worsening.[3,7] The tests include:[3,9]

- D-dimer test[8]
- Fibrinogen blood test
- Prothrombin time (PT)
- Fibrin degradation products
- Complete blood count (CBC)
- Partial thromboplastin time (PTT)

A scoring system developed by the International Society on Thrombosis and Haemostasis is the system most commonly used by physicians to evaluate the tests results to determine if DIC is present.[3] The score is based on the results of the D-dimer, fibrinogen, platelet count and PT; the higher the score, the higher the percentage chance that DIC is present.[3] The following, in addition to the scoring system, can also be used to diagnose DIC:[18,20,21]

- Prolonged PT
- Presence of fibrin-degradation products in plasma
- Prolonged activated partial-thromboplastin time (PTT)
- Recognition of underlying condition associated with DIC
- Low plasma levels of coagulation inhibitors, such as antithrombin

- *Platelet count* of less than 100,000 per cubic millimeter or the platelet count rapidly decreases[15]

The surgeon and anesthesia provider may order postoperative x-rays or other imaging scan to identify the location of blood clots and evaluate the function of organs.[17]

A reduction in the platelet count or a decreasing count over repeated laboratory measurements is a sensitive, but not specific, indicator of DIC.[15] Thrombocytopenia is reported in up to 98% of DIC cases in combination with a decrease in platelet count.[22] Fibrin degradation products also combined with the platelet count decrease is a strong indicator of DIC.[6] Additionally, PT is prolonged in approximately 50% - 60% of DIC cases.[6]

The signs and symptoms depend on the underlying disease, but the general clinical features of DIC include:[2-4,5,10]

- *Petechiae*
- Hematuria
- Low blood pressure
- Spontaneous bruising
- Respiratory tract bleeding
- Mucosal bleeding from the gums, mouth, nose
- Possibly bleeding at sites of venipuncture/IV catheters
- Thrombosis, e.g., extremity or extremities cold to the touch and no pulse is detected
- Perfuse bleeding at surgical wound site, e.g., CNS bleeding, gastrointestinal bleeding, hematuria

There is no specific treatment for DIC. The treatment goals are to quickly determine and treat the underlying cause to limit the excess generation of thrombin and stabilize the patient; treat the cause and DIC will resolve.[2-4,7,9] Supportive treatments include replacing coagulation factors and fibrinogen with fresh frozen plasma (PPF) infusion, heparin to prevent blood clotting, *cryoprecipitate* and platelet infusion if the platelet count is low.[2,3,8] The prognosis is based on the cause of DIC and the severity of the cause.[4]

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 this Guideline include: antithrombin; coagulation; cryoprecipitate; D-dimers; disseminated intravascular coagulation; fibrinolysis; petichiae; platelet count; protein C; sepsis. Key terms used in the Guidelines are italicized and included in the glossary.

Guideline I

CSTs in the first scrub role should know the measures taken to treat a surgical patient experiencing DIC to be an effective team member assisting the surgeon.

1. CSTs should know the physical signs of DIC and be alert to the presentation of these signs as indicators of the patient's condition.
    A. The key physical signs that are evident in the surgical patient include gastrointestinal bleeding, intracranial bleeding, perfuse bleeding at the surgical site, petichiae, mucous membrane bleeding and spontaneous bruising.[2,3,8,17]
2. CSTs should have a comprehensive understanding of hemostatic methods to proficiently assist the surgeon in controlling hemorrhaging at the surgical field.
    A. With the understanding that the initial treatment of DIC at the sterile field begins with hemostasis, the surgeon may direct the CST to assist in applying compression to blood vessels under his/her direct supervision.
    B. 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) If available in the inventory of equipment in the surgery department, the CST may inquire if the surgeon wants to use argon enhanced coagulation and/or ultrasonic coagulation devices.
        3) Upon confirmation of a DIC incident, the CST should immediately request additional mosquito and Crile hemostats, ties of various sizes, and medium and large hemoclip appliers and clips.
        4) The CST may also request that stapling devices be available in the OR, but not opened unless requested by the surgeon.
    C. 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) Upon confirmation of a DIC incident, 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.[23]
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 radiographic imaging (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. The CST must remember the exact amount of fluids, such as irrigation solutions, 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 additional blood and/or blood products need to be infused.
5. Due to the multiple patient care activities that are taking place at the sterile field during a DIC incident, the CST in the first scrub role may request to have another CST "scrub-in" to provide assistance.

Guideline II

CSTs in the assistant circulator role should be familiar with the blood products and other agents used to treat DIC to be an effective member of the surgical team.

1. The cornerstone of managing DIC is the specific treatment of the underlying disorder or condition, such as sepsis, abruptio placentae and hemolytic transfusion reaction.[2-4,6,7,9,19] By not treating the underlying cause, DIC treatments will fail. The treatment of secondary metabolic complications that are the result of the primary disease process, such as acidosis and hypotension, is necessary as well as the reversal of concomitant conditions, such as hypothermia and hypocalcemia, that can exacerbate the abnormal coagulation process that is occurring.[6] The treatment modalities will differ according to the presenting symptoms of the patient. For example, a patient who presents with severe hemorrhaging will require supportive treatment that will differ from the patient that presents with microvascular coagulation that can lead to multi-organ failure.[25] Table 2 provides broad recommendations for treating DIC.

Table 2: Treatment of DIC

Blood Product or Other Agent	Reason for Administering
Platelets[6,8]	Treat thrombocytopenia
Fresh frozen plasma[6,8]	Treat elevated PT and PTT
Cryoprecipitate or fibrinogen[6,8]	Treat low fibrinogen level
Tranexamic acid[6,26]	Control excessive thrombolysis that increases bleeding associated with DIC. A study conducted in 2010 reported that treatment with tranexamic acid significantly reduced the mortality of patients with trauma.[25,26]
Vitamin K[8]	Treat deficiency of vitamin.[17]
Antithrombin III	An inhibitor of coagulation that is naturally produced by the body.[15] However, its cost prohibits widespread use.
Antifibrinolytic agents	Effective in treating bleeding.[27]

2. Low molecular weight heparin (LMWH), which has gradually replaced unfractionated heparin, is not listed in Table 2 due to the differences in recommendations by professional organizations such as the British Committee for Standards in Haemotology and the ISTH.[19] However, patients with DIC are at a high risk for venous thromboembolism (VTE) and the administration of LMWH has become a standard of care.[28,29]
    A. The administration of heparin is not recommended in patients with massive bleeding type of DIC.[19]
    B. Heparin is recommended in patients with non-symptomatic type of DIC to prevent the onset of deep vein thrombosis.[19]
3. Treatment with coagulation-factor concentrates is contraindicated due to the concentrates possibly being contaminated with activated coagulation factors.[30] Concentrates only contain certain coagulation factors and the patient with DIC is deficient in all coagulation factors.[15]
4. CSTs should be knowledgeable of the various considerations and issues regarding cultural diversity, and understands that a patient's religious and/or cultural beliefs may not allow the use of certain blood replenishment products.[31-47]
    A. There are specific religions that prohibit the transfusion of blood and blood products, such as Jehovah's Witness.[31] 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.
        1) 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.
        2) 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.

3) Hetastarch is a plasma volume expander that restores blood plasma due to severe hemorrhaging.
4) IV ferritin (iron) products are available in the effort to stabilize the hematocrit level in patients experiencing severe hemorrhaging.

B. 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).[35-47]
    1) The surgeon and/or anesthesia provider have the responsibility of making the sole decisions regarding transfusing blood and/or blood products for these age groups based upon consultation with legal counsel.

Guideline III

CSTs in the assistant circulator role should be prepared to serve as transporters (informally referred to as "runners") to deliver blood samples to the laboratory, and retrieve blood and/or blood products from the blood bank to deliver to the OR.

1. Upon confirmation of a DIC incident, the surgical team should request additional assistance from surgical personnel since multiple patient care activities will need to be simultaneously addressed.
2. CSTs should know the protocols for reporting lab results to the surgical team. However, verbally reporting information is becoming less frequent due to the ability to quickly and efficiently communicate information to the OR with the use of computers.
3. CSTs should know the storage location of blood warming units to quickly transport to and set-up in the OR if requested by the anesthesia provider.

Guideline IV

CSTs should be familiar with and experienced in assisting with the completion of patient documents.

1. CSTs should be familiar with patient documents, such as the clinical record and patient's chart, and the protocols for completing the documentation.[24,48]

Guideline V

The surgery department should review the policies and procedures (P&P) regarding treatment of DIC in surgical patients on an annual basis.

1. The surgery department should include members of the surgical team and administration when reviewing the P&Ps, including CSTs, surgeons, anesthesia provider, RNs, risk management, and infection control officer.
    A. The surgery department should document when the P&Ps were reviewed, revision completed (if necessary), and who participated in the review process.
2. CSTs should be familiar with the P&Ps for treatment of DIC. The orientation of new employees should include reviewing the P&Ps.

Guideline VI

CSTs should complete continuing education to remain current in their knowledge of treating DIC in surgical patients.[49]

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.[50]
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 how DIC is treated.
    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
1. CSTs are knowledgeable of the signs and symptoms of DIC to assist the surgical team in confirming the patient's condition.	1. Educational standards as established by the *Core Curriculum for Surgical Technology*.[48]
2. CSTs can assist in the treatment of a patient with DIC under the direct supervision of the surgeon and/or anesthesia provider.	2. The didactic subjects of blood, blood-products and transfusion are included in a CAAHEP accredited surgical technology program.
3. CSTs can serve as "runners" to deliver blood samples to the lab; obtain blood and blood-products from the blood bank for delivery to the OR; and communicate blood sample lab results to the OR	3. The didactic subject of the pathophysiology of DIC and treatment protocols is included in a CAAHEP accredited surgical technology program.
4. CSTs are qualified to set-up the blood-warming unit.	4. CSTs in the assistant circulator role perform patient care duties by assisting the surgical team when a patient is experiencing DIC.
5. CSTs can assist in the documentation, such as the clinical record and patient's chart.	5. CSTs complete continuing education to remain current in their knowledge of hemorrhage, blood and blood-product transfusions, and patient care duties as related to treating DIC.[49]
6. CSTs are qualified to participate on HDO and/or surgery department committees that establish protocols for treating DIC.	

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Glossary

Antithrombin: A glycoprotein produced by the liver that inhibits coagulation by neutralizing the enzymatic activity of thrombin and other enzymes of the coagulation system.

Cleaved: Split into two halves or pieces.

Coagulation: The process by which the blood clots to form solid masses, or clots.

Cryoprecipitate: Blood product obtained from blood plasma. FFP is centrifuged and the precipitate is collected. The precipitate contains several clotting factors including fibrinogen and factor VIII.

D-dimers: A protein fragment that is present in the blood after a blood clot is broken down by the process of fibrinolysis; considered one of the fibrin degradation products that occurs due to DIC.

Disseminated Intravascular Coagulation (DIC): A condition in which blood clots form throughout the body's small blood vessels. These blood clots can reduce or block blood flow through the blood vessels, which can damage the body's organs

Fibrinolysis: A normal body process in which blood clots breakdown to prevent blood clots that occur naturally from growing and causing problems.

Petechiae: Tiny blood vessels (capillaries) that bleed and leak blood into the skin that cause the formation of visible, tiny, red dots on the surface of the skin. Blood can also collect under tissue in larger areas (called purpura) or in large bruised areas (called ecchymosis.)

Platelet count: Laboratory test to measure how many platelets are in the blood of a patient.

Protein C: Also called coagulation factor XIV; a protein that is important in regulating anticoagulation, inflammation, cell death and maintaining the permeability of blood vessel walls. Decreased levels contribute to the risk for the patient developing thrombosis.

Schistocytes: Fragmented part of a red blood cell that is irregularly shaped and jagged around the edges.

Sepsis: The body's overwhelming and over-active immune response to septicemia of the circulatory system.

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