Disseminated Intravascular Coagulation

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Oncologic emergencies, such as disseminated intravascular coagulation (DIC), can cause significant morbidity and mortality. DIC is a frequent thrombotic event that arises in the cancer population; in fact, patients with acute promyelocytic leukemia (APL) have an 85% risk of developing DIC (Ezzone, 2000; Holmes-Gobel, 2000). DIC is a coagulation disorder that can be caused by, for example, cancer or infection. DIC prompts overstimulation of the normal clotting cascade and results in simultaneous thrombosis and hemorrhage (Ezzone).

Intrinsic and extrinsic pathways are responsible for clotting. The intrinsic pathway is initiated by endothelial cell damage. Sepsis, a phenomenon that disrupts the endothelial cell membrane, is one type of intrinsic-triggering event. The extrinsic pathway is initiated during tissue injury, and triggering events include malignancy, trauma, or obstetric complications (Ezzone, 2000; Tan, 2002). Both the extrinsic and intrinsic pathways lead to the common pathways where fibrinogen is converted to fibrin; blood clotting, which balances homeostasis, subsequently occurs (Ezzone).

DIC develops when the clotting cascade becomes disrupted from the normal homeostatic balance. Activation of the clotting cascade causes plasmin and thrombin to circulate, which, in turn, simultaneously induces bleeding and clot formation. DIC results from abnormal procoagulant activation and consumption of clotting factors. Thrombosis and organ damage occur because of excess platelet aggregation. Excess fibrin clots capture the platelets and produce thrombosis with impaired organ perfusion. Platelet aggregation leads to thrombocytopenia and additional consumption of clotting factors (Holmes-Gobel, 2000).

Bleeding can occur in patients with DIC because excess thrombin facilitates the conversion of plasminogen to plasmin. The conversion of plasmin produces fibrinolysis, which leads to a rise in fibrin split products (FSPs). FSPs have strong procoagulant activity, thus causing hemorrhage (Holmes-Gobel, 2000).

Case Study

Mr. M is a 53-year-old male admitted to the oncology unit with newly diagnosed APL. He had a central venous catheter placed and began idarubicin and cytarabine yesterday. He offers no complaints at the beginning of the 12-hour shift. His vital signs are stable, and his laboratory values, drawn this morning, are hemoglobin 10 g/dl, platelet count 50,000/mm³, fibrinogen 160 mg/dl, FSPs 50 ug/ml, and international normalization ratio (INR) 1.6. A complete blood count and coagulation panel, including fibrinogen and FSP, are ordered to be drawn at 5 pm. Upon entering the patient’s room to measure his 12 pm vital signs, the nurse found Mr. M to be disoriented and lethargic. A large pool of blood is on his bed and shirt. Mr. M also has epistaxis, and a large ecchymotic area the size of an orange is present on his right thigh. After reporting these findings, “stat” laboratory studies reveal hemoglobin 8 g/dl, platelet count 22,000/mm³, prothrombin time (PT) 15.8 seconds, fibrinogen 96 mg/dl, FSP 100 ug/ml, and INR 2.0. Mr. M’s vital signs reveal a temperature of 100°F, blood pressure of 90/50 mm/Hg, pulse 120 beats per minute, respiration rate 22 breaths per minute, and oxygen saturation, as measured by pulse oximetry, 90%.

1. What event most likely precipitated DIC in Mr. M?
   a. Nutritional deficiencies
   b. Sepsis
   c. Placement of a new central venous catheter
   d. Initiation of chemotherapy

2. All of the following are causes of DIC except
   a. Trauma
   b. Sepsis
   c. Renal failure
   d. Malignancy

3. All of the following are signs and symptoms of DIC except
   a. Ecchymosis
   b. Hemoptysis
   c. Slow, irregular heart rhythm
   d. Scleral hemorrhage

4. After a thorough assessment and oxygen therapy, a care plan is developed in collaboration with Mr. M’s oncologist. Which of the following plans is most appropriate for this patient?
   a. Discontinue the chemotherapy, initiate a workup of the fever to determine its cause, and administer blood products.
   b. Continue chemotherapy and begin a normal saline solution at 200 ml per hour, work up the fever and administer antibiotics if indicated, administer blood products, and monitor the patient’s complete blood count, metabolic profile, coagulation studies, and liver panel.
   c. Initiate heparin at 2,200 units per hour and monitor coagulation studies, including PT, partial thromboplastin time (PTT), INR, FSP, and fibrinogen, every six hours.
   d. Administer furosemide 80 mg IV bolus (push) now, monitor complete blood count and coagulation panels daily, initiate thrombocytopenic precautions, and closely monitor intake and output.

5. Which series of blood tests can indicate the presence of DIC?
   a. Elevated PT and fibrinogen and presence of schistocytes
b. Elevated PTT, decreased fibrinogen, and decreased D-dimer.

c. Decreased PT, decreased fibrinogen, and decreased FSPs.

d. Elevated FSPs, elevated D-dimer, and decreased platelet count.

Discussion

Question 1: Choice d, initiation of chemotherapy, is correct. DIC often occurs during rapid cell turnover; therefore, chemotherapy likely initiated DIC. The rapid cell turnover initiates a procoagulant, and the consequence is a disruption in the bleeding and clotting cascade. Choice a, nutritional deficiencies, is incorrect. Although vitamin K depletion can lead to an increase in INR, nutritional deficiencies do not cause DIC. Choice b, sepsis, is incorrect because Mr. M has a low-grade fever; thus, his symptoms more likely are related to chemotherapy rather than sepsis. Choice c, placement of a new central venous catheter, is incorrect. Central venous catheter placement can result in bleeding but is not likely to cause DIC. The diagnosis of DIC is made based on the underlying disease associated with DIC, a platelet count less than 100,000/mm³, or a rapid decrease in the platelet count, prolongation of clotting times, the presence of FSPs, and low plasma levels of coagulation inhibitors (Holmes-Gobel, 2000).

Question 2: Choice c, renal failure, is incorrect because renal failure does not cause DIC. Trauma, choice a, particularly brain injury, is associated with DIC (Levi & Ten Cate, 1999). The release of fat and phospholipids from the tissues coupled with hemolysis and endothelial damage stimulates the activation of the coagulation cascade (Levi & Ten Cate). Sepsis, choice b, is the most common source of DIC (Holmes-Gobel, 1999; Levi & Ten Cate). Approximately 30%–50% of patients with gram-negative sepsis exhibit DIC (Levi & Ten Cate). Sepsis triggers the coagulation cascade by activation of the cytokine system, which is affected by by-products of microorganisms such as bacterial endotoxins (Levi & Ten Cate). Choice d, malignancy, including solid tumors, leukemia, and lymphomas, is another common cause of DIC. Mr. M, because of his diagnosis of APL, is at very high risk for DIC. Promyelocytic blast cells contain a procoagulant substance thought to be similar to that of thromboplastin. Kurtz (1993) postulated that this substance is released from the granulocytes, which, in turn, stimulates the clotting cascade.

Question 3: Choice c, slow, irregular heart rhythm, is correct. Although the cardiovascular system is usually affected by DIC, the most common cardiovascular symptom is tachycardia. Clinical symptoms of DIC may be difficult to detect because of their variability (Holmes-Gobel, 1999). Nurses must recognize the systemic signs and symptoms of DIC, such as fever, hypoxia, acidosis, and hypotension (Holmes-Gobel, 1999). The most common symptom of DIC is bleeding, often from at least three sites. Choices a, ecchymosis; b, hemoptysis; and d, scleral hemorrhage, are incorrect because they are signs of DIC. In Mr. M’s case, bleeding from the central venous catheter site, ecchymosis, and epistaxis were evident. Mr. M also exhibited symptoms of shock: hypotension, hypoxia, and change in mental status. Table 1 lists the signs and symptoms of DIC that are important to recognize and assess.

Question 4: Choice b, continue chemotherapy and begin other supportive and diagnostic measures as indicated, is correct. This approach is most appropriate for Mr. M because he showed signs of shock; therefore, treating his blood pressure and maintaining proper oxygenation are critical. Because of his bleeding, maintaining Mr. M’s platelet count above 50,000/mm³ was important. Choice a, discontinue the chemotherapy, is incorrect; the basic premise of treating DIC is to manage the underlying disorder (Holmes-Gobel, 1999). In this case study, the underlying disease is APL, and the initial treatment for leukemia is chemotherapy. Thus, stopping chemotherapy would not be an appropriate action. Choice c, initiate heparin at 2,200 units per hour, is incorrect. Although heparin can be a treatment for DIC.

### Table 1. Signs and Symptoms of Disseminated Intravascular Coagulation

<table>
<thead>
<tr>
<th>System</th>
<th>Symptoms</th>
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<tbody>
<tr>
<td>Integumentary</td>
<td>Temperature cool and clammy, petechiae, ecchymosis, purpura, and bleeding from breaks in skin integrity (e.g., IV sites, wounds, incisions)</td>
</tr>
<tr>
<td>Head, eyes, ears, nose, throat</td>
<td>Scleral hemorrhage, epistaxis, and bleeding in or around the mouth</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Tachycardia, hypotension, and peripheral edema</td>
</tr>
<tr>
<td>Respiratory</td>
<td>Hemoptysis, pulmonary congestion, and hypoxia</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Melena, hematochezia, hematemesis, and hemorrhoidal bleeding</td>
</tr>
<tr>
<td>Genitourinary</td>
<td>Hematuria and vaginal bleeding</td>
</tr>
<tr>
<td>Neurologic</td>
<td>Mental status changes and altered level of consciousness</td>
</tr>
</tbody>
</table>

*Note:* Based on information from Ezzone, 2000; Holmes-Gobel, 1999.

### Table 2. Laboratory Values

<table>
<thead>
<tr>
<th>Laboratory Test</th>
<th>Normal Value</th>
<th>Indication of Disseminated Intravascular Coagulation</th>
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<tbody>
<tr>
<td>Prothrombin time</td>
<td>11.3–13.1 seconds</td>
<td>Usually prolonged but is nonspecific; can be shortened, normal, or prolonged</td>
</tr>
<tr>
<td>Partial thromboplastin time</td>
<td>22–33.3 seconds</td>
<td>Usually prolonged but is nonspecific; can be shortened, normal, or prolonged</td>
</tr>
<tr>
<td>International normalization ratio</td>
<td>1.0</td>
<td>Usually prolonged but is nonspecific; can be shortened, normal, or prolonged</td>
</tr>
<tr>
<td>Fibrinogen</td>
<td>170–410 mg/dl</td>
<td>Decreased value</td>
</tr>
<tr>
<td>Fibrin split products</td>
<td>0–10 ug/ml</td>
<td>Increased value</td>
</tr>
<tr>
<td>D-dimer</td>
<td>&lt; 0.25 ug/ml</td>
<td>Decreased value</td>
</tr>
<tr>
<td>Antithrombin</td>
<td>75% or greater</td>
<td>Decreased value</td>
</tr>
<tr>
<td>Platelet count</td>
<td>150,000–300,000/mm³</td>
<td>Decreased from patients’ normal values</td>
</tr>
</tbody>
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*Note:* Laboratory value indices may vary from different institutions.

*Note:* Based on information from Bick, 1998; Ezzone, 2000; Yu et al., 2000.
Mr. M had a platelet count of 22,000/mm³, and pulmonary bleeding had not been ruled out. Therefore, heparin would be contraindicated at this time. When heparin is indicated, a low dose of heparin is recommended (Holmes-Gobel, 2000). Choice d, administer furosemide 80 mg IV bolus, is incorrect because of Mr. M’s hypotension. The diuretic furosemide would not be indicated unless he showed symptoms of fluid overload, which were not present.

Question 5: Choice d, elevated FSPs, elevated D-dimer, and decreased platelet count, is the correct answer. FSPs often are elevated in patients with DIC because FSPs are byproducts of the clotting cascade. The sensitivity of the FSP assay reportedly is as high as 100%, with a specificity of 67% (Yu, Nardella, & Pechet, 2000). The elevated D-dimer is reflective of a neoantigen made in the clotting cascade when fibrinogen is stimulated by thrombin to form fibrin. The D-dimer test has a sensitivity of 91% and a specificity of 68%. Although nonspecific, a platelet count often is decreased in patients with DIC. The FSP assay results and elevated D-dimer level provide an efficient and reliable diagnosis of DIC with a combined sensitivity of 91% and specificity of 94% (Yu et al.). Choice a, elevated PT and fibrinogen, is incorrect. Although PT often is prolonged in patients with DIC, PT is nonspecific and can be normal, prolonged, or shortened (Bick, 1998; Ezzone, 2000). Fibrinogen normally is decreased in patients with DIC. Schistocytes, fragments of red blood cells, are a frequent but nonspecific discovery in acute DIC (Holmes-Gobel, 2000). Choice b, elevated PTT, and choice c, decreased PT, are incorrect because they are nonspecific; in addition, the D-dimer is elevated rather than decreased, and the FSP assay should be elevated in DIC (Ezzone). See Table 2 for a review of the laboratory tests used in the diagnosis of DIC.

Conclusion

Healthcare providers must be aware that the primary treatment for patients with DIC is to manage the underlying cause (e.g., cancer, sepsis). Chemotherapy also may trigger DIC; therefore, nurses must monitor for DIC in patients with cancer prior to and following the administration of chemotherapy. When patients experience rapid cell division (e.g., blast crisis, relapsed disease), close monitoring and prompt recognition of DIC symptoms are instrumental in promoting patient comfort and recovery.

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References