Essentials of Pediatric Hematology/ Oncology Nursing

A CORE CURRICULUM

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Bone-Marrow Suppression

Nan Werther

Bone-marrow suppression results from an insult to normal functioning bone marrow, whether from disease or induced by chemotherapy or radiation. Suppression of the marrow leads to a decline in the hematopoietic stem-cell line of red blood cells (RBCs), white blood cells, and platelets. After myelosuppressive therapy, bone-marrow suppression can be noted within 10 to 14 days, with its lowest point identified as the nadir. The timing of the recovery of blood counts is affected by the treatment the patient receives as well as by the patient's history of previous therapies. During blood count recovery, the patient remains at risk for serious infection and bleeding. Administration of blood products and colony-stimulating factors (CSFs) (i.e., granulocyte colony-stimulating factor [GCSF], granulocyte-macrophage colony-stimulating factor [GMCSF], Epogen) provides protection and assists in the recovery of the blood counts for the patient.

Conditions Related to Bone-Marrow Suppression

Anemia

Definition

Anemia is a deficiency in the number of RBCs necessary for normal tissue and organ oxygenation due to hemolysis, replacement of bone marrow by malignant cells, myelosuppression induced by chemotherapy or radiation, viral suppression, or the effects of a chronic disease.

Clinical Presentation

The symptoms of anemia include fatigue; pale skin, lips, and nail beds; tachycardia; tachypnea; decreased energy; and headache.

No evidence-based guidelines currently exist for determining when to transfuse a pediatric patient with RBCs; therefore, it is important to understand that laboratory values guide clinical decisions, and it is necessary to base transfusions on patient needs (Agrawal, Hastings, & Feusner, 2010) (**Table 5-1**).

Table 5-1. Disease and Treatment Transfusion: Suggested Guidelines Based on Hemoglobin

Indication	Hemoglobin
Prior to a course of chemotherapy	<8 g/dl
Receiving radiation therapy (controversial)	8–10 g/dl
Recovering from therapy-induced bone-marrow suppression; asymptomatic	<7 g/dl
Signs and symptoms of anemia	<7–8 g/dl
Active bleeding or procedure with anticipated blood loss	<8–10 g/dl

Note. Adapted from "Hematological Supportive Care for Children with Cancer," by A. K. Agrawal, C. A. Hastings, and J. Feusner, 2010, in P. A. Pizzo and D. G. Poplack (Eds.), *Principles and Practice of Pediatric Oncology* (6th ed., pp. 1152–1189), Philadelphia, PA: Lippincott Williams and Wilkins; "Blood Transfusion Therapy," by C. Nixon, 2010, in D. Tomlinson and N. E. Kline (Eds.), *Pediatric Oncology Nursing: Advanced Clinical Handbook* (2nd ed., pp. 546–557), Berlin, Germany: Springer-Verlag.

Treatment

All pediatric RBCs must be leukocyte depleted and irradiated. Dosing for pediatric patients is 10–15 ml/kg over 2–4 hours, completed within 4 hours. Volume is based on ml/kg of the patient's body weight, with the standard being 10 ml/kg (Agrawal et al., 2010). The hemoglobin should increase by 2–3 g/dl. Adult dosing is 1–2 units over 2–4 hours, completed within 4 hours. Packed RBCs must be ABO compatible (**Table 5-2**), based on patients' ABO typing (American Red Cross, 2013).

Stimulation of erythropoiesis with EPO-stimulating agents (ESAs) such as erythropoietin (Epogen) should be considered, particularly for patients whose cultural and religious beliefs prevent them from receiving transfusions. Patients and families need to understand that guidelines on the use of ESAs and their safety and effectiveness are limited and have not been established in pediatric patients with cancer. In adult patients, such hematopoietic CSFs have been shown to decrease the need for red-cell transfusions, as well as improve the quality of life, particularly in patients who experience fatigue related to anemia (Agrawal et al., 2010).

Thrombocytopenia

Definition

Thrombocytopenia is a deficiency in the number of platelets necessary for blood clotting caused by

Table 5-2. ABO Compatibility

Patient with ABO Blood Type	Can Donate Red Cells to	Can Receive Red Cells from
O+	O+, A+, B+, AB+	O+, O-
O-	All types (universal donor)	O-
A+	A+, B+	A+, A-, O+, O-
A-	A-, A+, AB-, AB+	A-, O-
B+	B+, AB+	B+, B-, O+, O-
B-	B-, B+, AB-, AB+	B-, O-
AB+	AB+	All types Universal recipient
AB-	AB-, AB+	AB-, A-, B-, O-

myelosuppressive therapy, malignant cells in the bone marrow, increased consumption of platelets (i.e., disseminated intravascular coagulation), or fever.

Clinical Presentation

Thrombocytopenia presents with petechiae, increased bruising, epistaxis, mucosal bleeding, hematuria, hematochezia, neurological changes secondary to intracranial bleeding, and spontaneous bleeding if platelet count is lower than 5,000/mm^3.

Laboratory Findings

- Mild thrombocytopenia: platelet count of 75,000/mm^3 to 99,999/mm^3
- Moderate thrombocytopenia: platelet count of 50,000/mm^3 to 74,900/mm^3
- Moderately severe thrombocytopenia: platelet count of 20,000 to 49,900/mm^3
- Severe thrombocytopenia: platelet count of <20,000/mm^3

Treatment

Maintain platelet count of >10,000/mm^3 by administering single-donor, irradiated, cytomegalovirus-negative, leukocyte-depleted platelets. The advantages of providing single-donor platelets are (a) it decreases donor exposure by using platelets obtained by the apheresis technology, (b) it reduces the potential transfusion-transmitted infections, and (c) it decreases the incidence of alloimmunization (Slichter, 2007). The number of units of platelets ordered for a patient is based on the weight of the child and the desired posttransfusion platelet count. A dose of 1 unit per 10 kg of single-donor platelets should increase the platelet count by 50,000–100,000 platelets/mm^3 by 1 hour posttransfusion (Agrawal et al., 2010). Consider maintaining a platelet count of >50,000/mm^3 for patients with signs of bleeding, high fever, hyperleukocytosis, a rapid decrease in platelet count, or coagulation abnormalities and for those undergoing invasive procedures such as lumbar punctures, bone marrow aspirations and biopsies, surgeries, or endotracheal intubation. The administration of oprelvekin (Neumega, IL-11)—a thrombopoietic growth factor that stimulates proliferation and maturation of megakaryocytes in the bone marrow, resulting in an increased number of circulating platelets—is controversial. Its safety and efficacy have not been established in pediatric patients, particularly those younger than 12 years of age (Children's Oncology Group [COG], 2009). Platelet transfusion guidelines are summarized in **Table 5-3**.

Neutropenia

Definition

Neutropenia is a reduction in circulating neutrophils or white blood cells that is determined by the percentage of segmented neutrophils and band neutrophils that constitute the total white blood cell (WBC) count. Neutropenia is the most severe consequence of bone-marrow suppression. The risk of infection is determined by the absolute neutrophil count (ANC). ANC is calculated as total WBCs x neutrophils (i.e., % polys + % bands).

Clinical Presentation

Neutropenia can be asymptomatic; however, if a patient is anemic or thrombocytopenic, he or she frequently is also neutropenic. The symptoms associated with neutropenia include fever and infection (bacterial, fungal, viral).

Severity of Neutropenia

- Mild: ANC of 1,500–1,900/mm^3
- Moderate: ANC of 1,000–1,499/mm^3