Hematologic assessment is part of the routine assessment of acute and critically ill patients. Nurses must be aware of the reference ranges for complete blood cell counts and common coagulation profiles. A case study is presented of an elderly patient, taking warfarin for atrial fibrillation, who falls and sustains a head laceration. The subsequent assessment, hospital course, and treatments required are outlined. (Critical Care Nurse. 2012;32[5]:42-47)

Critical and ongoing assessments of patients are important functions of acute and critical care nurses. In addition to monitoring patients for physical changes, nurses must also monitor and evaluate changes in the patients’ laboratory data. Early detection of hematologic abnormalities, before a patient becomes symptomatic, can help clinicians treat problems before the abnormalities have caused any damage. The hematopoietic system (blood system) is best assessed by evaluating complete blood cell counts (CBCs) and coagulation profiles. A working knowledge of the reference-range values for these tests and of the diseases and drugs that might result in a change in the values are essential knowledge for assessment of the hematopoietic system.

In this article, I review the CBC and coagulation profiles as assessment data. I also discuss the heme assessment of an elderly patient who was taking warfarin for chronic atrial fibrillation and had marked hemorrhaging after she fell.

Case Report

Mrs C was a 72-year-old woman with a history of chronic atrial fibrillation, hypertension, myocardial infarction 5 years earlier (she had placement of 2 coronary artery stents at that time), peripheral arterial disease, and renal insufficiency. She was a thin, tall woman with osteoporosis who had quit smoking 5 years earlier. She had no known drug allergies and was currently taking warfarin (Coumadin) 6 mg daily, metoprolol (Toprol-XL) 50 mg daily, digoxin 0.25 mg daily, simvastatin (Zocor) 40 mg daily, and alendronate (Fosamax) 70 mg weekly.

History of Trauma

Mrs C fell while gardening and struck her head on the driveway, sustaining a large scalp laceration and fractures of the wrist and 2 ribs on her right side. Whether or not she lost consciousness at the time of the fall was unknown. Computed tomography of the head showed moderate atrophy and no bleeding. Her last international normalized ratio (INR) was 2.3. Staff in the emergency department were able to control the bleeding without using reversal agents. The scalp laceration required 26 sutures.

Mrs C was admitted to the telemetry unit for follow-up with cardiological, orthopedic, and neurosurgical evaluation and monitoring. The first 12 hours on the unit were uneventful. Vital signs included heart rate 74/min (atrial fibrillation), blood pressure 146/62 mm Hg,
respirations 24/min, and temperature 36.5° C. She was alert and oriented. She had a 20-gauge saline lock in her left hand and was being treated with oral pain medications, which provided adequate pain relief. All of her routine medications were ordered, but her nightly warfarin dose for the day of admission was not administered because of the potential for a delayed intracerebral hemorrhage and the possibility that the wrist fracture would require surgery.

The Bloody Mess

At 4 AM while making rounds, the night-shift nurse found Mrs C moaning and covered in blood. Mrs C was confused about time and place. Vital signs were heart rate 76/min (with metoprolol and digoxin), blood pressure 90/48 mm Hg, respirations 34/min, and temperature 35.7° C. Apparently, in her sleep, Mrs C had scratched the suture line, reopened the wound, and bled profusely. The nurse had checked on her less than 50 minutes earlier.

Immediate Treatment

A rapid response was called. A bed was available in the medical intensive care unit, so Mrs C was moved quickly to that unit. If a bed had not been available, she could have been managed on the telemetry unit. The major reason for the move was to have more nursing staff available for fluid and blood replacement and assistance with the suturing and any other procedures that might be required.

Two large-bore peripheral intravenous catheters were inserted, and infusion of normal saline was started until the blood products were available from the blood bank. Mrs C received 3 units of packed red blood cells (RBCs), 6 units of platelets, and 3 units of fresh-frozen plasma. Pressure was applied to the open head laceration. The bleeding was controlled. A slow infusion of vitamin K 10 mg was administered. The current evidence-based practice recommendations1 for bleeding in patients with a high INR are intravenous administration of vitamin K. Mrs C tolerated the blood products and the vitamin K administration, and the scalp laceration was resutured. All 3 therapies (blood products, vitamin K, and closure of the wound) were necessary to achieve homeostasis. Repeat computed tomography of the head showed no changes or bleeding. Delayed or late bleeding is not uncommon in elderly persons taking anticoagulants.

Hematology Assessment

RBC Count

Mrs C had a low RBC count on admission (Table 1). In addition to bleeding, 2 other reasons for a low RBC count are underproduction of erythrocytes from the bone marrow and early elimination or destruction of RBCs. The most common cause in adults for underproduction is agents that suppress bone marrow. Production also goes down with aging. Potential causes for early elimination or destruction of RBCs include thalassemia, sickle cell anemia, hemoglobin C anemias, malignant neoplasms, rheumatoid arthritis,
chronic liver disease, and malnutrition (protein and vitamin deficiencies). The most likely explanation for Mrs C’s low RBC count was blood loss. On admission at 10 AM, her hemoglobin and hematocrit levels were 9 g/dL and 27%, respectively. At 4 AM, the values had decreased to 5 g/dL and 22%, respectively, because of the bleeding (Table 1).

**RBC Indices**

RBC indices are basically a description of the red cells. The mean corpuscular volume indicates the size of the red cell, the mean corpuscular hemoglobin indicates the weight, and the RBC distribution width indicates the width of the red cell. When anemia is not due to blood loss, these descriptors determine the cause of low RBC counts. For example, a microcytic (small cell size) anemia can be due to lead poisoning or iron deficiency. A macrocytic (large cell size) anemia can be due to aplastic anemia, vitamin \( B_{12} \) deficiency, or hypothyroidism. Mrs C’s RBC indices did not change between the 10 AM and the 4 AM blood tests. She lost blood because of the open wound; she did not have a change in her general hematopoiesis (forming of new blood cells), which would be indicated by a change in the indices.

**Reticulocytes**

Reticulocytes are immature red blood cells. Mrs C had a low reticulocyte count on admission, and according to the early morning (4 AM) laboratory results, the number had decreased. Of the total RBC count, approximately 0.5% to 2.5% of the cells are normally immature. When a decrease occurs in oxygen delivery, the kidneys produce the hormone erythropoietin. Erythropoietin goes to the bone marrow and stimulates the stem cells (undifferentiated cells that can become RBCs, white blood cells, or platelets) to become RBCs, a change that can increase the hemoglobin level and therefore increase the oxygen-carrying capacity of the cells. When a stem cell becomes an RBC, the immature cell is first a reticulocyte for 11 to 14 days. If during that time the patient is well nourished (vitamins, minerals, and protein are needed for a healthy maturation process) and has a functioning liver (protein synthesis), the immature RBC becomes a fully functioning erythrocyte and lives approximately 120 days.

Reticulocyte counts are low when the normal number of immature RBCs is not being produced. Low numbers of reticulocytes can be due to bone marrow suppression, malnutrition, liver disease, renal insufficiency, and alcoholism. Reticulocyte counts are high when a patient is making more than the normal number of RBCs. High reticulocyte counts occur in hemolytic anemias such as sickle cell anemia; thrombotic thrombocytopenia purpura; and the combination of hemolysis, elevated liver enzymes, and low platelet (HELPP) syndrome.

Mrs C’s reticulocyte count was only 0.35% at the time of admission. She had lost blood because of the initial fall and laceration. Her baseline reticulocyte count was probably also slightly lower than normal because of her age and, possibly, malnutrition. Because of the mechanism of erythropoiesis and the changes between the complete blood cell count (CBC) at 10 AM and the CBC at 4 AM, logically the reticulocyte count should have increased. The decrease in Mrs C’s reticulocyte count most likely was due to the amount of normal saline (approximately 3 L) she received between admission and the blood sampling at 4 AM and to the marked bleeding she experienced between 3 AM and 4 AM. In the short time between the initial injury and 4 AM, she had not been hypoxic long enough for hematopoiesis to start. The blood sample for the CBC was obtained before any blood products had been administered.

**Hemoglobin and Hematocrit**

The hemoglobin and hematocrit levels are probably the parts of the CBC most familiar to nurses. The hematocrit level is the percentage of plasma accounted for by RBCs. Hemoglobin is a protein substance found in erythrocytes. Hemoglobin contains heme (iron) and globin (protein) and carries oxygen and carbon dioxide. Mrs C had low hemoglobin and hematocrit levels when she arrived in the emergency department. But because her condition was easily stabilized and the bleeding was controlled rather quickly, the decision was made to forgo transfusion. The current guidelines for administration of blood are to forgo transfusion as long as the hemoglobin level is 7 to 9 g/dL unless the patient’s hemodynamic status is unstable and/or the patient has cardiac disease. Although Mrs C did have a history of cardiac disease, her condition was stable. At 4 AM, her hemoglobin had decreased to 5 g/dL, her level of consciousness had changed, her hemodynamic condition was unstable, and controlling
the bleeding was difficult. Transfusion of packed RBCs was ordered. Each unit of packed RBCs increases the hemoglobin level by approximately 1 g/dL. Because Mrs C’s hemoglobin level was 5 g/dL, 3 units of blood were administered.

**Thrombocytes**

Mrs C’s thromocyte (platelet) count at admission was only 120 × 10³/μL (Table 2). She had lost some blood with the initial trauma, but her baseline platelet count may have been low. Two known contributing factors were her age and the daily dose of metoprolol, a drug that does cause thrombocytopenia. Another possible factor suggested by the laboratory results was malnutrition. The results of the complete metabolic panel done at the time of admission to the emergency department did indicate malnutrition. Other causes for thrombocytopenia include autoimmune diseases, bone marrow suppression, liver disease, and renal disease. Medications such as antibiotics, aspirin, and many diuretics can also decrease platelet counts. The decrease of 30 × 10³/μL platelets shown by Mrs C’s 4 AM laboratory results (Table 2) can be attributed to bleeding and dilutional factors. A platelet count of only 90 × 10³/μL at 4 AM was one reason for the difficulty in controlling the bleeding. However, if a patient’s platelet count is at least 50 × 10³/μL, the patient should be able to form a clot. So, if bleeding is difficult to control when the platelet count is 90 × 10³/μL, something in addition to thrombocytopenia is contributing to the bleeding. In Mrs C’s case, that something was the elevation in the prothrombin time and the INR due to the daily dose of warfarin. The combination of a low platelet count and chronic use of anticoagulant was the reason Mrs C required a platelet transfusion.

**Prothrombin and Activated Partial Thromboplastin Times**

Mrs C had her prothrombin time and INR monitored monthly at a nurse-run Coumadin clinic at the hospital. At her last visit, 3 weeks before admission to the emergency department, her INR had been 2.3. The 2008 guidelines for anticoagulation management with warfarin in patients with atrial fibrillation call for maintaining the INR between 2.0 and 3.0. At the time of her fall and subsequent admission to the emergency department, Mrs C’s INR was 3.6. She said she had made no recent change in her 6.0-mg daily dose of warfarin and no marked change in her diet. Interestingly, these events took place at the change in seasons between spring and summer. The weather had been warm, and Mrs C was working daily outside in her garden. Heat and increased physical activity can cause an increase in INR, and some patients actually must decrease their warfarin dose in the summer months.

Warfarin blocks entry of vitamin K into the liver, decreasing the production of the liver-synthesized vitamin K–dependent clotting factors (II, VII, IX, X). Mrs C was not given her warfarin the evening of admission, an event that contributed to the decrease in the INR at 4 AM. However, at that time, her INR was still 3.2, which played a major role in the difficulty in controlling the bleeding and was the reason for the administration of vitamin K in addition to platelets and fresh-frozen plasma.

Prothrombin time is the blood test used to evaluate the extrinsic clotting factors. The international sensitivity index is used to compare a patient’s prothrombin time with the control prothrombin time and allows determination of the INR. This process has helped standardize the anticoagulant recommendations for patients taking warfarin. Before the introduction of the INR, the

<table>
<thead>
<tr>
<th>Test</th>
<th>Normal reference rangea</th>
<th>Mrs C’s results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet count, × 10³/µL</td>
<td>150-400</td>
<td>120</td>
</tr>
<tr>
<td>Prothrombin time, s</td>
<td>11-15</td>
<td>39</td>
</tr>
<tr>
<td>International normalized ratio</td>
<td>0.7-1.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Activated partial thromboplastin time, s</td>
<td>60-70</td>
<td>82</td>
</tr>
</tbody>
</table>

a Information from Lichtman et al.2

Table 2 Coagulation studies and Mrs C’s results

Anticoagulation target recommendations were based on the prothrombin time control time ratio. The control time varies, which made dosing and recommendations challenging.

The activated partial thromboplastin time (aPTT) is used to evaluate all the clotting factors except factor VII. The aPTT is used to evaluate the intrinsic cascade because the prothrombin time takes only the extrinsic factors into account. Heparin is evaluated by using the aPTT. Mrs C’s aPTT was elevated in both of her blood tests. Because she was taking warfarin, this elevation was not surprising. Although the aPTT is not typically used to regulate warfarin dosing, the drug does have an effect on the aPTT.

**Summary and Outcome**

Mrs C had no more bleeding during this hospitalization. She remained in the hospital for 3 more days until her INR was within her goal range. Her wrist did not require surgery but was the source of marked pain along with the rib fractures. She was discharged home on a lower dose of warfarin. Her scalp laceration healed without incident, and she was followed up by the staff at the Coumadin clinic every other week for 1 month and then returned to monthly blood sampling.

The CBC and coagulation profiles are the primary measures clinicians have to assess the hematologic system. All patients, regardless of the cause of their admission, have some risk for clotting or bleeding. Hematologic assessment allows clinicians to evaluate not only a patient’s risk factors for clotting or bleeding but also the medications and treatments the patient has received that might affect the hematologic system. Acute and critical care nurses should evaluate patients’ CBC and coagulation profiles as part of the patients’ routine assessment. 

**References**


CNE Test  Test ID C125: Beyond the Bloody Mess: Hematologic Assessment

Learning objectives: 1. Identify physiologic features of red blood cell production and factors that can affect their production  2. Recognize risk factors for thrombocytopenia  3. Differentiate conditions that contribute to abnormal reticulocyte counts

1. The hematologic system is best assessed by evaluating which of the following?
   a. Level of consciousness
   b. Complete blood count results and coagulation profiles
   c. Visual inspection of the area of blood loss
   d. Hemodynamic monitoring

2. Which of the following statements describes erythropoietin production?
   a. Erythropoietin is a protein that is released by the kidneys.
   b. Erythropoietin is a hormone produced by the liver.
   c. Erythropoietin is a hormone produced by the kidneys.
   d. Erythropoietin produces a decreased number of reticulocytes.

3. Which of the following terms describes the formation of new blood cells?
   a. Reticulocytosis
   b. Thrombocytosis
   c. Erythropoiesis
   d. Hematopoiesis

4. What type of cells can increase oxygen-carrying capacity?
   a. Red blood cells
   b. Platelets
   c. White blood cells
   d. Undifferentiated stem cells

5. Which of the following statements is true regarding hemoglobin?
   a. Hemoglobin is the percentage of red blood cells in plasma.
   b. Hemoglobin is a protein substance that binds to white blood cells.
   c. Hemoglobin contains iron and protein that prevent carbon dioxide transport in the body.
   d. Hemoglobin acts as a card for oxygen and carbon dioxide.

6. How many days does a fully functioning erythrocyte live?
   a. 11 to 14 days
   b. 90 days
   c. 120 days
   d. 365 days

7. Which of the following can lead to high reticulocyte counts?
   a. High platelet counts
   b. Malnutrition
   c. Renal insufficiency
   d. Elevated liver enzymes

8. Which of the following can lead to low reticulocyte counts?
   a. Bone marrow suppression
   b. Sickle cell anemia with hemolysis
   c. Increased production of immature red blood cells
   d. Exogenous erythropoietin administration

9. Which of the following patients would be at risk for thrombocytopenia?
   a. A 30-year-old man who runs marathons and takes multivitamin supplements daily who was admitted for a sudden cardiac arrest.
   b. An 82-year-old woman who has a history of congestive heart failure and takes diuretics, aspirin, and metoprolol daily.
   c. A 22-year-old man who has severe depression and was admitted for suicidal ideations.
   d. A 62-year-old woman who was admitted for an ischemic stroke with aphasia but had no previous medical history or medication use.

10. Based on current evidence-based practice, which of the following should be administered to treat bleeding that is present with an elevated international normalized ratio?
    a. Subcutaneous vitamin K
    b. Intramuscular vitamin K
    c. Intravenous vitamin K
    d. Transdermal vitamin K

11. Which of the following may be determined by evaluating red blood cell indices?
    a. Total amount of blood loss
    b. The cause of a low red blood cell count
    c. The amount of packed red blood cells that should be administered to treat blood loss
    d. The average age of the red blood cells

12. When administering 1 unit of packed red blood cells, the nurse should expect to see what increase in hemoglobin level?
    a. 0.25 g/dL
    b. 0.5 g/dL
    c. 1 g/dL
    d. 4 g/dL

13. Which of the following can lead to an elevated international normalized ratio?
    a. Heat and increased physical activity
    b. Cold environmental temperature
    c. Administration of vitamin K
    d. Administration of fresh frozen plasma

14. Which of the following is the prothrombin time blood test used to evaluate?
    a. Heparin effectiveness
    b. Extrinsic clotting factors
    c. All clotting factors except factor VII
    d. The intrinsic cascade

Test answers: Mark only one box for your answer to each question. You may photocopy this form.

1. a  b  c  d  e  f  g  h  i  j  k  l  m  n  o  p  q  r  s  t  u  v  w  x  y  z
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7. a  b  c  d

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