Chapter 91
Approach to Anemia in the ICU

91.1 Introduction

Anemia is a common and multifactorial condition encountered in critically ill patients, with potential consequences such as impaired oxygen delivery, increased cardiac workload, delayed wound healing, and worsened clinical outcomes. In the ICU, anemia often arises from acute blood loss, inflammation, impaired erythropoiesis, frequent phlebotomy, or nutritional deficiencies, making its evaluation and management a critical component of patient care. Understanding the complex interplay of these factors is essential for optimizing patient outcomes both during critical illness and after ICU discharge [1, 2] [Ref: Algorithm 91.1].

91.2 Hemoglobin Level Assessment

- Threshold: Begin with the measurement of hemoglobin (Hb). Current evidence supports a restrictive transfusion strategy, generally indicating red blood cell (RBC) transfusion when Hb levels are <7 g/dL, as it may improve oxygen delivery without increasing transfusion-related risks. For Hb ≥7 g/dL, further clinical evaluation is warranted before considering transfusion.
- Rationale: Transfusion thresholds should balance the risks of transfusion-associated complications—such as immunosuppression, transfusion-related acute lung injury (TRALI), and infections—with the benefits of improving oxygenation. Restrictive transfusion strategies have been associated with similar or better outcomes compared to liberal strategies in critically ill patients.

S. B. Mishra et al., *Mastering ICU Care*,
https://doi.org/10.1007/978-981-95-0179-3_91

91.3 Clinical Context and History Evaluation

- Key Considerations: Evaluate symptoms, underlying conditions, and clinical history to guide the diagnostic workup. Consider the following:
- Presence of active bleeding or hemodynamic instability.
- Past medical history of chronic diseases (e.g., chronic kidney disease, heart failure) or malnutrition.
- ICU-related factors such as frequent phlebotomy, inflammation, or renal dysfunction.
- Objective: Narrow down the likely etiology and initiate targeted diagnostic studies, while considering the patient's overall clinical status and comorbidities [3].

91.4 Pathophysiological Insights into Anemia in Critical Illness

Anemia in critically ill patients is multifactorial, resulting from a combination of decreased red blood cell (RBC) production, increased RBC loss, and shortened RBC lifespan. Key contributing factors include:

- Bleeding: Acute blood loss from overt sources such as gastrointestinal bleeding, surgical sites, or procedural punctures.
- Phlebotomy-Related Blood Loss: Frequent blood sampling can cumulatively result in significant blood loss, potentially amounting to a unit of blood per week.
- Inflammation and Anemia of Chronic Illness: Inflammatory cytokines like interleukin-1 (IL-1), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-alpha) impair erythropoiesis and iron metabolism. IL-6 stimulates the production of hepcidin, a hormone that reduces iron availability by inhibiting intestinal iron absorption and trapping iron within macrophages.
- Erythropoiesis Impairment: Suppression of erythropoietin production and resistance to erythropoietin action occur during critical illness and inflammation, further reducing RBC production. Renal dysfunction exacerbates this impairment due to decreased erythropoietin synthesis.
- Nutritional Deficiencies: Deficiencies of iron, vitamin B_{12}, and folate are common due to poor nutritional intake and increased metabolic demands.

91.5 Evaluation of Common Causes

The evaluation should be systematic, considering each potential cause:

Bleeding

- Action: Assess for overt bleeding sources such as gastrointestinal bleeding (via stool occult blood test or endoscopy), surgical wounds, and catheter sites.

- Diagnostic Imaging: Perform imaging studies if occult bleeding is suspected but not evident clinically.
- Rationale: Acute blood loss is a leading cause of anemia in the ICU and requires prompt identification and management.

Phlebotomy-Related Loss

- Action: Quantify the volume of blood drawn daily. Implement strategies to minimize blood loss, such as using pediatric-sized tubes, point-of-care testing, and consolidating laboratory tests.
- Rationale: Cumulative blood loss from frequent phlebotomy can significantly contribute to anemia, potentially equating to a unit of blood per week.

Inflammation and Anemia of Chronic Illness

- Action: Measure inflammatory markers (e.g., IL-6, CRP), iron studies (ferritin, transferrin saturation), and hepcidin levels if available.
- Rationale: Inflammation leads to anemia of chronic illness, characterized by impaired iron utilization and decreased erythropoiesis due to cytokine-mediated effects and elevated hepcidin levels.

Erythropoiesis Impairment

- Action: Assess erythropoietin levels and renal function tests. Evaluate for bone marrow suppression.
- Rationale: Suppressed erythropoietin production and resistance to its effects are common in critical illness, especially with renal dysfunction and inflammatory cytokines interfering with erythropoiesis.

Nutritional Deficiencies

- Action: Measure serum levels of iron, vitamin B_{12}, and folate. Interpret iron studies cautiously, as ferritin is an acute-phase reactant and may be elevated in inflammation despite iron deficiency.
- Rationale: Nutritional deficiencies contribute to anemia, with microcytic anemia suggesting iron deficiency and macrocytic anemia indicating vitamin B_{12} or folate deficiency.

91.6 Diagnostic Workup

After identifying potential causes, further diagnostics include:

Peripheral Blood Smear

- Action: Examine morphology for signs of hemolysis (e.g., schistocytes), megaloblastic changes, or other abnormalities.
- Rationale: Provides clues to underlying causes such as hemolysis or nutritional deficiencies.

Reticulocyte Count

- Action: Assess reticulocyte count to evaluate bone marrow response.
- Rationale: A low reticulocyte count indicates decreased RBC production, whereas a high count suggests active RBC production in response to anemia.

Coagulation Profile

- Action: Evaluate coagulation parameters to rule out disseminated intravascular coagulation (DIC) or other bleeding disorders.
- Rationale: Important in patients with active bleeding or unexplained anemia.
- Ultrasonography might be necessary in patients who have suffered trauma or have undergone recent surgery or in coagulopathic patients with no other obvious source of bleeding. A high LDH and reticulocyte count and/or positive Coombs test might suggest hemolysis.

91.7 Management Strategies

Management is tailored to the underlying cause, with a focus on minimizing risks and promoting recovery.

Transfusion Strategies

- Restrictive vs. Liberal Transfusion: Adopt a restrictive transfusion strategy, transfusing RBCs when Hb <7 g/dL, unless specific conditions warrant higher thresholds (e.g., acute coronary syndrome, severe hypoxia).
- Evidence: Studies have shown that restrictive strategies are associated with similar or improved outcomes compared to liberal strategies, reducing exposure to transfusion-related risks.

Acute Blood Loss

- Action: Control bleeding sources promptly. Stabilize hemodynamics with fluids and vasopressors as needed.
- Correction of Coagulopathies: Administer platelets, fresh frozen plasma (FFP), or specific factor concentrates as indicated.

Phlebotomy-Related Anemia

- Action: Implement blood conservation strategies, minimize unnecessary blood draws, and utilize point-of-care testing when feasible.

Inflammation and Anemia of Chronic Illness

- Action: Address the underlying inflammatory or infectious conditions aggressively.
- Erythropoiesis-Stimulating Agents (ESAs): Consider ESAs in select patients, acknowledging limitations and risks such as thromboembolic events and hypertension.

- Iron Supplementation: Evaluate the use of intravenous iron therapy, especially when oral absorption is impaired, while being cautious of risks like infections or anaphylaxis with certain formulations.

Erythropoiesis Impairment

- Action: Optimize renal function where possible. Consider ESAs in patients with chronic kidney disease.
- Monitoring: Regularly monitor Hb levels and adjust therapy accordingly [4].

Nutritional Deficiencies

- Iron Supplementation.
- Action: Administer intravenous iron in cases of confirmed deficiency, especially when oral iron is ineffective or contraindicated.
- Caution: Be aware of potential adverse effects and monitor for hypersensitivity reactions.
- Vitamin B_{12} and Folate Supplementation.
- Action: Provide appropriate supplementation for deficiencies.

Post-ICU Anemia Management

- Awareness: Recognize that anemia often persists after ICU discharge, potentially impacting physical function, quality of life, and rehabilitation.
- Follow-Up: Arrange for continued monitoring and management of anemia in the outpatient setting, integrating strategies to facilitate recovery.

91.8 Special Considerations for Subgroups

Patients with Heart Failure

- Impact: Anemia can exacerbate heart failure symptoms due to decreased oxygen delivery and increased cardiac workload.
- Management: Careful fluid management and consideration of ESAs under specialist guidance.

Chronic Kidney Disease (CKD) Patients

- Impact: CKD patients often have anemia due to decreased erythropoietin production and iron utilization.
- Management: ESAs and iron supplementation are mainstays, with close monitoring for complications.

Postsurgical Patients

- Impact: Blood loss during surgery contributes to anemia; optimizing Hb levels preoperatively and minimizing intraoperative blood loss are critical.
- Management: Employ blood conservation techniques and consider cell salvage when appropriate.

91.9 Addressing Persistent Post-ICU Anemia

- Prevalence: Anemia frequently persists after ICU discharge, with recovery often taking weeks to months.
- Impact: Persistent anemia can lead to decreased exercise capacity, fatigue, and reduced quality of life.
- Rehabilitation Planning: Recognize the importance of addressing anemia in post-ICU care to enhance recovery and rehabilitation outcomes.
- Long-Term Monitoring: Implement follow-up plans to monitor Hb levels and adjust treatment as needed.

91.10 Pathophysiological Summary

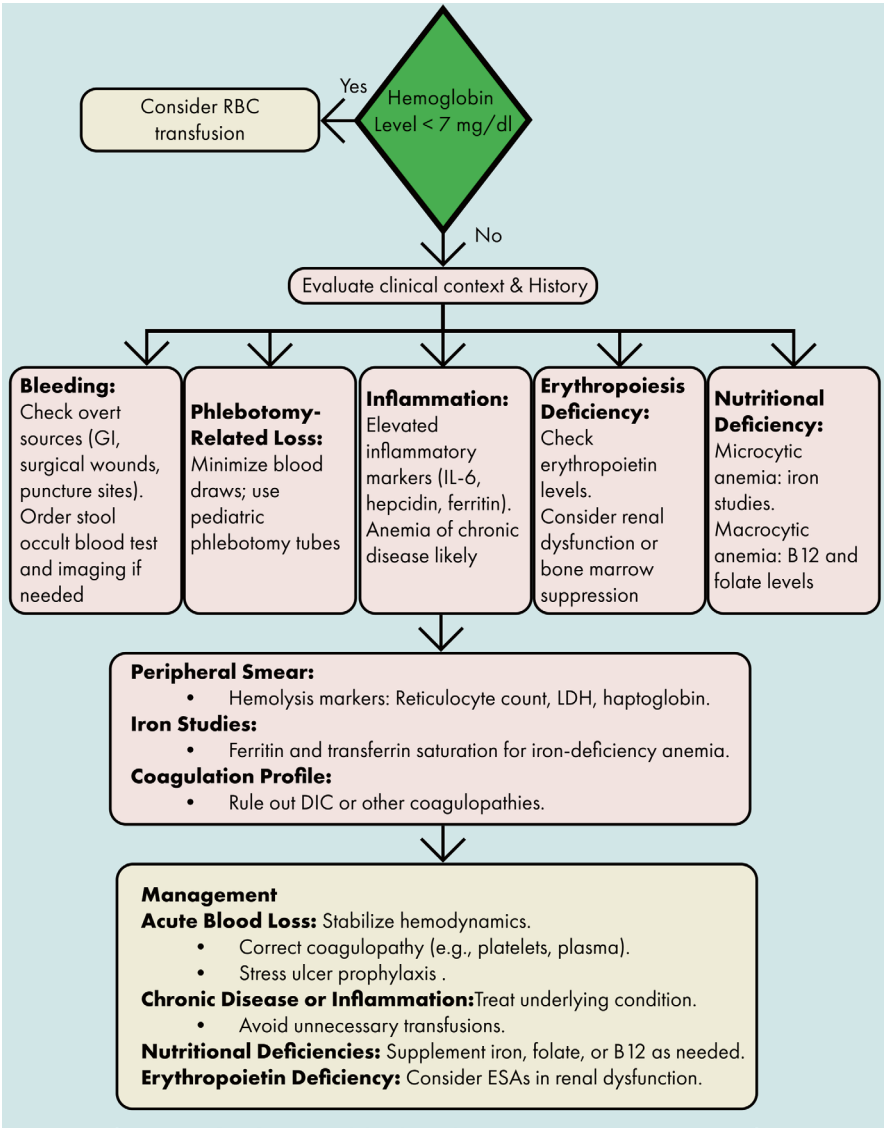
Anemia in critical illness is multifactorial, involving:

- Decreased RBC Production: Due to impaired erythropoiesis from inflammation, reduced erythropoietin production, and nutritional deficiencies.
- Increased RBC Loss: From overt bleeding and frequent phlebotomy.
- Shortened RBC Lifespan: Resulting from hemolysis or the effects of inflammatory cytokines.

91.11 Conclusion

Managing anemia in the ICU requires a comprehensive and systematic approach that addresses the underlying causes while minimizing risks associated with interventions. Adopting a restrictive transfusion strategy, minimizing iatrogenic blood loss, correcting nutritional deficiencies, and managing inflammation are key components. Understanding the multifactorial nature of anemia in critical illness allows for targeted therapies, improving patient outcomes both during critical illness and in the recovery phase. Special attention should be given to vulnerable subgroups, and plans should be made for ongoing management of anemia after ICU discharge to facilitate full rehabilitation.

Algorithm 91.1: Approach to anemia in the ICU



Bibliography

1. Hayden SJ, Albert TJ, Watkins TR, Swenson ER. Anemia in critical illness: insights into etiology, consequences, and management. Am J Respir Crit Care Med. 2012;185(10):1049–57.
2. Kumar N, Borkotoky A. Approach to anemia in ICU. In: Critical care hematology. Singapore: Springer; 2024. p. 47–59.
3. Rawal G, Kumar R, Yadav S, Singh A. Anemia in intensive care: a review of current concepts. J Crit Care Med (Targu Mures). 2016;2(3):109–14.
4. Warner MA, Hanson AC, Frank RD, Schulte PJ, Go RS, Storlie CB, et al. Prevalence of and recovery from anemia following hospitalization for critical illness among adults. JAMA Netw Open. 2020;3(9):e2017843.