

Chapter 30

Approach to Hypomagnesemia in the ICU



30.1 Introduction

Magnesium is an essential mineral that plays a pivotal role in numerous physiological processes. Serving as a cofactor in over 300 enzymatic reactions—including ATP synthesis and DNA replication—it is fundamental to energy production, muscle and nerve function, and the immune response. Magnesium's influence extends from cellular metabolism to the maintenance of normal heart rhythm and bone health. Hypomagnesemia, defined as low serum magnesium levels, is a common electrolyte disturbance not only in the intensive care unit (ICU) but also among patients with chronic illnesses such as diabetes, cardiovascular diseases, and gastrointestinal disorders.

Magnesium deficiency is prevalent in hospitalized patients and is associated with increased morbidity and mortality. Given its widespread impact and the potential severity of hypomagnesemia—including life-threatening conditions like seizures and arrhythmias—early recognition and appropriate management are crucial. This guide provides a structured approach to diagnosing and treating hypomagnesemia, emphasizing understanding the underlying causes, identifying risk factors, and implementing evidence-based treatment strategies to improve patient outcomes [1] [Ref: Algorithm 30.1].

30.2 Identify Symptoms and Risk Factors

The initial step in managing hypomagnesemia is to identify patients who are at risk or already symptomatic. Common symptoms include:

- Neuromuscular Symptoms: Lethargy, muscle cramps, muscle weakness, tremors, tetany, and seizures.
- Cardiovascular Symptoms: Arrhythmias (such as torsades de pointes), hypertension, and coronary vasospasm.

- Electrolyte Imbalances: Refractory hypokalemia and hypocalcemia that do not respond to supplementation.

Hypomagnesemia often coexists with other electrolyte disturbances, including hypokalemia, hypocalcemia, and metabolic alkalosis. Magnesium deficiency can exacerbate these conditions, making treatment more complex. For example, hypokalemia may be refractory to potassium supplementation unless magnesium levels are corrected, due to magnesium's role in maintaining cellular potassium levels [2].

Risk Factors

- Chronic Illnesses: Diabetes mellitus, cardiovascular diseases, gastrointestinal disorders (e.g., Crohn's disease, celiac disease), and chronic kidney disease.
- Medications: Diuretics (loop and thiazide), proton-pump inhibitors (PPIs), aminoglycosides, amphotericin B, and certain chemotherapeutic agents like cisplatin.
- Lifestyle Factors: Chronic alcohol use, malnutrition, and prolonged hospitalization, especially in the ICU setting.
- Gastrointestinal Losses: Diarrhea, vomiting, and malabsorption syndromes.
- Endocrine Disorders: Hyperaldosteronism and hyperparathyroidism.

Identifying these symptoms and risk factors necessitates a high index of suspicion, particularly in at-risk populations, to facilitate early detection and proactive management.

2. Evaluate Serum Magnesium Levels

Once hypomagnesemia is suspected, the next step is to measure serum magnesium levels. However, it is important to note that serum magnesium may not accurately reflect total body magnesium stores, especially in critically ill patients. Continuous monitoring and clinical correlation are essential.

- Threshold Levels: A serum magnesium level below 1.7 mg/dL (0.7 mmol/L) indicates hypomagnesemia.
- Normal or High Levels: If serum magnesium is above this threshold but symptoms persist, evaluate other electrolyte imbalances such as calcium, potassium, or phosphate.
- Low Levels: Confirm hypomagnesemia and proceed with classification to guide treatment [3].

3. Differentiate Between Mild and Moderate to Severe Hypomagnesemia

Treatment is guided by the severity of hypomagnesemia and the presence of symptoms, following evidence-based guidelines.

Mild Hypomagnesemia (1.2–1.6 mg/dL) Without Symptoms

- Treatment: Oral magnesium supplementation.
- Options: Magnesium oxide, magnesium citrate, or magnesium glycinate.
- Dosage: 200–400 mg of elemental magnesium daily.
- Considerations: Monitor for diarrhea, a common side effect. Adjust the dose if necessary.

Moderate to Severe Hypomagnesemia (<1.2 mg/dL) or Symptomatic

- Treatment: Intravenous magnesium supplementation.
- Regimen: IV magnesium sulfate, 1–2 g over 1–2 h.
- Repetition: May need to repeat every 6–12 h based on serum levels and clinical response.
- Monitoring: Continuous cardiac monitoring is recommended due to the risk of arrhythmias. Recheck serum magnesium levels at least every 24 h to ensure adequate correction and prevent toxicity.

Studies have demonstrated the beneficial effects of intravenous magnesium replacement in severe cases, including the reduction of arrhythmias and improvement of neuromuscular function. Continuous monitoring is especially crucial in the ICU, where serum levels may not accurately reflect total body magnesium.

4. Determine the Underlying Cause of Hypomagnesemia

Identifying and addressing the underlying cause is essential for effective management and prevention of recurrence.

1. Detailed Patient History

- Medication Review: Identify drugs that may cause renal magnesium loss.
- Dietary Assessment: Evaluate for insufficient magnesium intake or malabsorption issues.
- Renal Function: Assess for chronic kidney disease or tubular dysfunction.
- Alcohol Use: Consider the multifactorial impact of chronic alcohol consumption.
- Endocrine Evaluation: Screen for disorders like diabetes mellitus, hyperaldosteronism, and hyperparathyroidism.

Magnesium deficiency contributes to chronic conditions such as osteoporosis, hypertension, and metabolic syndrome. Addressing these factors has implications not only for acute management but also for long-term health.

2. Comprehensive Diagnostic Testing

- 24-h Urinary Magnesium Excretion:
- Low Excretion (<10–20 mg/day): Suggests gastrointestinal losses or poor intake.
- High Excretion (>20 mg/day): Indicates renal wasting.
- Fractional Excretion of Magnesium (FEMg):
- Calculation:

$$\text{FEMg} = (\text{Urine Mg} \times \text{Serum Creatinine}) / (\text{Serum Mg} \times \text{Urine Creatinine}) \times 100\%$$

- Interpretation: FEMg >2% suggests renal magnesium wasting.
- Serum Electrolytes and Additional Tests:

- Evaluate for coexisting electrolyte imbalances (e.g., hypokalemia, hypocalcemia).
- Consider tests for parathyroid function if hypocalcemia is present.
- Genetic Testing (if indicated):
 - For familial hypomagnesemia or when other causes are excluded.
- Imaging and Specialized Tests:
 - Renal ultrasound to assess structural abnormalities.
 - Bone density studies in chronic cases [4].

30.3 Consequences of Mismanagement

Failure to properly manage hypomagnesemia can lead to severe, life-threatening complications:

- Cardiovascular Risks: Increased incidence of arrhythmias, including ventricular tachycardia and torsades de pointes.
- Prolonged Hospitalization: Extended ICU stays due to unresolved symptoms and complications.
- Increased Mortality: Higher risk of death in both acute and chronic settings.

These risks underscore the importance of early recognition, appropriate treatment, and continuous monitoring to improve patient outcomes.

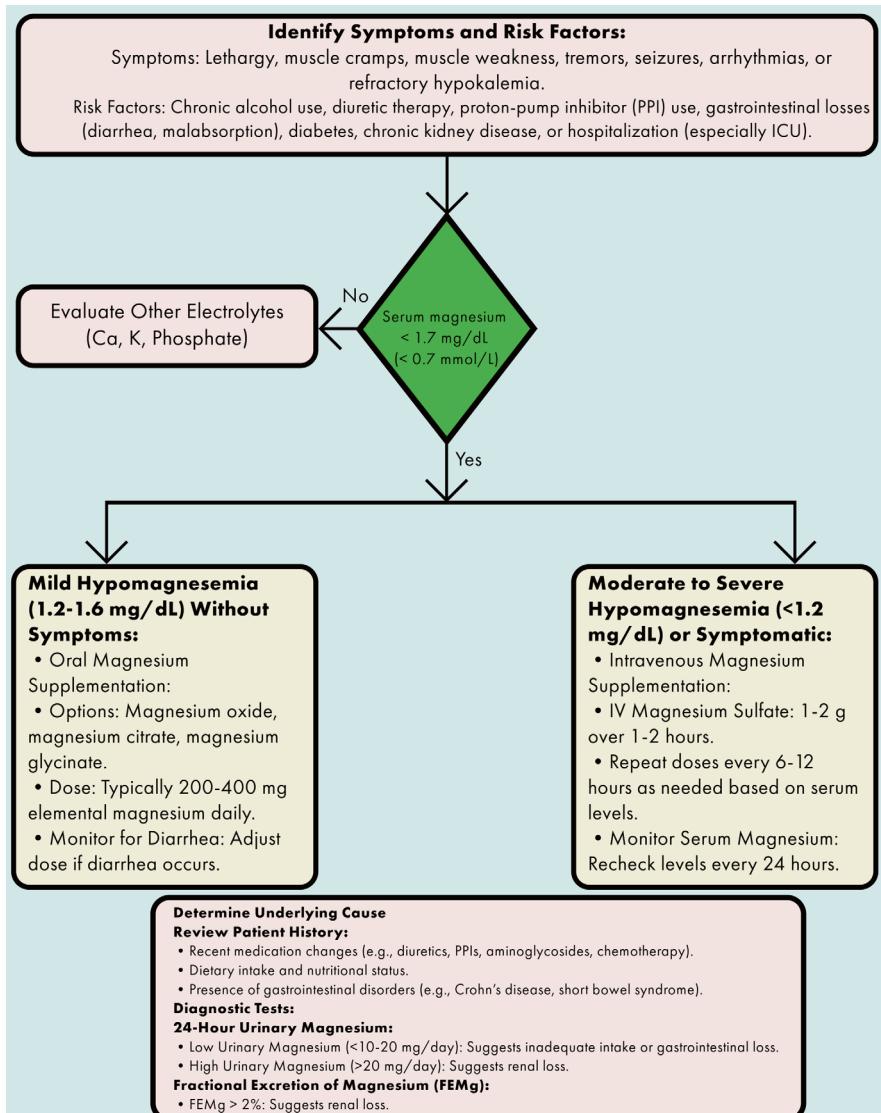
30.4 Conclusion

Managing hypomagnesemia requires a systematic and comprehensive approach. Early identification is essential, with prompt recognition of symptoms and risk factors to initiate timely intervention. Accurate evaluation involves measuring serum magnesium levels, though it is important to acknowledge that these may not always reflect total body magnesium stores, especially in critically ill patients. Treatment should be guided by evidence-based protocols, adjusting supplementation based on the severity of the deficiency. Addressing underlying causes is crucial for preventing recurrence, necessitating a thorough patient assessment. Continuous monitoring of magnesium levels is necessary, with regular reassessment to ensure appropriate adjustment of treatment and to avoid complications.

Magnesium's role extends beyond the ICU, impacting public health and the prevention of chronic diseases like osteoporosis, diabetes, and cardiovascular disorders. Addressing magnesium deficiency is therefore crucial not only for immediate

patient care but also for long-term health outcomes. By implementing evidence-based strategies and maintaining vigilance in monitoring, healthcare providers can effectively manage hypomagnesemia and mitigate its associated risks.

Algorithm 30.1 Approach to hypomagnesemia in the ICU



Bibliography

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