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A REVIEW ARTICLE ON FLUID AND ELECTROLYTE IMBALANCES

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ABSTRACT

Fluid and electrolyte imbalances are among the most common and potentially life-threatening conditions encountered in emergency medicine. If not identified and managed promptly, these disturbances can rapidly impair cardiovascular stability, neurological function, and renal performance. A thorough understanding of fluid dynamics, electrolyte homeostasis, clinical presentation, and evidence-based treatment strategies is therefore essential for emergency physicians. This review outlines the pathophysiology, classification, clinical manifestations, diagnostic evaluation, and emergency management of major fluid and electrolyte disorders, with particular focus on sodium, potassium, calcium, and magnesium abnormalities. Special emphasis is placed on early recognition, appropriate correction rates, and prevention of complications resulting from rapid or inappropriate therapy.

KEYWORDS: Emergency medicine, Fluid imbalance, Electrolyte disorders, Hyponatremia, Hyperkalemia, Dehydration

INTRODUCTION

The maintenance of normal fluid and electrolyte balance is vital for cellular integrity and optimal organ function. The human body regulates water and electrolyte distribution through coordinated interactions between the kidneys, endocrine system, and central nervous system. In emergency situations, this delicate balance is and frequently disrupted due to acute illnesses, trauma, infections, poisoning, renal dysfunction, endocrine abnormalities, or iatrogenic factors.[1]

Fluid and electrolyte disturbances constitute a substantial proportion of emergency department admissions and are associated with increased morbidity and mortality, particularly among critically ill patients, elderly individuals, and children. Timely assessment and correction are cornerstones of emergency care. However overly rapid or inappropriate correction may precipitate serious complications such as cerebral edema, cardiac arrhythmias, or osmotic demyelination syndrome. Hence, astructured and evidence-based approach is mandatory in emergency practice.[2]

AIMS AND OBJECTIVES

Aim

The aim of this review Is to provide a comprehensive overview of fluid and electrolyte imbalances encountered in emergency medicine, with emphasis on their pathophysiology, clinical presentation, diagnostic evaluation, and are evidence-based emergency management.

Objectives

- To describe the normal physiology of fluid and electrolyte balance and its relevance in emergency care.
- To classify common fluid imbalances and electrolyte disorders to the presenting in emergency settings.
- To outline the clinical features associated with major disturbances of sodium, potassium, calcium, and magnesium.
- To highlight the diagnostic approach and essential investigations required for rapid assessment in the emergncy department.

- To discuss evidence-based management strategies and safe , correction principles for fluid and electrolyte abnormalities.
- To emphasize the importance of early recognition and prevention of complications related to inappropriate or rapid correction

MATERIALS AND METHODS

1.Basic overview

This study was designed as a narrative review focusing on fluid and electrolyte imbalances in emergency medicine.

Published literature relevant to emergency assessment and management was systematically reviewed. All the information were collected from genuine resources. Standard textbooks of emergency medicine, internal medicine, and critical care were also consulted. Keywords used for the search included fluid imbalance, electrolytic disorders, hyponatremia, hypernatremia, potassium imbalance, clcium disorders, magnesium imbalance, and emergency management

2. Physiology of Fluid and Electrolyte Balance

Total body water accounts for approximately 60% of adult body weight and is distributed between the intracellular compartment (about two-thirds) and the extracellular compartment (one-third). Electrolytes including sodium, potassium, calcium, magnesium, chloride, and bicarbonate are essential for maintaining osmotic equilibrium, acid–base balance, neuromuscular excitability, and cardiac heart conduction. The kidneys are the primary regulators of fluid and electrolyte homeostasis, modulating water reabsorption and electrolyte excretion under the influence of hormones such as antidiuretic hormone, aldosterone, natriuretic peptides, and parathyroid hormone. Disruption of these regulatory mechanisms can lead to acute imbalances requiring urgent medical intervention.

3. Fluid Imbalance in Emergency Medicine

3.1 Dehydration

- Dehydration refers to a reduction in total body water and is a frequent presentation in emergency settings. It may be classified as:
- Isotonic dehydration: Proportional loss of water and sodium, commonly associated with hemorrhage, vomiting, or diarrhea.

- Hypotonic dehydration: Predominant sodium loss leading to intracellular fluid shifts.
- Hypertonic dehydration: Greater water loss then sodium, resulting in cellular dehydration.

Clinical Features:

- Dry mucous membranes, decreased skin turgor, tachycardia, hypotension, oliguria, altered sensorium, and shock in severe cases.
- Emergency Management:
- Rapid evaluation of volume status
- Administration of intravenous isotonic fluids (0.9% normal saline or Ringer's lactate)
- Close monitoring of vital signs, urine output, and serum electrolytes

3.2 **Fluid Overload**

Fluid overload occurs when fluid intake exceeds the body's excretory capacity and is frequently observed in patients with heart failure, renal failure, liver disease, or excessive intravenous fluid administration.

Clinical Features:

- Peripheral edema, pulmonary edema, raised jugular venous pressure, dyspnoea, and hypertension (HTN)
- Emergency Management:
- Fluid restriction
- Administration of diuretics, particularly loop diuretics.

4. **Electrolyte Imbalances**

4.1 **Sodium Disorders**

4.1.1 **Hyponatremia**

Hyponatremia is defined as a serum sodium level below 135 mEq/Lit and represents the most common electrolyte abnormality encountered in hospitalized patients.

Etiology:

SIADH, diuretic therapy, gastrointestinal losses, adrenal insufficiency, renal failure, and excessive free water intake.

Clinical Manifestations:

Nausea, vomiting, headache, confusion, seizures, coma, and respiratory failure in severe cases.

Emergency Management:

- Assessment of severity and neurological status
- Fluid restriction in mild, asymptomatic cases
- Careful administration of 3% hypertonic saline in severe symptomatic hyponatremia
- Sodium correction should not exceed 8–10 mEq/L within 24 hours to prevent osmotic demyelination syndrome

4.1.2 **Hypernatremia**

Hypernatremia, defined as serum sodium above 145 mEq/L, usually reflects a deficit of free water rather than excess sodium.

Etiology:

Diabetes insipidus, inadequate water intake, excessive sweating, osmotic diuresis, and hypertonic saline administration.

Clinical Manifestations:

Intense thirst, irritability, neuromuscular excitability, seizures, and coma.

Emergency Management:

- Gradual correction using hypotonic solutions such as 5% dextrose or 0.45% saline
- Avoidance of rapid correction to prevent cerebral edema

4.2 **Potassium Disorders**

4.2.1 **Hypokalemia**

Hypokalemia is defined as a serum potassium level below 3.5 mEq/L.

Etiology:

Diuretics, gastrointestinal losses, metabolic alkalosis, insulin therapy, and inadequate dietary intake.

Clinical Manifestations:

Muscle weakness, cramps, paralytic ileus, cardiac arrhythmias, and characteristic ECG changes including U waves.

Emergency Management:

- Oral potassium replacement for mild cases
- Intravenous potassium chloride for severe or symptomatic and hypokalemia
- Continuous ECG monitoring during intravenous therapy

4.2.2 **Hyperkalemia**

Hyperkalemia (serum potassium >5.0 mEq/L) is a medical emergency due to its potentially fatal cardiac effects.

Etiology:

Renal failure, metabolic acidosis, tissue breakdown, potassium-sparing diuretics, and ACE inhibitors.

Clinical Manifestations:

Muscle weakness, paresthesia, life-threatening arrhythmias, peaked T waves, and widened QRS complexes on ECG.

Emergency Management:

- Intravenous calcium gluconate for cardiac membrane stabilization
- Insulin with glucose to promote intracellular potassium shift.
- Beta-agonists or sodium bicarbonate in selected cases
- Dialysis for refractory or severe hyperkalemia

4.3 **Calcium Disorders**

4.3.1 **Hypocalcemia**

Hypocalcemia is defined as a total serum calcium level below 8.4 mg/dL.

Etiology:

Hypoparathyroidism, vitamin D deficiency, pancreatitis, and massive blood transfusions.

Clinical Manifestations:

Tetany, muscle spasms, seizures, prolonged Q-T interval, and positive + Chvostek's and Trousseau's signs.

Emergency Management:

- Intravenous calcium gluconate in acute symptomatic cases
- Oral calcium and vitamin d supplementation for long-term management

4.3.2 **Hypercalcemia**

Hypercalcemia is most commonly associated with malignancy or primary hyperparathyroidism.

Clinical Manifestations:

Polyuria, dehydration, constipation, altered mental status, and cardiac arrhythmias.

Emergency Management:

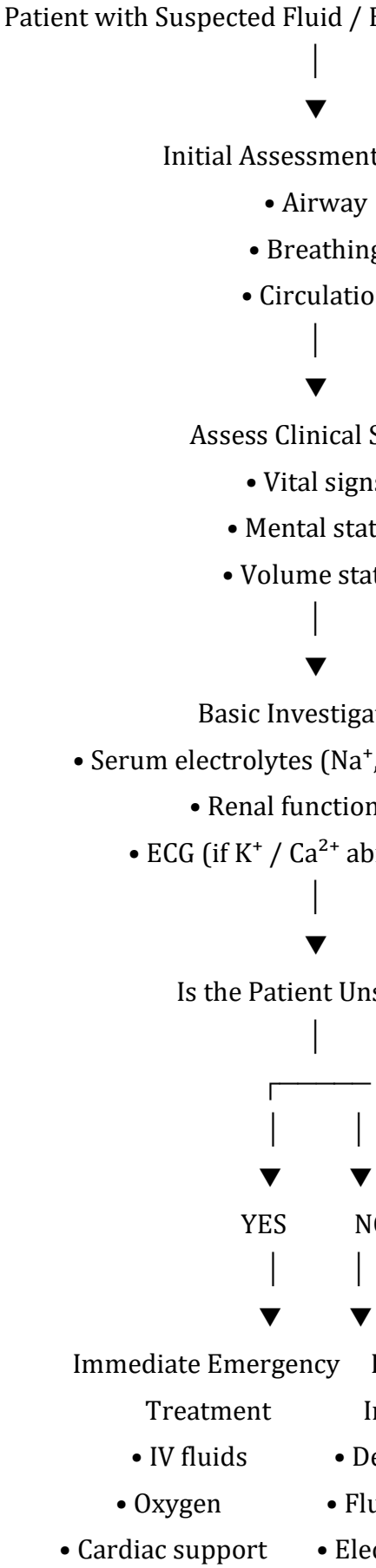
- Aggressive intravenous hydration with isotonic saline
- Loop diuretics following adequate rehydration
- Bisphosphonates or calcitonin in severe cases

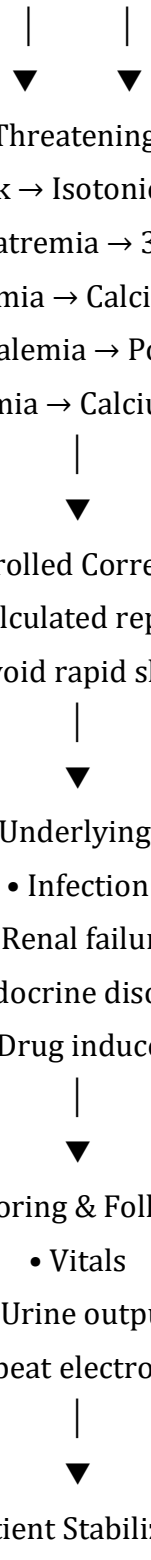
5. **Diagnostic Approach in the Emergency Department**

- Comprehensive history and physical examination
- Serum electrolyte levels and renal function tests
- Arterial blood gas analysis when indicated
- Continuous ECG monitoring for potassium and calcium abnormalities
- Strict monitoring of intake–output balance and vital signs

6. **Principles of Emergency Management**

- Immediate assessment of airway, breathing, and circulation
- Rapid identification of life-threatening electrolyte abnormalities
- Controlled and gradual correction to prevent complications
- Treatment of the underlying etiology
- Continuous monitoring and reassessment


Patient with Suspected Fluid / Electrolyte Imbalance
Initial Assessment (ABCs)
• Airway
• Breathing
• Circulation
Assess Clinical Status
• Vital signs
• Mental status
• Volume status
Basic Investigations
• Serum electrolytes (Na^+, K^+, Ca^{2+}, Mg^{2+})
• Renal function tests
• ECG (if K^+ / Ca^{2+} abnormality)
Is the Patient Unstable?
YES
NO
Immediate Emergency Treatment
• IV fluids
• Oxygen
• Cardiac support
Identify Type of Imbalance
• Dehydration
• Fluid overload
• Electrolyte disorder



Electrolyte Imbalance Management in Vamana

Electrolyte imbalance during or after Vamana Karma occurs mainly due to excessive emesis leading to fluid and electrolyte loss, especially sodium and potassium.

Management includes:

- Early recognition of symptoms such as dizziness, weakness, hypotension, reduced urine output, and altered sensorium.
- Immediate cessation of Vamana in case of excessive bouts (Ati Vamana).
- Oral rehydration with warm fluids after Vamana.
- Samsarjana Krama (graded diet starting from peya to normal diet) to restore fluid and electrolyte balance.
- Monitoring of vital signs and urine output.
- Serum electrolyte estimation if weakness, confusion, or cardiac symptoms occur.

Correction of imbalance:

- Hyponatremia → Controlled sodium correction with oral/IV fluids.
- Hypokalemia → Oral or IV potassium supplementation under supervision.
- IV isotonic fluids in moderate to severe dehydration.
- Emergency referral if severe electrolyte disturbance or cardiac manifestations are present.

Electrolyte Imbalance Management in Virechana

Electrolyte imbalance during Virechana Karma (therapeutic purgation) occurs due to excessive purgation leading to loss of fluids and electrolytes, mainly sodium and potassium.

Management includes:

Early identification of symptoms such as excessive loose stools, weakness, dizziness, dehydration, and reduced urine output.

Immediate stoppage of Virechana in cases of Ati Virechana (excessive purgation).

Adequate oral rehydration using warm fluids after purgation.

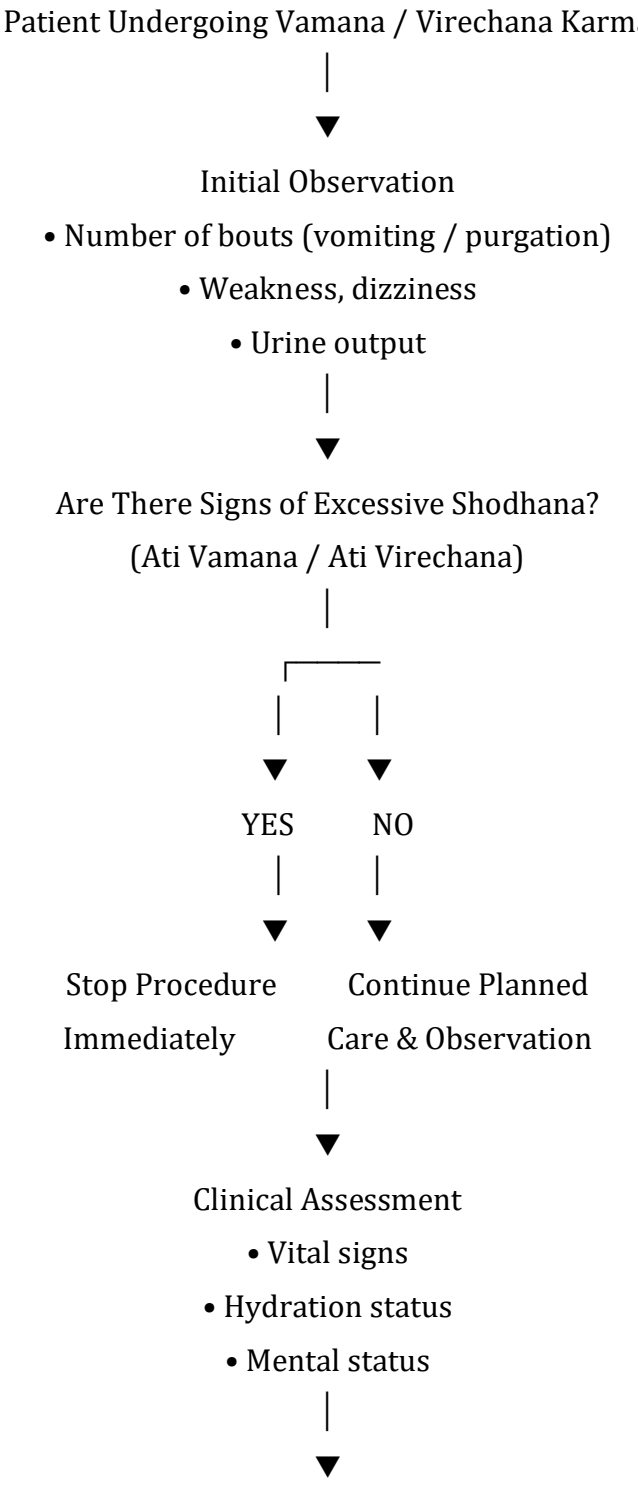
Strict Samsarjana Krama, beginning with peya, vilepi, yusha, and gradually normal diet to restore electrolyte balance.

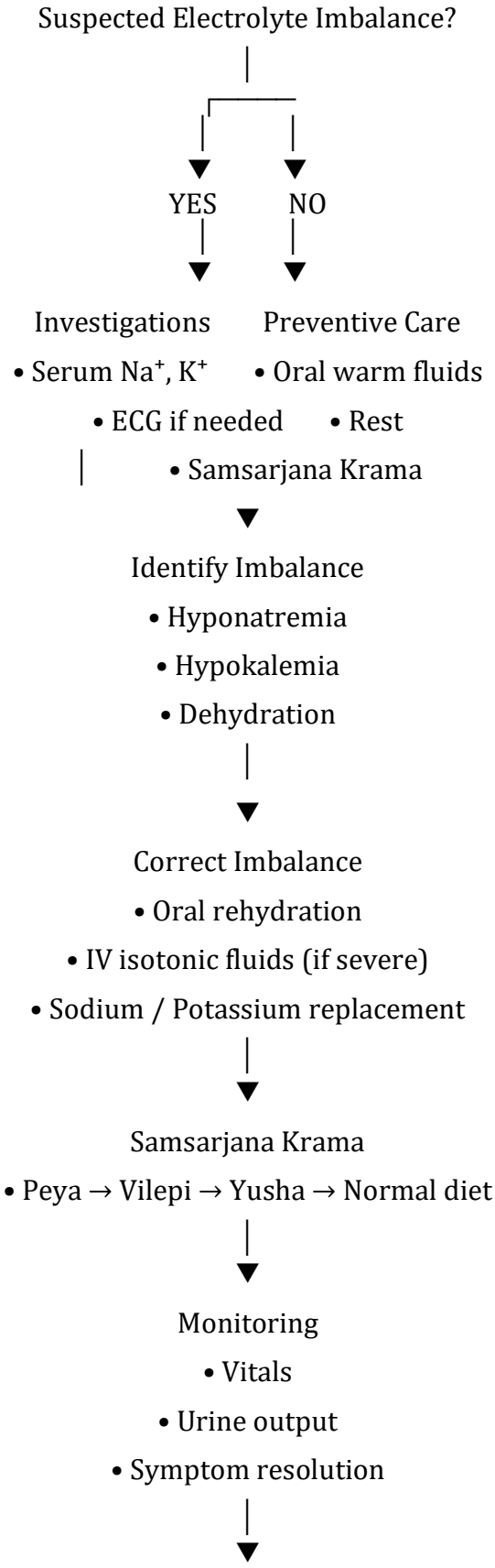
Monitoring of vital signs, hydration status, and urine output.

Serum electrolyte assessment if symptoms of imbalance appear.

Correction of electrolyte disturbances:

- Hyponatremia → Controlled sodium replacement with oral or IV fluids.
- Hypokalemia → Oral or IV potassium supplementation as needed.
- IV isotonic fluids in moderate to severe dehydration.
- Emergency referral if severe electrolyte imbalance or systemic complications occur.




Suspected Electrolyte Imbalance?
YES
NO
Investigations
• Serum Na^+, K^+
• ECG if needed
Preventive Care
• Oral warm fluids
• Rest
• Samsarjana Krama
Identify Imbalance
• Hyponatremia
• Hypokalemia
• Dehydration
Correct Imbalance
• Oral rehydration
• IV isotonic fluids (if severe)
• Sodium / Potassium replacement
Samsarjana Krama
• Peya → Vilepi → Yusha → Normal diet
Monitoring
• Vitals
• Urine output
• Symptom resolution
Patient Stabilized

DISCUSSION

Fluid and electrolyte imbalances remain a frequent cause of emergency department admissions and are associated with significant morbidity and mortality. Rapid physiological changes in acute illness often make early diagnosis challenging, highlighting the need for vigilant clinical assessment.[3] Sodium and potassium disturbances are particularly critical and due to their direct effects on neurological and cardiac function.[4]

In emergency settings, treatment priorities include stabilization of vital functions and identification of life-threatening abnormalities. While prompt correction is essential, excessive or rapid correction may result in serious iatrogenic complications are such as arrhythmias or osmotic demyelination syndrome. Evidence-based protocols emphasize controlled correction and continuous monitoring to ensure patient safety.[5]

CONCLUSION

Fluid and electrolyte imbalances represent a major clinical challenge in emergency medicine. Early recognition, accurate diagnosis, and timely intervention are critical for reducing morbidity and mortality. Emergency physicians must carefully balance the need for rapid correction with patient safety to prevent iatrogenic complications. A systematic, evidence-based approach plays a pivotal role in improving outcomes for patients presenting with these4 potentially fatal disturbances.

CONFLICT OF INTEREST –NIL

SOURCE OF SUPPORT –NONE

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