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Article

Emergency Nursing Management of Hyperkalemia in Dialysis Patients: Evidence-Based Interventions for Critical Electrolyte Imbalance

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Abstract: Background: Hyperkalemia is a life-threatening electrolyte imbalance commonly seen in dialysis patients due to impaired renal potassium excretion, missed dialysis sessions, dietary factors, and medication effects, leading to severe cardiac complications and increased risk of sudden cardiac arrest if untreated. Aims: To review pathophysiology, risk factors, clinical features, and evidence-based emergency nursing interventions for hyperkalemia in dialysis patients. Methods: This review was conducted using published peer-reviewed articles, clinical guidelines, and nursing literature focusing on hyperkalemia in dialysis patients. Databases including Google Scholar and PubMed were explored to identify relevant studies. Key themes such as pathophysiology, risk factors, clinical manifestations, emergency management, and nursing interventions were analyzed. Evidence from recent studies was synthesized to present updated clinical practices and nursing strategies for effective emergency management of hyperkalemia. Results: Findings indicate that hyperkalemia in dialysis patients is primarily caused by reduced renal potassium excretion, inadequate dialysis, dietary potassium intake, and drug-related factors. Clinically, it presents with neuromuscular weakness, gastrointestinal symptoms, and life-threatening cardiac manifestations such as arrhythmias and ECG changes. Evidence-based nursing interventions include immediate cardiac monitoring, calcium gluconate administration, insulin-glucose therapy, and preparation for hemodialysis. Potassium redistribution therapies provide temporary stabilization, while dialysis offers definitive correction. Early recognition and rapid nursing response significantly reduce mortality and improve patient outcomes in emergency settings. Conclusion: Early nursing intervention, continuous monitoring, and timely dialysis are essential to prevent complications and reduce mortality in hyperkalemia among dialysis patients.

Keywords: Hyperkalemia, Dialysis patients, Emergency nursing, Electrolyte imbalance, Cardiac arrhythmia.

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Introduction

Hyperkalemia is essentially an electrolyte imbalance with hyperkalemic serum potassium concentrations usually exceeding 5.5 mEq/L and is a serious condition affecting the level of potassium in the blood that is important for normal cell function, nerve activity, and cardiac muscle activation. Normal physiology maintains potassium balance by excreting additional amounts of potassium through urine. This is also disrupted in patients with end-stage renal disease (ESRD), where there is a build-up of potassium in the blood [1]–[3].

Hyperkalemia occurs especially in patients with impaired renal function (including dialysis patients), who are relying on intermittent hemodialysis for elimination of potassium. Potassium may build up quickly between periods of dialysis and may increase further from what's eaten in the diet, what's given as medications, and metabolic reactions. This risk is further raised by missed or inadequate periods of dialysis; thus, hyperkalemia is frequently a clinical emergency in renal care units [4], [5]. Also, medications including angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs), and potassium-sparing (K^+) diuretics have the potential to reduce renal excretion of K^+ (hyperkalemic) and lead to high serum K^+ levels.

The clinical relevance of hyperkalemia is due to its direct effects on cardiac electrophysiology. Cardiac cells' resting membrane potential is changed by increased K^+ levels, resulting in conduction abnormalities and life-threatening arrhythmia. Early electrocardiographic (ECG) changes are 'peaked T wave' and 'prolonged PR interval,' and severe changes may lead to wider QRS complexes, ventricular fibrillation, and cardiac arrest. These rapid and potentially dangerous effects make hyperkalemia a medical emergency that needs to be quickly recognized and acted upon [6], [7].

The treatment of hyperkalemia is emergency management and involves both short-term stabilization and definitive potassium therapy. Because of these, the initial treatment consists of intravenous calcium gluconate for cardiac membrane stabilization and insulin and glucose for a potassium shift and to prevent hypokalemia. In some cases, beta-agonists and sodium bicarbonate can also be employed in order to further lower serum potassium levels. The most effective and definitive method of removing potassium in ESRD (end-stage renal disease) patients, however, is hemodialysis [8]–[10]. Earlier assessment and intervention by the nurse are therefore essential for the care given in an emergency situation.

Dialysis patients have a higher risk of developing hyperkalemia that must be detected early, managed, and prevented, and nurses are vital to these processes. They have to keep a constant watch on the patient, interpret ECGs, supervise their intake, schedule with others, and educate patients on a regular basis. Steps taken to prevent the recurrence, such as dietary potassium limitation, drug review, and dialysis schedule adherence, are all crucial in order to optimize recurrence rates and long-term outcomes [11], [12].

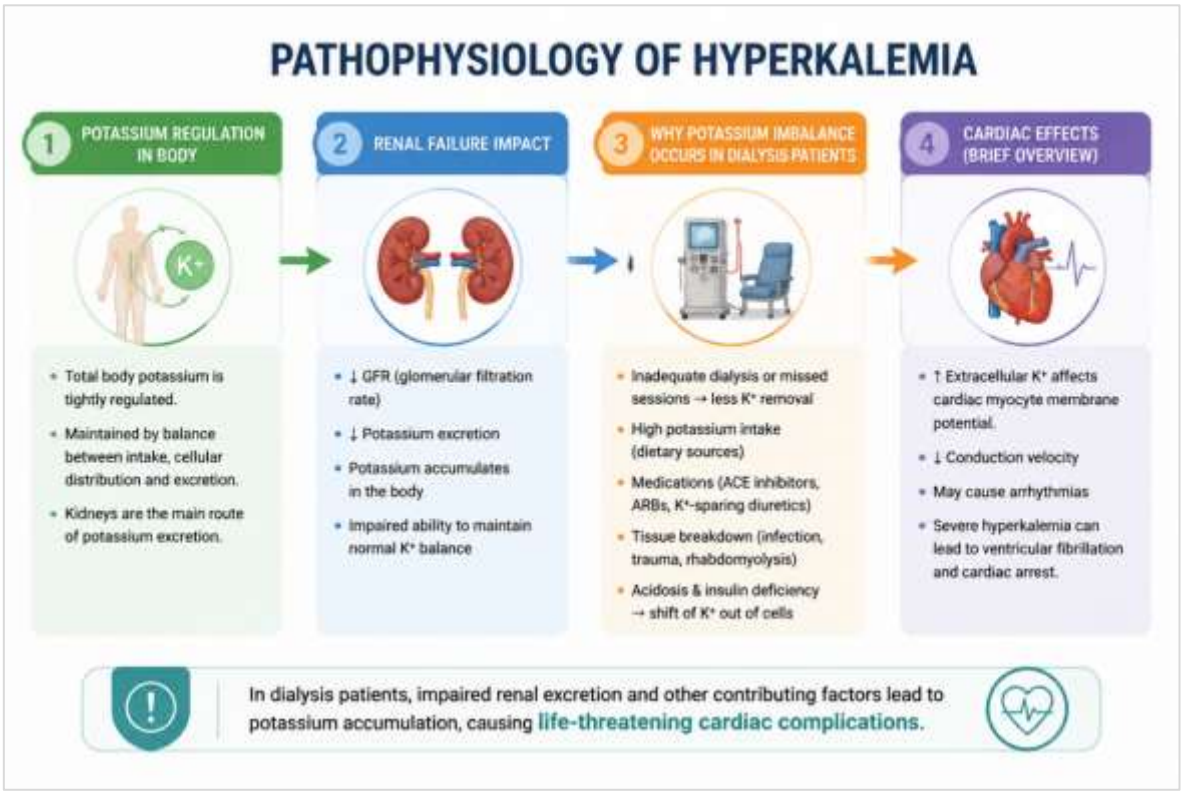
The purpose of this review is to provide an overview of the pathophysiology underlying hyperkalemia, associated risk factors, symptoms, and nursing interventions in dialysis patients that are supported by evidence and to highlight specific nursing interventions that may require caution for hyperkalemia, especially in the emergency department. This study concludes that nursing care becomes a critical role in improving patient safety and reducing mortality concerning this life-threatening condition, and the study successfully collects the available evidence from various sources.

2. Pathophysiology of Hyperkalemia

Hyperkalemia are common and life-threatening problems in dialysis patients mainly because with end-stage renal disease, reduced renal potassium clearance contributes (Figure 1) [13]. Failure or poor dialysis results in further progressive renal potassium retention in the blood [14]. Other risk factors include high intake of dietary potassium, use of some medications (including ACE inhibitors and antihypertensive drugs of the angiotensin receptor blocker type), metabolic acidosis, and shifts of potassium from cells due to insulin deficiency or breakdown of tissues [15]. Severe hyperkalemia is greatly predisposed in chronic dialysis patients to these factors.

There is evidence that early intervention by the emergency nurse is important to better outcomes. Timely intervention can be achieved by continuous ECG monitoring and the early detection of cardiac changes [16]. In severe cases of calcium membrane-stabilizing drugs, calcium gluconate should be recommended for intravenous injection. Insulin (with glucose) is being widely used to shift potassium into cells and lower the potassium quickly in the blood in the case of hyperkalemia [17]. But in end-stage renal disease patients (renal failure), definitive potassium removal comes from hemodialysis. When the recognition is delayed, or the regulation is not sufficient, the heart can experience very troublesome arrhythmias, such as ventricular fibrillation and cardiac arrest [18]. In general, the evidence shows that early evaluation and adoption of efficient and evidence-based interventions in hyperkalemia patients in dialysis significantly decrease morbidity and mortality.

Figure 1. Pathophysiology of hyperkalemia in dialysis patients showing impaired



potassium regulation due to renal failure, increased serum potassium accumulation, dialysis-related imbalance, and resulting cardiac effects leading to potential arrhythmias.

3. Risk Factors in Dialysis Patients

Hyperkalemia is the result, in most cases, of the failure of the dialysis patient's renal potassium excretion secondary to decreased glomerular filtration rate (GFR), resulting in progressive elevation of potassium in the blood [19]. Poor or infrequent dialysis will also elevate serum potassium levels by decreasing its external removal shown in Figure 2, which is another factor that is important for determining electrolyte balance [20]. Furthermore, dietary potassium has been associated with increasing potassium load, which is more difficult to excrete in patients with end stage renal disease (ESRD) [14].

In addition, various metabolic and pharmacologic issues aggravate hyperkalemia. Potassium-sparing diuretics, metabolic acidosis, and insulin deficiency induce shifts of potassium into the extracellular compartment, increasing the serum potassium concentration [20]. Proteolytic conditions such as trauma, injury, infection, or even rhabdomyolysis increase the level of intracellular potassium, further contributing to the imbalance. The presence of all these risk factors makes a person at higher risk of developing life-threatening cardiac arrhythmia and cardiac arrest if not promptly identified and treated [21].

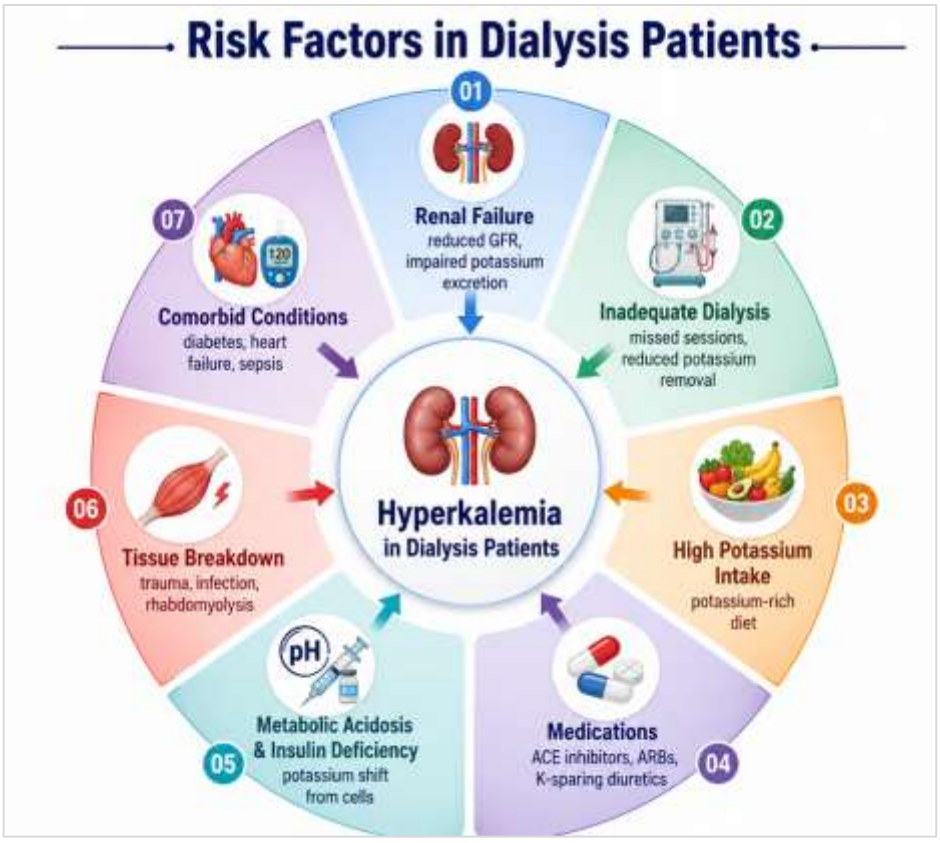


Figure 2. Risk factors contributing to hyperkalemia in dialysis patients. The diagram illustrates a circular flow of key contributing factors including renal failure, inadequate dialysis, high potassium intake, medications, metabolic acidosis with insulin deficiency, tissue breakdown, and comorbid conditions. These factors collectively lead to increased serum potassium levels and significantly increase the risk of life-threatening cardiac arrhythmias in dialysis patients.

4. Clinical Manifestations

Hyperkalemia in dialysis patients appear across several body system areas, most typically in cardiovascular, neuromuscular, respiratory, gastrointestinal, and general areas (Figure 3). The more serious cardiovascular side effects are most commonly reported and have been seen on electrocardiograms (ECG) as peaked T waves, widened QRS complexes, bradycardia, arrhythmia, and, in severe cases, cardiac arrest [22]. As serum potassium increases and cellular excitability decreases, neuromuscular symptoms, such as muscle weakness, fatigue, paresthesia's, reduced deep tendon reflexes, and flaccid paralysis, occur commonly [23].

Shortness of breath, a reduction of breathing effort, and, in more severe cases, respiratory failure are common signs of respiratory involvement, along with other symptoms such as nausea and vomiting, abdominal discomfort, and ileus [24]. The systemic involvement and exacerbation of electrolyte disturbances are reflected by the general symptoms of malaise, weakness, confusion, and lethargy. In general, the worse the symptoms, the lower the serum potassium level, and the poorer the time of recognition, the higher the risk of life-threatening symptoms, especially sudden cardiac arrest in dialysis patients [25].

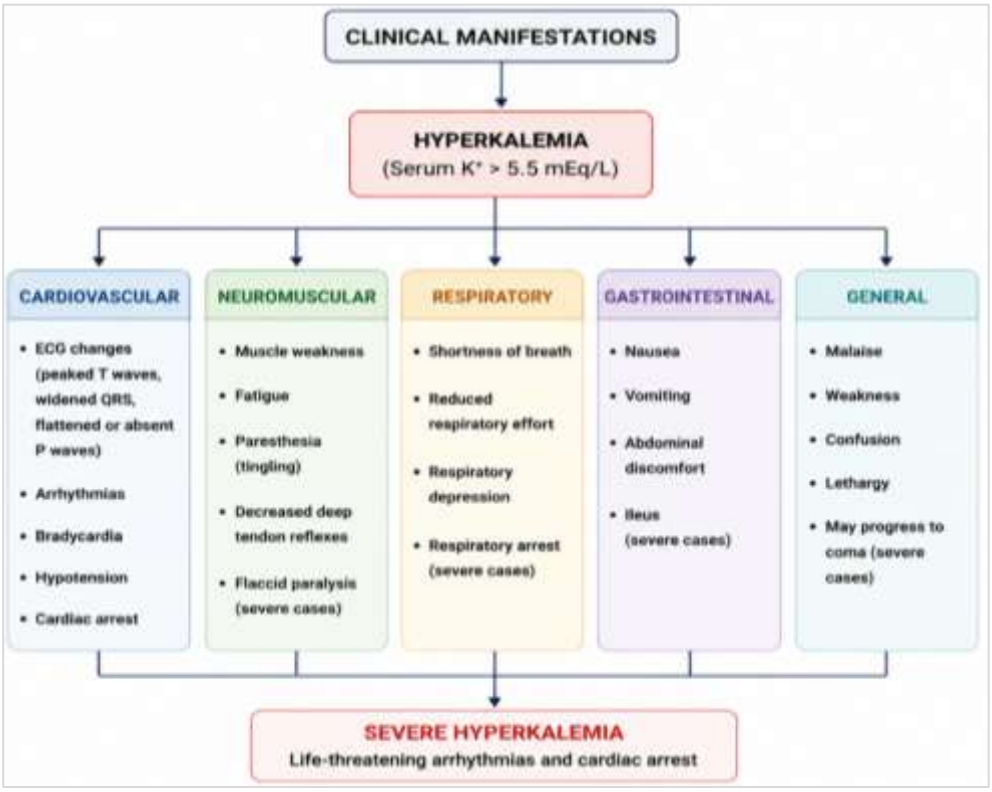


Figure 3. Clinical manifestations of hyperkalemia in dialysis patients. The figure illustrates the systemic effects of elevated serum potassium (>5.5 mEq/L), showing its impact on cardiovascular, neuromuscular, respiratory, gastrointestinal, and general systems. The diagram highlights key symptoms such as ECG changes, muscle weakness, respiratory distress, and gastrointestinal disturbances, which may progress to life-threatening arrhythmias and cardiac arrest in severe cases.

5. Emergency Assessment in Nursing Practice

The importance of structured and quick assessment for emergency nursing for hyperkalemia patients undergoing dialysis in order to identify various life-threatening complications at an early stage (Table 1). The initial evaluation is the ABC (Airway, Breathing, Circulation) assessment, which can reveal any of the following: Respiratory distress, hypotension, weak pulse, and altered oxygen saturation are all ways to assess severe cardiovascular instability [26]. Continuous monitoring of vital signs and immediate ECG are critical, as typical ECG findings of hyperkalemia, such as widened QRS complexes, arrhythmias, and peaked T waves, have been shown to be significant and well correlated with rising blood potassium levels and risk for cardiac arrest [27], [28].

Also, neurological and respiratory evaluation gives further clues as to the degree of potassium imbalance. Altered excitability of membranes in the neuromuscular system is reflected by findings like muscle weakness, fatigue, paresthesia, and, in severe cases, flaccid paralysis [29]. Further renal function tests, arterial blood gases (ABG), and serum potassium levels can be used as laboratory profiles to help support the diagnosis and severity of hyperkalemia, and a review of dialysis history and medications may help identify contributing factors, such as missing dialysis dates and medications that raise serum potassium levels, respectively [30]. In summary, patients in dialysis have a better prognosis due to early detection of the complications (cardiac) that may lead to death through the systematic survey of the patient by nursing and care workers [31].

Table 1. Emergency nursing assessment of hyperkalemia in dialysis patients and clinical importance.

Assessment Domain	What to Assess	Clinical Findings / Indicators	Nursing Significance	References

Initial Rapid Assessment (ABC)	Airway, Breathing, Circulation status	Dyspnea, respiratory distress, hypotension, weak pulse	Identifies life-threatening instability requiring immediate intervention	[28]
Vital Signs Monitoring	BP, HR, RR, SpO_2, temperature	Bradycardia, hypotension, irregular pulse, low oxygen saturation	Early detection of cardiovascular compromise due to hyperkalemia	[27]
Cardiac Assessment (ECG Monitoring)	Continuous ECG tracing	Peaked T waves, widened QRS, flattened P wave, arrhythmias	Most critical indicator of severe hyperkalemia; risk of cardiac arrest	[32]
Neuromuscular Status	Muscle strength, reflexes, sensation	Muscle weakness, fatigue, paresthesia, flaccid paralysis	Reflects potassium effect on neuromuscular excitability	[33]
Respiratory Assessment	Breathing pattern, effort, lung function	Shortness of breath, shallow breathing, respiratory depression	Indicates severe electrolyte imbalance affecting respiratory muscles	[34]
Laboratory Evaluation	Serum potassium, ABG, renal function tests	$K^+ > 5.5$ mEq/L, metabolic acidosis, elevated creatinine	Confirms diagnosis and severity of hyperkalemia	[35]
Dialysis Status Review	Recent dialysis sessions, adherence	Missed/inadequate dialysis, poor compliance	Identifies primary cause of potassium accumulation	[36]
Medication History	Drugs affecting potassium balance	ACE inhibitors, ARBs, K-sparing diuretics, NSAIDs	Helps identify drug-induced hyperkalemia risk	[37]
Fluid & Volume Status	Edema, intake/output balance	Fluid overload, dehydration signs	Assists in evaluating renal and cardiovascular stability	[38]

6. Evidence-Based Nursing Interventions

6.1 Immediate Stabilization

This review highlights the critical importance of evidence-based interventions of nursing care in the acute management of hyperkalemia in people on dialysis that shown in Table 2. Immediate stabilization is provided by quick assessment, intravenous calcium gluconate (to keep the cardiac membranes stable and reduce the risk of serious arrhythmias), oxygen, and continuous electrocardiogram (ECG) monitoring [39]. Prevention of sudden cardiac complications is the most important result of severe hyperkalemia, and these are the early interventions necessary [40].

Other studies demonstrate the efficacy of the potassium redistribution therapies (insulin/glucose, beta-agonists, and, in isolated cases, sodium bicarbonate) in rapidly lowering plasma potassium levels due to a shift of potassium into the intracellular space [20], [41]. Definitive elimination of potassium is only possible by hemodialysis, particularly in patients with end-stage renal disease [42]. It is crucial to monitor and track the levels of potassium, changes in the ECG, and clinical responses in the patient to monitor the effectiveness of the treatment and prevent recurrent cases. Also, medication review and detection of potassium-raising agents are key prevention measures to minimize potassium elevation risk for dialysis patients in the future [11], [43].

Table 2. Evidence-based nursing interventions for hyperkalemia in dialysis patients showing immediate stabilization, potassium redistribution, and potassium removal strategies.

Intervention Phase	Nursing Intervention	Mechanism / Purpose	Expected Outcome	Key Nursing Consideration	References
Immediate Stabilization	IV Calcium gluconate administration	Stabilizes cardiac membrane, reduces excitability	Prevents arrhythmias and cardiac arrest	Monitor ECG continuously during administration	[39]
	Oxygen therapy	Improves tissue oxygenation	Reduces hypoxia-related complications	Maintain $SpO_2 > 94\%$	[40]
	Cardiac monitoring (ECG)	Detects early arrhythmias	Early detection of life-threatening changes	Continuous monitoring required	
Potassium Redistribution	IV Insulin + glucose	Drives potassium into cells	Rapid temporary reduction of serum K^+	Monitor blood glucose for hypoglycemia	[41]
	Nebulized beta-agonists	Enhances cellular potassium uptake	Decreases serum potassium level	Observe for tachycardia	
	Sodium bicarbonate (if acidotic)	Corrects metabolic acidosis	Shifts potassium intracellularly	Use cautiously in fluid overload	[42]
Potassium Removal	Hemodialysis	Direct removal of potassium from blood	Definitive correction of hyperkalemia	Most effective in ESRD patients	[43]
	Diuretics (if residual renal function)	Increases urinary potassium excretion	Helps reduce potassium load	Monitor urine output and electrolytes	[11]
Monitoring & Safety	Frequent serum potassium checks	Evaluates treatment response	Ensures potassium normalization	Repeat labs as per protocol	[21]
	Neurological & vital sign monitoring	Detect deterioration early	Prevents complications	Assess weakness, paralysis, hypotension	[17]
	Medication review	Identify potassium-increasing drugs	Prevent recurrence	ACE inhibitors, ARBs, K-sparing diuretics	[13]

6.2 Potassium Redistribution Strategies

Potassium redistribution should be a key immediate therapy to manage hyperkalemia in dialysis patients. Insulin and glucose are the best and most widely used methods, which cause a sudden shift in the direction of the sodium/potassium ATPase pump, bringing potassium into the cells and causing the serum potassium level to decrease significantly but temporarily [44]. The effect of this intervention is usually seen within 15–30 minutes, and it is usually the first choice for emergency treatment of severe hyperkalemia (Figure 4).

Additionally, beta$_2$-agonists like nebulized salbutamol affect potassium in the cell by stimulating intracellular potassium uptake processes, and bicarbonate is helpful when a patient is suffering from metabolic acidosis, as it has the dual effects of correcting acid-base balance and enhancing potassium uptake [44]. These measures ensure short-term control of blood K^+ concentrations; however, permanent removal, i.e., hemodialysis, is required in patients with end-stage renal disease. Evidence suggests a quick start to potassium redistribution therapies can lower the likelihood of heart-threatening arrhythmia prior to full treatment being initiated [45].

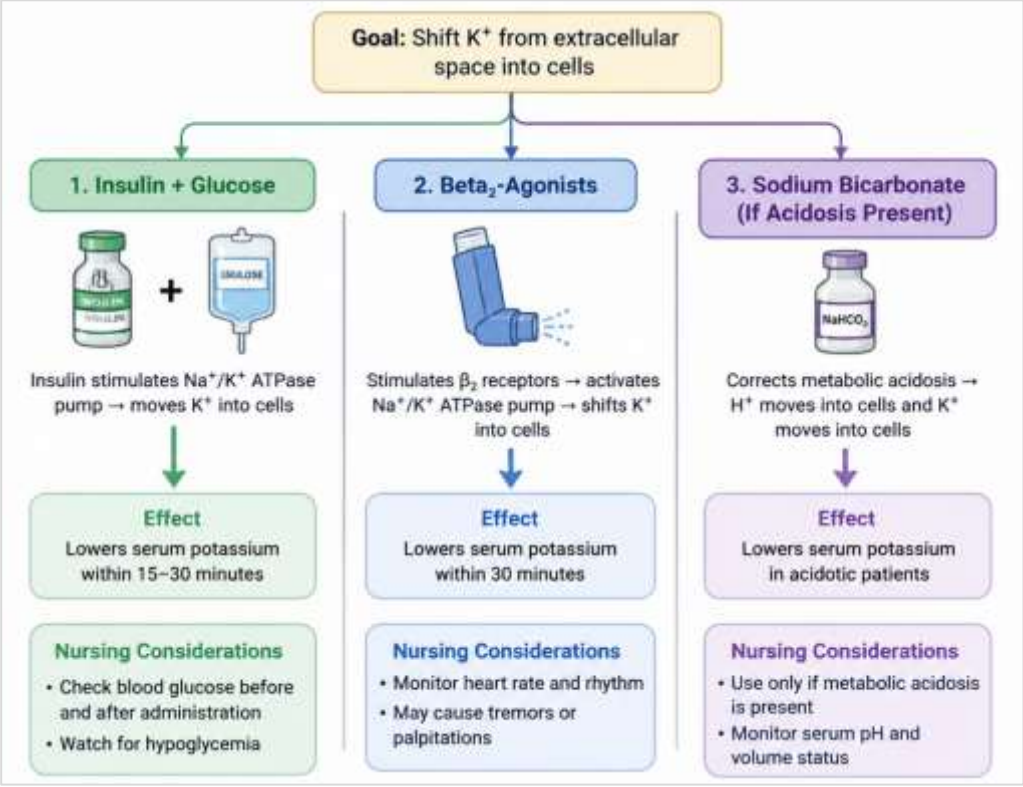


Figure 4. Potassium redistribution strategies in emergency management of hyperkalemia in dialysis patients. The figure illustrates key temporary intracellular shifting interventions including insulin with glucose, beta$_2$-agonists, and sodium bicarbonate, highlighting their mechanisms, onset of action, and nursing considerations, with emphasis on their role as bridge therapy before definitive hemodialysis.

7. Role of the Nurse in Emergency Care

The nurse's role is important in the emergency treatment of hyperkalemia in dialysis patients. Early detection is the first step and most essential. Samples the patient according to the ABC method (airway, breathing, and circulation) and measures vital signs, including blood pressure, respiration, heart rate, and oxygen saturation. Typically, the first symptoms of muscle weakness, fatigue, tingling sensation, and shortness of breath are noted and reported as soon as they are observed [46]. It is also a critical nursing task to monitor the ECG continuously, as peaked T waves, a widened QRS complex, and arrhythmia are all signs of increased hyperkalemia and potential cardiac arrest [47].

Surgical treatment (when necessary) should also be administered immediately as ordered by the doctor, which is another large portion of nursing duties. This involves some of the steps taken to stabilize the cardiac membrane, including intravenous administration of calcium gluconate, to help prevent arrhythmias. Insulin and dextrose are also used transiently to move potassium from blood into cells and will contribute to lowering the serum potassium level [48]. During interventions, nurses closely monitor the blood glucose to ensure that the child does not become hypoglycemic and continually watch the child's cardiac rhythm for any signs of change in the rhythm. Sometimes, beta-agonists or sodium

bicarbonate are also administered, where they are necessary, and are carefully administered by the nurse, and side effects are monitored for, including tachycardia or any fluid balance effects.

Additionally, nurses take care of preparing patients for hemodialysis, the best way to eliminate extra potassium in end-stage renal disease patients. They ensure that vascular access is at the correct height and that they have implemented the correct technique and that dialysis and nephrology staff are ready for treatment to be started at the appropriate time [49]. Also, nurses are able to routinely review laboratory findings as the effectiveness of treatment and signs of deterioration are monitored throughout, such as serum potassium, renal function tests, and arterial blood gases.

Safety and education are other care considerations by nurses. Nurses need to give guidance on dietary potassium restriction, medication adherence, and regular dialysis sessions for avoiding recurrent hyperkalemia [50]. In emergency situations of hyperkalemia, the nurse is essential in reducing complications and improving survival outcomes through continuous monitoring and rapid intervention as well as coordination of care.

8. Prevention Strategies

It is very important to prevent hyperkalemia in dialysis patients in order to decrease the risk of complications during dialysis and better long-term outcomes. A major measure available is diet potassium management. Patients should be warned against high-potassium items like bananas, oranges, potatoes, tomatoes, and processed food (potassium additives). They need their diets to be monitored regularly by nurses and dietitians so that the patients can maintain safe levels of potassium in their blood and avoid getting too much potassium in between dialysis [51], [52].

Regular adequate dialysis treatment is another important preventive measure. It is important to follow the dialysis schedule, as missed or abbreviated dialysis sessions will increase the risk of having an electrolyte imbalance of potassium buildup. Nurses have significant input in terms of ensuring the patient adheres to the treatment regime and teach patients the need for complete dialysis treatment as directed [53]. Furthermore, with correct assessment of the dry weight and the efficiency of dialysis, appropriate potassium removal can be achieved.

Medication review is a key prevention strategy as well. Common medications that increase serum potassium include angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs), potassium-sparing diuretics, and non-steroidal anti-inflammatory drugs (NSAIDs). Patients' medications should be monitored by nurses regularly, and high-risk medications must be reported to physicians for consideration of adherence to the medication [13]. A routine check of serum K and renal function is another important prevention. The early detection of elevated potassium levels will help to take preventative measures before any complications occur due to the devastating effects of high potassium levels. Chronic kidney disease (CKD) requires laboratory monitoring of analytes as part of the management [14].

Last but not least, patient education is key to prevention. Educating patients about dietary restrictions, medication management, symptom recognition, and the importance of regular dialysis will help to minimize the incidence of hyperkalemia. Hyperkalemia can be greatly prevented in dialysis patients when you use a combination of dietary control, dialysis at regular intervals, medication accounts, and monitoring it around the clock.

9. Discussion

Hyperkalemia is a common, potentially life-threatening electrolyte disturbance in dialysis patients and is believed to be caused, mainly, by inadequate potassium excretion by the dialysis kidneys. This review stresses that multiple interrelated factors contribute to its development, such as lowering of renal function, being unattended or having

insufficient dialysis sessions, dietary potassium intake, the effects of medication, and metabolic disturbances. The results of this study were similar to findings observed in the previous study, where end-stage renal disease was found to be the most important end risk for chronic potassium derangements [27], [31], [40]. All of these contribute to the increased vulnerability of dialysis patients amidst the current era of renal replacement therapy (RRT).

The review also highlights that hyperkalemia is directly and critically associated with cardiac function. Excessive potassium can result in changes in the cell membrane's potential in the myocardial cells, causing the appearance of peaked T waves, a widened QRS complex, and potentially lethal tachycardia and arrhythmias. This result is consistent with previous studies that report a sudden cardiac arrest as the most serious complication in severe hyperkalemia if not treated in a timely manner [22], [35]. recognition and quick intervention are still vital steps that are still important in the treatment of emergency diseases.

This review has demonstrated nursing actions are vital to patient outcomes. Cardiac function can be stabilized and the serum potassium level can be lowered temporarily by immediate treatment with ECG monitoring, calcium gluconate, and insulin and glucose anti-hyperkalemia therapy. These interventions are, however, only short-term, and definitive correction would be hemodialysis, which would remove excess potassium from the body [42], [48], [50]. This reflects the need for teamwork and care between different specialties in emergencies.

Additionally, the review covers the role of potassium redistributive therapy (beta-agonist and sodium bicarbonate in certain instances). As effective as these methods are, it is important to keep a close eye on them to prevent such side effects as tachycardia or hypoglycemia. This should strengthen the importance of good sound when treating regurgitation [37], [35].

Preventative measures are also crucial to limiting the chances of a recurrence. The risks of recurring hyperkalemia episodes are greatly decreased with dietary control, medication statistics, and dialyzing appointments. Education of patients is an important duty of the nurse in order to help them remain compliant and safe in the long run. Research indicates that dedicated education efforts can lead to increased knowledge and lower emergency room admissions for electrolyte troubles [33], [54].

In conclusion, results of this review strongly confirm hyperkalemia is a preventable, but high-risk, condition in dialysis. In reducing the morbidity and mortality, early recognition, early nursing-appropriate intervention, and effective long-term prevention strategies are vital. Improving the nursing knowledge and evidence-based protocols will drastically improve patients' outcomes in emergency and chronic care.

10. conclusion

Hyperkalemia in dialysis patients is a serious and potentially life-threatening condition that requires early recognition and immediate management. It is mainly caused by impaired renal potassium excretion, missed dialysis sessions, dietary factors, and medication effects. Rapid nursing assessment, ECG monitoring, and timely administration of evidence-based interventions such as calcium gluconate, insulin with glucose, and hemodialysis are essential in preventing fatal cardiac complications. Prevention strategies including dietary control, medication review, and dialysis adherence are also important in reducing recurrence. Overall, effective nursing care plays a key role in improving patient safety and outcomes in emergency hyperkalemia management.

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