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Understanding Post-Dialysis Hypoglycaemia: Causes, Symptoms and Solutions

Ajit Pal Singh[1], Rahul Saxena[2], Suyash Saxena[3]

[1]Assistant Professor, Department of Medical Lab Technology, SSAHS, Sharda University, Gr. Noida, U.P, India
[2]Professor, Department of Biochemistry, SSAHS, Sharda University, Gr. Noida, U.P, India
[3]Assistant Professor, Department of Biochemistry, SSAHS, Sharda University, Gr. Noida, U.P, India

***Corresponding Author:** Ajit Pal Singh | **Received:** 03.02.2025 | **Accepted:** 12.03.2025 | **Published:** 13.03.2025

Abstract: Dialysis is a life-saving treatment for failing kidneys which may cause hypoglycaemia, or low blood sugar. This is due to a variety of reasons, including a lack of glucose (the body's fuel) in traditional dialysis solutions, the loss of some blood sugar during the dialysis process, and the prevalence of diabetes among dialysis patients, which affects the body's response to low sugar levels. Symptoms range from slight tremors to a possibly lethal coma. Fortunately, collaborative techniques exist to reduce the danger. Regular blood sugar monitoring is essential for early detection. In some circumstances, healthcare experts may administer glucose-containing dialysis solutions or change diabetes medicines to prevent excessive decreases. Dietary modifications play an important influence. Focusing on complex carbohydrates, such as whole grains and vegetables, offers a long and consistent stream of glucose into the bloodstream, whereas limiting simple carbohydrates, such as sugary drinks, reduces blood sugar spikes and crashes. Open communication between patients and healthcare professionals is essential. Discussing pre-dialysis meals, medication changes, and any symptoms allows patients to become active partners in their care. Healthcare providers and patients can work together to provide a safe dialysis experience that reduces the risk of hypoglycaemia by testing blood sugar regularly, investigating glucose-containing solutions, modifying medications, and eating a balanced meal rich in complex carbs.

Keywords: Dialysis, Kidney failure, Hypoglycaemia, Glucose, Tremors.

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INTRODUCTION

Dialysis, a life-saving treatment for individuals with end-stage renal disease (ESRD), plays a critical role in removing waste products and excess fluids from the blood that healthy kidneys would normally eliminate. However, this process can also disrupt the delicate balance of blood sugar levels, leading to a potentially serious complication known as hypoglycaemia. Hypoglycaemia, also referred to as low blood sugar, is a condition where the body's blood sugar (glucose) levels fall below the normal range. Blood sugar serves as the primary source of energy for our cells, and maintaining a consistent level is crucial for optimal organ function, particularly in the brain. In a healthy individual, a complex interplay of hormones and the body's natural mechanisms ensures that blood sugar remains within a tight range. Hypoglycaemia can occur when the body uses glucose faster than it can produce or release from storage, or when external factors interfere with this process [1].

Peritoneal dialysis cycler

Hypoglycaemia's Symptoms and Risks

The symptoms of hypoglycaemia can vary depending on the severity of the episode and the individual's response. Common early signs include:

a) Shakiness or trembling
b) Sweating
c) Palpitations
d) Anxiety
e) Hunger pangs
f) Irritability
g) Difficulty concentrating

As blood sugar levels drop further, more pronounced neurological symptoms may develop, including:

a) Confusion
b) Drowsiness
c) Blurred vision
d) Slurred speech
e) Seizures
f) Coma

In severe cases, hypoglycaemia can lead to permanent brain damage or even death.

The unique vulnerability of dialysis patients

While hypoglycaemia can occur in anyone, dialysis patients face a particularly heightened risk. Several factors contribute to this vulnerability:

a) **Reduced Kidney Function:** Healthy kidneys play a crucial role in regulating blood sugar by removing excess glucose from the bloodstream and filtering hormones like glucagon, which helps raise blood sugar levels during a hypoglycaemic event. ESRD significantly impairs this regulatory function [2].
b) **Dialysis Treatment:** The dialysis process itself can contribute to hypoglycaemia. During haemodialysis, blood flows through an external filter where waste products and excess fluids are removed. This process can also inadvertently deplete blood sugar levels, especially if the dialysis session is prolonged or blood flow rates are high [3].
c) **Medications:** Many patients with diabetes, a common comorbidity in ESRD, require medications like insulin to manage their blood sugar. However, with reduced kidney function, these medications may have a more potent effect, leading to an increased risk of hypoglycaemia [4].
d) **Nutritional Deficiencies:** Malnutrition is a frequent complication in patients with ESRD. This can lead to depleted glycogen stores, the body's primary reservoir for readily available glucose. With limited reserves, hypoglycaemia can develop more readily in response to decreased blood sugar levels [5].
e) **Autonomic Neuropathy:** Chronic kidney disease can damage the autonomic nervous system, which regulates involuntary functions like sweating and heart rate. This can blunt the body's early warning signs of hypoglycaemia, making it more difficult for patients to recognise and respond promptly to a drop in blood sugar [6].

Hypoglycaemia's Potential Consequences

Frequent episodes of hypoglycaemia can have significant consequences for dialysis patients. These include:

a) **Cognitive Impairment:** Episodes of severe hypoglycaemia can damage brain cells and lead to cognitive decline, memory problems, and difficulty concentrating [7].
b) **Cardiovascular Events:** The stress response triggered by hypoglycaemia can increase heart rate and blood pressure, potentially leading to heart attacks or strokes [8].
c) **Hospitalisation:** Severe hypoglycaemia often requires emergency medical attention, resulting in increased healthcare utilisation [9].
d) **Reduced Quality of Life:** The constant fear of hypoglycaemia can significantly impact a patient's quality of life, leading to anxiety, depression, and limitations in daily activities. Hypoglycaemia is a serious complication for dialysis patients, but it is a manageable one. With a clear understanding of the causes and risks, healthcare professionals can develop personalised strategies to prevent hypoglycaemia and ensure optimal outcomes for their patients. The following sections will delve deeper into the specific causes of after-dialysis hypoglycaemia and explore effective prevention and management strategies [10].

Table 01: showing the understanding of Post-Dialysis Hypoglycaemia

Aspect	Description
Cause	**Depletion of blood sugar (glucose) during dialysis**, **Factors contributing to depletion**- 1) Dialysis solution containing low glucose levels, 2) Increased insulin sensitivity due to removal of insulin-inhibiting substances by dialysis, * Medications like diabetes medications
Symptoms	**Can range from mild to severe** 1) Mild symptoms: Shakiness, sweating, light-headedness, hunger, anxiety, difficulty concentrating 2) Severe symptoms: Confusion, seizures, coma (rare)

Solutions	**Prevention is key**: 1) Doctor may adjust dialysis prescription 2) Monitor blood sugar levels before, during, and after dialysis 3) Consume a snack with complex carbohydrates and protein before or during dialysis 4) Discuss medication adjustments with doctor if needed, **Treatment for a hypoglycaemic episode**: 1) Consume quick-acting sugar sources like glucose tablets, juice, or honey (if conscious) 2) Glucagon injection if unconscious (requires prescription and training) 3) Seek medical attention if symptoms worsen or don't improve

Causes of After-Dialysis Hypoglycaemia

For individuals with end-stage renal disease (ESRD), dialysis serves as a lifeline, effectively removing waste products and excess fluids the kidneys can no longer eliminate. However, this life-sustaining treatment can also disrupt the delicate balance of blood sugar levels, leading to a potentially serious complication known as after-dialysis hypoglycaemia [11]. This condition arises when blood sugar (glucose) levels plummet below the normal range following a dialysis session. Understanding the complex interplay of factors that contribute to this phenomenon is crucial for healthcare professionals to develop effective prevention and management strategies.

This section delves deeper into the key causes of after-dialysis hypoglycaemia, exploring the latest research and insights:

Depletion of Blood Sugar Stores

a) **Glycogenosis:** Healthy individuals maintain a readily available reserve of glucose in the form of glycogen, primarily stored in the liver and muscles. During periods of low blood sugar, the body breaks down glycogen (glycogenosis) to release glucose back into the bloodstream. However, in ESRD patients, several factors can lead to depleted glycogen stores, making them more susceptible to hypoglycaemia [12]

b) **Reduced Dietary Intake:** Many patients with ESRD experience decreased appetite and a diminished ability to absorb nutrients due to gastrointestinal complications. This can lead to insufficient glycogen synthesis [13].

c) **Inflammation: chronic** inflammation, commonly observed in ESRD, increases glucose utilisation by tissues, further depleting glycogen reserves [14].

d) **Increased Catabolism:** The breakdown of muscle tissue (catabolism) is often accelerated in ESRD patients, leading to a loss of readily available glycogen stores in the muscles [15].

Gluconeogenesis is another critical mechanism for maintaining blood sugar levels. It is the process by which the body synthesizes glucose from non-carbohydrate precursors like amino acids and lactate. However, this process is significantly impaired in ESRD.

a) **Deficiency in Gluconeogenic Precursors:** Reduced protein intake and muscle wasting can limit the availability of amino acids, essential building blocks for gluconeogenesis [16].

b) **Decreased Enzyme Activity:** Certain enzymes crucial for gluconeogenesis, such as phosphoenolpyruvate carboxykinase (PEPCK), exhibit reduced activity in patients with ESRD [17].

Reduced Insulin Clearance by Kidneys

Healthy kidneys play a vital role in regulating blood sugar by filtering out excess insulin, a hormone that signals cells to take up glucose from the bloodstream. However, ESRD severely compromises this clearance function, resulting in:

a) **Elevated Insulin Levels:** With reduced clearance, insulin accumulates in the bloodstream, potentially leading to an exaggerated response to a post-dialysis decline in blood sugar [18].

b) **Increased Insulin Sensitivity:** Chronic exposure to elevated insulin levels can make tissues more sensitive to its effects, further promoting glucose uptake and potentially causing hypoglycaemia [19].

Medications (Diabetes Medications)

Many patients with ESRD also have diabetes, a condition characterised by chronic hyperglycaemia (high blood sugar). These patients often rely on medications like insulin or oral hypoglycaemic agents to manage their blood sugar. However, in the context of dialysis, these medications can become problematic:

a) **Altered Pharmacokinetics:** Reduced kidney function can significantly alter the way the body absorbs, distributes, and eliminates medications. This can lead to unpredictable effects, with a heightened risk of hypoglycaemia [20].

b) **Dialysis Clearance:** Certain diabetes medications, particularly some types of insulin, can be removed from the body during dialysis, potentially leading to a rapid drop in blood sugar levels post-dialysis [21].

Dialysis Treatment Factors

The dialysis process itself can contribute to after-dialysis hypoglycaemia in several ways:

a) **Dialysis Duration:** Longer dialysis sessions are associated with an increased risk of hypoglycaemia. Longer exposure of the blood to the dialysate (the cleansing fluid) increases the potential for glucose diffusion from the blood into the dialysate [22].

b) **Blood Flow Rates:** Higher blood flow rates during haemodialysis can also lead to a more pronounced loss of glucose from the bloodstream [23].

c) **Dialysate Glucose Concentration:** Traditionally, dialysate solutions are devoid of glucose. However, recent research has explored the use of low-dose glucose-containing dialysates to mitigate the risk of hypoglycaemia. While promising, further investigations are ongoing to determine the optimal glucose concentration for dialysate solutions [24].

Recent advancements and ongoing research

The field of dialysis medicine is constantly evolving, with ongoing research aimed at developing novel strategies to prevent and manage after-dialysis hypoglycaemia. Some promising areas of exploration include:

a) **Personalised Glucose Management: tailoring** dialysis regimens and medication dosages based on individual patient characteristics and blood sugar profiles [25].

b) **Continuous Glucose Monitoring (CGM):** The use of CGM

Table-02: showing Symptoms after Dialysis Hypoglycaemia

Category	Symptom	Description
Neurologic	Shakiness or Trembling	A feeling of tremors or shaking, often noticeable in the hands or limbs.
	Dizziness	Feeling lightheaded, dizzy, or faint.
	Weakness	Generalized weakness or fatigue as the body's energy levels drop.
	Confusion	Mental confusion or difficulty concentrating.
	Headache	Headaches, sometimes severe.
	Blurred Vision	Vision changes, such as blurriness or difficulty focusing.
	Tingling Sensation	Tingling or numbness, particularly in the lips, tongue, or extremities.
	Seizures (Severe)	Uncontrolled muscle movements and loss of consciousness.
	Loss of Consciousness (Severe)	Extreme hypoglycaemia can cause coma if not treated promptly.
Autonomic	Sweating	Profuse sweating, even in cool conditions.
	Palpitations	Rapid heartbeat or heart palpitations.
Gastrointestinal	Nausea	Feeling nauseated, and in some cases, vomiting.
Behavioural	Hunger	Intense hunger, often sudden and disproportionate to the time since the last meal.
	Irritability	Mood swings, irritability, or feelings of anxiety.

Additional Notes

a) Not everyone experiences all symptoms, and the order of appearance can vary.

b) Some people, particularly diabetics, may have blunted hormonal responses and experience minimal or no symptoms despite low blood sugar.

c) This table is for informational purposes only. If you experience any of these symptoms, it's crucial to check your blood sugar level immediately and seek medical attention if necessary.

For individuals with end-stage renal disease (ESRD) undergoing dialysis, maintaining a healthy blood sugar balance is crucial. However, after dialysis sessions, a potentially dangerous condition called after-dialysis hypoglycaemia can occur. This section explores the various symptoms of after-dialysis hypoglycaemia, emphasising the importance of blood sugar monitoring and early recognition [26].

The Spectrum of Symptoms

After dialysis, hypoglycaemia manifests through a spectrum of symptoms that can vary depending on the severity of the episode and the individual's response. We can broadly categorize these symptoms into two main groups:

Autonomic Symptoms

The body's autonomic nervous system, which controls involuntary functions like heart rate and sweating, triggers these early warning signs. Recognising these early symptoms is critical for taking timely action to prevent the progression to more severe complications.

Common autonomic symptoms of after-dialysis hypoglycaemia include:

a) **Sweating:** It is one of the most common early signs. Patients may experience unexpected sweating, often described as a cold sweat, even in cool environments [27].
b) **Anxiety:** A feeling of unease, restlessness, or a sense of impending doom can be a hallmark of after-dialysis hypoglycaemia [28].
c) **Hunger Pangs:** Due to the body's depleted glucose stores, patients may experience intense hunger pangs, signalling the body's need for rapid energy replenishment [29].
d) **Palpitations:** An irregular or rapid heartbeat can occur as the body attempts to compensate for the drop in blood sugar by increasing blood flow [30].
e) **Tremor or Shaking:** Fine tremors or shaking, particularly in the hands, can be another early indicator of hypoglycaemia [31].

Neurological Symptoms

If we do not promptly address the hypoglycaemic episode, the low blood sugar levels can affect the brain, resulting in a range of neurological symptoms. These symptoms can be progressively severe and require immediate medical attention. Examples include:

a) **Confusion:** Patients may become disoriented, forgetful, or struggle to think clearly.
b) **Drowsiness:** A sense of fatigue and a strong urge to sleep can develop due to the brain's limited access to glucose, its primary energy source.
c) **Blurred Vision:** The eyes may struggle to focus, and vision may become blurry or distorted.
d) **Slurred Speech:** Difficulty speaking clearly or forming words can occur as brain function deteriorates.
e) **Seizures:** In severe cases, hypoglycaemia can trigger seizures, characterised by uncontrollable jerking movements and loss of consciousness.
f) **Coma:** The most serious complication, a coma, represents a state of profound unconsciousness and requires immediate emergency medical intervention.

The Importance of Blood Sugar Monitoring

Because ESRD patients have the potential for blunted autonomic responses, early warning signs of hypoglycaemia may not always be readily apparent. Therefore, regular blood sugar monitoring becomes an essential tool for managing after-dialysis hypoglycaemia. These strategies can help:

a) **Identify Trends:** Regular blood sugar monitoring before, during, and after dialysis sessions helps establish individual patterns and identify potential risks for hypoglycaemia [32].
b) **Inform Treatment Decisions:** Blood sugar readings guide healthcare professionals in adjusting dialysis treatment parameters, medication dosages, and dietary plans to minimise the risk of hypoglycaemia [33].
c) **Empower Patients:** Knowledge gleaned from regular monitoring empowers patients to recognise subtle symptoms and take early corrective actions, such as consuming sugary foods or beverages [34].

Recognising Symptoms: Beyond Blood Sugar Monitoring

While blood sugar monitoring is crucial, patients and carers should also be adept at recognising non-glucose-related symptoms of hypoglycaemia. Here's how:

a) **Behavioural Changes:** Observe for sudden changes in behaviour, such as irritability, difficulty concentrating, or uncharacteristic clumsiness.
b) **Mood Swings:** Emotional alterations like sudden sadness, anger, or anxiety can signal hypoglycaemia.
c) **Coordination Issues:** Difficulty with balance, walking, or hand-eye coordination may point to a drop in blood sugar levels.

Education and Communication

Effective communication between patients, carers, and healthcare professionals is paramount in managing after-dialysis hypoglycaemia. Patients and carers should be well-versed in recognising symptoms, interpreting blood sugar readings, and taking appropriate actions to address hypoglycaemia promptly [35]. Healthcare professionals should provide comprehensive education, develop personalised management plans, and encourage patients to seek immediate medical attention if severe neurological symptoms arise. After dialysis, hypoglycaemia, while a serious threat, can be effectively managed with proactive blood sugar monitoring, symptom awareness, and a collaborative approach between patients, carers, and healthcare professionals. Recognising the early warning signs, both autonomic and non-glucose-related, can avert severe complications and improve overall outcomes for dialysis patients [36].

Management of After-Dialysis Hypoglycaemia

For individuals with end-stage renal disease (ESRD) undergoing dialysis, maintaining a balanced blood sugar level is a constant challenge. After dialysis sessions, the risk of after-dialysis hypoglycaemia, a potentially dangerous drop in blood sugar, necessitates a multi-pronged management approach [37]. This section explores effective strategies for preventing and treating after-dialysis hypoglycaemia, empowering both patients and healthcare professionals.

Monitoring blood sugar during dialysis

Regular blood sugar monitoring throughout the dialysis session is the cornerstone of preventing after-dialysis hypoglycaemia. Here's how it helps:

a. **Identification of Early Declines:** Frequent blood sugar checks during dialysis allow for early detection of a downward trend, enabling prompt corrective measures before severe hypoglycaemia develops.
b. **Guiding Treatment Adjustments:** Blood sugar readings during dialysis can inform adjustments in dialysis parameters like duration or blood flow rates, potentially minimising glucose loss.
c. **Optimising medication doses:** Dialysis-induced changes in blood sugar levels may necessitate adjustments in medication dosages, such as insulin or oral hypoglycaemic agents. Healthcare professionals can use these readings to tailor medication regimens for optimal blood sugar control.

Monitoring Frequency

The optimal frequency of blood sugar monitoring during dialysis can vary depending on individual patient risk factors. Healthcare professionals typically recommend:

1. **Baseline Check:** Measuring blood sugar before dialysis initiation establishes a starting point.
2. **Periodic Checks:** Monitoring blood sugar every 30–60 minutes throughout the dialysis session helps track glucose levels and identify trends.
3. **Individualised Approach:** Factors like the patient's history of hypoglycaemia, diabetes status, and dialysis type (haemodialysis or peritoneal dialysis) influence the recommended monitoring frequency.

Dietary Adjustments

Dietary modifications before and after dialysis play a crucial role in managing blood sugar levels.

a. **Pre-dialysis Meal:** Consuming a well-balanced pre-dialysis meal containing complex carbohydrates can provide a sustained release of glucose into the bloodstream, potentially mitigating the risk of hypoglycaemia [38].
b. **Post-dialysis Snack:** A small, easily digestible snack rich in simple carbohydrates following dialysis helps replenish depleted glucose stores and prevent hypoglycaemia.
c. **Individualised Plans:** A registered dietitian can collaborate with the healthcare team to develop personalised dietary plans that consider individual nutritional needs, preferences, and dialysis schedules [39].

Considerations for Dietary Adjustments

a. **Protein Intake:** While protein is essential for overall health, excessive intake can stimulate gluconeogenesis, further depleting glycogen stores and potentially contributing to hypoglycaemia. A balanced protein intake is recommended.
b. **Fluid Restrictions:** Individuals with ESRD often have fluid restrictions. However, dehydration can exacerbate hyperglycaemia, making it crucial to consume fluids according to a doctor's recommendations.
c. **Dialysis Schedule:** The timing and frequency of dialysis sessions influence dietary recommendations. For example, for longer dialysis sessions, post-dialysis snacks may be more important.

Oral Glucose Administration

If blood sugar monitoring during dialysis identifies a downward trend or if mild hypoglycaemic symptoms develop, oral glucose administration can be a safe and effective way to raise blood sugar levels. Here's how it works:

a. **Simple Sugars:** Glucose tablets, gels, or sugary drinks are readily absorbed by the body and provide a quick source of energy to counteract hypoglycaemia.
b. **Patient Awareness:** Patients should be educated on recognising early symptoms of hypoglycaemia and trained on the proper use of oral glucose products.
c. **Monitoring After Administration:** Following oral glucose administration, further blood sugar checks are essential to ensure adequate correction and prevent rebound hypoglycaemia.

Intravenous Glucose Administration

In severe cases of hypoglycaemia, where the patient is unable to take oral glucose due to unconsciousness, confusion, or difficulty swallowing, intravenous glucose administration becomes necessary. This is a medical emergency, and immediate contact with emergency medical services is crucial.

Communication with the Dialysis Team and Healthcare Providers

Open communication between patients, carers, the dialysis team, and healthcare providers is essential for successful after-dialysis hypoglycaemia management. This includes:

a. **Sharing Blood Sugar Data:** Sharing blood sugar monitoring data with the dialysis team allows for real-time adjustments to dialysis protocols or medication regimens if necessary.
b. **Reporting Symptoms:** Promptly informing healthcare professionals about any symptoms of hypoglycaemia, even mild ones, helps in early intervention and prevents complications.
c. **Reviewing Medication Regimens:** Regularly discussing current medications and potential interactions with a healthcare professional is

crucial to minimising the risk of hypoglycaemia.

d. **Educational Support:** Healthcare professionals should provide ongoing education to patients and carers regarding hypoglycaemia awareness, symptom recognition, and appropriate response strategies. After dialysis, hypoglycaemia, while a serious potential complication, can be effectively managed through a proactive approach. Utilising a combination of strategies

Prevention of After-Dialysis Hypoglycaemia

For individuals with end-stage renal disease (ESRD) undergoing dialysis, maintaining a stable blood sugar level is vital. However, the dialysis process itself can lead to a potentially dangerous condition called after-dialysis hypoglycaemia. Fortunately, proactive preventive measures can significantly reduce the risk of this complication [40]. This section explores various strategies for preventing after-dialysis hypoglycaemia, empowering healthcare professionals and patients to work together towards optimal outcomes.

Pre-dialysis Meal Planning

Strategically planning the pre-dialysis meal plays a crucial role in preventing after-dialysis hypoglycaemia. Here's how it helps:

a) **Sustained Glucose Release:** Consuming a well-balanced meal rich in complex carbohydrates, such as whole grains, fruits (excluding those high in sugar), and vegetables, provides a sustained release of glucose into the bloodstream throughout dialysis, mitigating the risk of a sudden drop [41].

b) **Protein Considerations:** While protein is essential for overall health, excessive intake can stimulate gluconeogenesis, the process of generating glucose from non-carbohydrate sources like amino acids. This can further deplete glycogen stores and contribute to hypoglycaemia. A balanced protein intake, as recommended by a registered dietitian, is crucial [42].

c) **Individualised Plans:** A personalised approach is essential. A registered dietitian can collaborate with the healthcare team to develop a pre-dialysis meal plan that considers individual needs, preferences, dialysis schedules, and any co-existing conditions, such as diabetes [43].

Key Considerations for Pre-Dialysis Meals

a) **Timing:** Ideally, the pre-dialysis meal should be consumed one to two hours before the dialysis session begins. This allows for proper digestion and absorption of nutrients.

b) **Portion Sizes:** Overeating can lead to blood sugar spikes and subsequent crashes. Moderate portion control is key [44].

c) **Fluid Restrictions:** Patients with ESRD often have fluid restrictions. However, dehydration can exacerbate hyperglycaemia. Consuming fluids according to your doctor's recommendations is crucial for maintaining overall hydration and preventing a potential fluid-electrolyte imbalance [45].

d) **Dialysis Schedule:** The timing and frequency of dialysis sessions will influence meal recommendations. For example, patients undergoing longer dialysis sessions may benefit from a more substantial pre-dialysis meal followed by a smaller post-dialysis snack [46].

Table-03: showing Nutrient importance

Nutrient	Importance	Tips
Protein	Builds and repairs tissues	- Choose lean or low-fat protein sources like chicken, fish, or eggs. - Limit processed meats high in sodium and phosphorus. - Talk to your doctor about the right amount of protein for you.
Sodium (Salt)	Controls blood pressure and fluid balance	Limit added salt and read food labels carefully. Choose low-sodium or "no salt added" options. - Use herbs and spices for flavour instead of salt.
Potassium	Important for muscle function, but too much can be harmful	Some fruits and vegetables are higher in potassium. Discuss with your doctor or dietitian which ones to limit. Consider low-potassium versions of certain fruits and vegetables. - Cooking methods like boiling or roasting can help reduce potassium content.
Phosphorus	Needed for bones, but excess can weaken bones	Limit dairy products, nuts, seeds, and some processed foods. Choose low-phosphate protein sources like chicken or fish. Talk to your doctor about phosphate binders if needed.
Fluids	Maintains hydration, but excess can be a concern	Follow your doctor's recommendation on fluid intake. Count all fluids, including water, beverages, and foods with high water content (soups, fruits).

Adjusting Diabetes Medications

For patients with diabetes who also have ESRD, carefully adjusting diabetes medications is essential for preventing after-dialysis hypoglycaemia. Here's why:

a) **Altered Pharmacokinetics:** Reduced kidney function significantly impacts how the body absorbs, distributes, and eliminates medications. This can lead to unpredictable effects of diabetes medications, potentially increasing the risk of hypoglycaemia [47].

b) **Dialysis Clearance:** Certain diabetes medications, particularly some types of insulin, can be removed from the body during dialysis. This can lead to a rapid drop in blood sugar levels post-dialysis.

Medication adjustment strategies

a) **Healthcare Professional Collaboration:** A nephrologist (kidney specialist) and endocrinologist (hormone specialist) should collaborate to adjust medication dosages based on individual needs, dialysis schedules, and blood sugar monitoring data [48].

b) **Reduced Doses:** Lowering medication dosages, particularly insulin, may be necessary to prevent hypoglycaemia, especially after dialysis.

c) **Alternative Medications:** Healthcare professionals may consider switching to medications less susceptible to dialysis clearance, potentially minimising the risk of post-dialysis hypoglycaemia.

Dialysis Treatment Adjustments

Optimising the dialysis treatment itself can also contribute to preventing after-dialysis hypoglycaemia. Here are some approaches:

a) **Dialysis Duration:** Shortening the duration of dialysis sessions, whenever medically feasible, can minimise glucose loss from the bloodstream. Healthcare professionals will balance the need for adequate dialysis clearance with the risk of hypoglycaemia [49].

b) **Blood Flow Rates:** Reducing blood flow rates during haemodialysis may decrease the rate at which glucose is removed from the bloodstream. However, we must balance this with the need for efficient removal of waste products.

c) **Dialysate Glucose Concentration:** Traditionally, dialysate solutions used in haemodialysis do not contain glucose. However, recent research has explored the use of low-dose glucose-containing dialysate solutions to reduce the risk of hypoglycaemia. Further investigations are ongoing to determine the optimal glucose concentration for dialysate solutions.

Patient education on recognizing and managing hypoglycaemia

Empowering patients and caregivers with knowledge about hypoglycaemia is critical for early detection and effective management. This includes:

a) **Symptom Awareness:** Thorough education concerning the various symptoms of hypoglycaemia, both autonomic (sweating, anxiety, hunger) and neurological (confusion, seizures), is crucial.

b) **Blood Sugar Monitoring:** Patients should be trained on how to properly use a blood sugar metre and interpret the readings [50].

CONCLUSION

Post-dialysis hypoglycaemia (PDH) presents a significant issue for renal specialists since effective care necessitates understanding the causes, diagnosing symptoms, and applying suitable treatments. Recent research has revealed the complex relationship between the body's sugar metabolism, insulin sensitivity, and the dialysis process. This emphasises the significance of various aspects, such as the amount of sugar in the dialysis fluid, the body's insulin clearance, and a patient's nutritional state. Dialysis technique and specific patient characteristics, along with fast sugar elimination during dialysis, all contribute to PDH. However, a patient's sensitivity, poor blood sugar control, and medications can all heighten the risk. Understanding the specific pathways involved in PDH is critical for designing targeted therapeutics and prevention strategies. Recognising PDH symptoms is crucial for taking timely action and preventing problems; unfortunately, some symptoms, such as sweating or dizziness, are ambiguous, making diagnosis difficult. This demands further monitoring by healthcare providers, particularly for people with diabetes and severe kidney disease. Continuous glucose monitoring (CGM) systems are a potential technique for real-time blood sugar tracking, allowing patients and healthcare providers to better manage hypoglycaemia. Addressing PDH requires a multimodal approach that involves optimising dialysis settings, tailoring blood sugar management, and educating patients. Tailoring dialysis prescriptions to reduce blood sugar variations, employing sugar-conserving dialysis procedures, and giving guidelines for adding sugar to dialysis fluid are all important steps towards reducing the risk of hypoglycaemia during and after dialysis sessions. Furthermore, effective PDH management necessitates teamwork among many professionals, including nephrologists (kidney physicians), endocrinologists (diabetes specialists), dietitians, and nurses. Providing patients with information on hypoglycaemia diagnosis, self-monitoring tools, and lifestyle changes is critical for motivating self-care behaviours and improving long-term results. Further research is required to comprehend the fundamental mechanisms of PDH and improve treatment methods, and the integration of technologies like artificial intelligence algorithms and

wearable devices holds potential for enhanced risk prediction and customized management strategies. In essence, a collaborative effort focused on deepening understanding of PDH, fostering interdisciplinary collaboration, and embracing innovative solutions is critical to reducing the burden of hypoglycaemia and improving the quality of life for dialysis patients. By comprehensively addressing all aspects of PDH, nephrologists can work towards a future that minimises hypoglycaemic complications and fosters truly patient-centred and adaptable renal care.

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