Hyperkalemia in Chronic Kidney Disease

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Potassium balance and serum potassium level are maintained until very late in chronic kidney disease (CKD), mainly because of an increase in renal and colonic excretion. Hyperkalemia may develop earlier in the course of CKD in patients with hyporeninemic hypoaldosteronism. Hyperkalemia in CKD patients may occur in association with excess dietary potassium intake, constipation or prolonged fasting. It may also be seen with the use of potassium-sparing diuretics, angiotensin converting enzyme inhibitors, angiotensin receptor blockers, and non-steroidal anti-inflammatory drugs. If suspected, pseudohyperkalemia should be excluded to avoid unnecessary treatments. Acute treatment of hyperkalemia in marked or symptomatic hyperkalemia, particularly in the presence of electrocardiographic changes includes combinations of intravenous calcium gluconate and infusions of glucose and insulin with or without bicarbonate. In patients with kidney failure, dialysis may be required. Either asymptomatic and mild hyperkalemia or chronic hyperkalemia in CKD patients can be treated by potassium restriction, a loop diuretic at high doses, and cation exchange resin.

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sium balance in CKD are reviewed initially. Then clinical management of hyperkalemia including acute and chronic treatment of hyperkalemia in CKD will be discussed. In this review, we will focus on potassium balance and chronic therapy for hyperkalemia in CKD patients.

**Potassium balance in CKD**

1. Renal excretion of potassium

Under normal conditions, the kidney can excrete large quantities of potassium. The daily ingestion of 400 mEq of KCl, which is several-fold greater than the usual daily intake, increases plasma potassium on average by less than 1 mEq/L if renal function is normal and potassium excretion mechanisms are intact. Less than 1% normal healthy adults develop hyperkalemia. This low frequency is a testament to the potent mechanisms for renal potassium excretion. Accordingly, hyperkalemia should suggest an underlying impairment of renal potassium excretion. This may be due to either advanced CKD, which decreases the number of nephron units available for potassium secretion, or to factors that impair the rate of collecting duct potassium secretion.

Approximately two-thirds of the hyperkalemic patients with CKD whose GFR is able to maintain normokalemia manifest the syndrome of hyporeninemic hypoaldosteronism. Hypoaldosteronism, especially when combined with a decrease in GFR and/or a reduction in the delivery of salt and fluid to the distal nephron, can substantially impair renal potassium excretion. As a result of the decline in renin and aldosterone, along with a modest fall in GFR, elderly patients are at increased risk to develop hyperkalemia.

2. Extra-renal excretion of potassium in CKD

The colon also secretes small amounts of potassium. Some regulation of colonic potassium secretion occurs, particularly in CKD stage 4 or 5. Adaptation is detectable when the GFR is reduced to one-third of normal, is maximal at a GFR of less than 10 mL/min, and accounts for 10–20 mEq/day of the potassium elimination. Since uremic patients eliminate potassium via the gastrointestinal tract by as much as 25% of their daily potassium excretion, whereas normal healthy subjects eliminate 5–10% of their intake, the constipation occasionally observed in patients with kidney failure can be one of the sources for inadequate potassium elimination from the body.

Both the proximal and distal portions of the colon secrete potassium. Proximal colon reabsorbs Na+ and secretes K+ predominantly via transcellular mechanisms, but also by a paracellular, voltage-dependent pathway. Aldosterone enhances sodium and potassium transport without effects on either transmural potential difference or short-circuit current. Distal colon can either reabsorb or secrete potassium. Aldosterone also increases Na+ absorption and K+ secretion by this segment together with a raised transmural potential difference. In contrast to proximal colon, these effects are inhibited by amiloride. The enhanced capacity to secrete potassium in response to a high potassium diet is more prominent in the distal colon, whereas the diminution in potassium secretion in response to a low-potassium diet is more prominent in the proximal colon.

3. Redistribution of potassium

Acidosis also results in hyperkalemia due to exchange of intracellular potassium for extracellular hydrogen ions. The increase in the plasma potassium concentration occurs only with not organic acid-induced forms of metabolic acidosis. Hyperglycemia produces hyperkalemia in diabetic patients by the combined effects of hyperosmolarity and insulin deficiency on transcellular potassium distribution.