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PROPER MANAGEMENT OF HYPERKALEMIA IN EMERGENCY MEDICINE

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Abstract:

Hyperkalemia is a typical electrolyte disorder that can result in morbidity and mortality if not managed appropriately. In this review we discuss the importance of management and different approaches in ED. We conducted a narrative review over the literature using electronic databases as; MEDLINE, and EMBASE for studies involving data on Hyperkalemia management in emergency department, published in English language up to 2018. Hyperkalemia is a potentially life-threatening disease that can be difficult to detect as a result of a paucity of unique symptoms and signs. The medical professional must be quick to take into consideration hyperkalemia in patients that are at risk for this disorder procedure. Due to the fact that hyperkalemia can result in sudden death from cardiac arrhythmias, any type of recommendation of hyperkalemia calls for an instant ECG to ascertain whether electrocardiographic indications of electrolyte discrepancy exist.

If the hyperkalemia is known to be serious (potassium > 7.0 mEq/L) or if the patient is symptomatic, start therapy prior to diagnostic investigation of the underlying reason. Embellish therapy based upon the patient's discussion, potassium degree, and ECG.

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INTRODUCTION:

Potassium (K^+) is an electrolyte required to allow regular transmembrane voltage gradients and physiology. A significant concentration gradient for K+ remains in between intracellular and extracellular environments [1]. This gradient enables the establishment of valuable transmembrane voltage gradients and the establishment of activity potentials in" excitable membranes," such as those that exist in skeletal muscle, cardiac muscle mass, smooth muscular tissue, and nerve cells [1], [2].

K+ degrees in the body are controlled largely by the renal system. The kidneys perform 90% of the K+ excretion, with the continuing to be 10% eliminated through the gastrointestinal system [2]. Normal serum K+ level varieties from 3.5- 5.0 mmol/L [2]. Adjustments in these levels may influence transmembrane potentials and therefore, excitable membrane function in all muscle mass and nerve cells. The sodium-potassium-adenosine triphosphatase (Na-K ATPase) pump located in the cell membrane preserves the transmembrane voltage gradient, and this pump proactively delivers salt out and K+ right into the cell [1].

Hyperkalemia prevails among emergency department (ED) patients and can be related to negative end results. Hyperkalemia is specified by serum K+ degree > 5.5 mmol/L. Hyperkalemia can be identified in about 10% of patients confessed from an ED [3]. Moderate hyperkalemia includes K+ degrees of 5.5-6.5 mmol/L, modest hyperkalemia consists of K+ degrees of 6.5- 7.5 mmol/L, and severe hyperkalemia includes K+ degrees ≥ 7.5 mmol/L. Nevertheless, dependence on K+ degrees alone to determine the potential need for therapy is not recommended [2]. Extreme hyperkalemia can be fatal, and rapid medical diagnosis and management are important. The rate at which hyperkalemia accumulated is a crucial variable that influences the seriousness of a hyperkalemic insult to the body's physiology [2], [3].

Hyperkalemia is a typical electrolyte disorder that can result in morbidity and mortality if not managed appropriately. In this review we discuss the importance of management and different approaches in ED.

METHODOLOGY:

We conducted a narrative review over the literature using electronic databases as; MEDLINE, and EMBASE for studies involving data on Hyperkalemia management in emergency department, published in English language up to 2018. keywords were used in our search as following: "Hyperkalemia", "emergency medicine"," treatment" We then reviewed the references lists of included studies to find more relevant articles to be for additional evidence.

DISCUSSION:

- **Clinical Manifestations of Hyperkalemia**

A transformation in K^+ plasma concentration can trigger a number of clinical effects consisting of cardiac, neuromuscular, and metabolic results. Hyperkalemia lowers the transmembrane K+ gradient. This results in cell membrane layer depolarization, reducing of ventricular conduction, and a decrease of the activity prospective period. These modifications lead to electrocardiogram (ECG) symptoms consisting of peaked T waves, widening of the QRS facility, loss of the P wave, and eventually, ventricular fibrillation, which leads eventually to asystole [3], [4]. Traditional modifications are demonstrated in Table 1 [4], [5]. Peaked T waves are a result of relaxing membrane potential changes, which lead to very early excitatory reaction. These T waves are most generally discovered in the precordial leads.

These changes may not appear in step-wise fashion. For instance, Dodge et al. in 1953 located that patients might proceed from normal sinus rhythm directly to ventricular fibrillation [6]. The ECG in hyperkalemia may be changed by several elements. These consist of the serum pH and the serum levels of catecholamines, insulin, calcium, sodium, and osmolality. Changes in serum K+ concentration might not cause ECG changes, and ECG alone is an inadequate tool to discover hyperkalemia, as it shows a level of sensitivity of just 34 - 43% [8]. As a result, medical professionals must not rely solely on the ECG for medical diagnosis, although ECG modifications are more usual when the K+ degree has actually boosted swiftly [9]. Undoubtedly, when the change in the serum K+ has actually happened gradually, this may cause no ECG transformations. For example, serum K+ levels > 9.0 mmol/L might not be connected with the expected ECG transformations after hyperkalemia has accrued much more gradually [9]. ECG discoveries also include sinus bradycardia, right or left bundle branch blocks, and 2nd- or 3rd-degree atrioventricular blocks [10]. QRS prolongation, bradycardia < 50 beats/min, and junctional rhythm are related to unfavorable effects, while peaked T waves are not correlated with clinically significant problems [10]. In patients with pacemakers or implantable cardioverter-defibrillators, problems consist of QRS widening and grew pacer threshold, which can cause failing to

record, oversensing paced or spontaneous T waves, and inappropriate shocks [11].

Hyperkalemia may also result in neuromuscular, gastrointestinal (GI), and metabolic abnormalities. Neuromuscular impacts consist of paresthesias, weak point, and even paralysis [2]. Deep tendon reflexes might be depressed or lacking, though cranial nerves, diaphragm function, and sensation are commonly normal. GI effects consist of nausea, vomiting, and diarrhea. Metabolic perturbations consist of hyperchloremic metabolic acidemia [10].

Table 1. Hyperkalemia ECG Changes [3-5].

Serum Potassium (mmol/L)	Predicted ECG status
5.5-6.5	Tall, peaked T waves with narrow base QT interval shortening ST-segment depression
6.5-8.0	Peaked T waves PR-interval prolongation P wave decreased amplitude or disappearance QRS widening R-wave amplification
>8.5	P-wave absence QRS widening Intraventricular/fascicular/bundle branch blocks Sine wave

ECG Changes of Hyperkalaemia:

- The ECG is one of the most important diagnostic tools in detecting hyperkalaemia
- Predicted ECG changes associated with Hyperkalaemia include

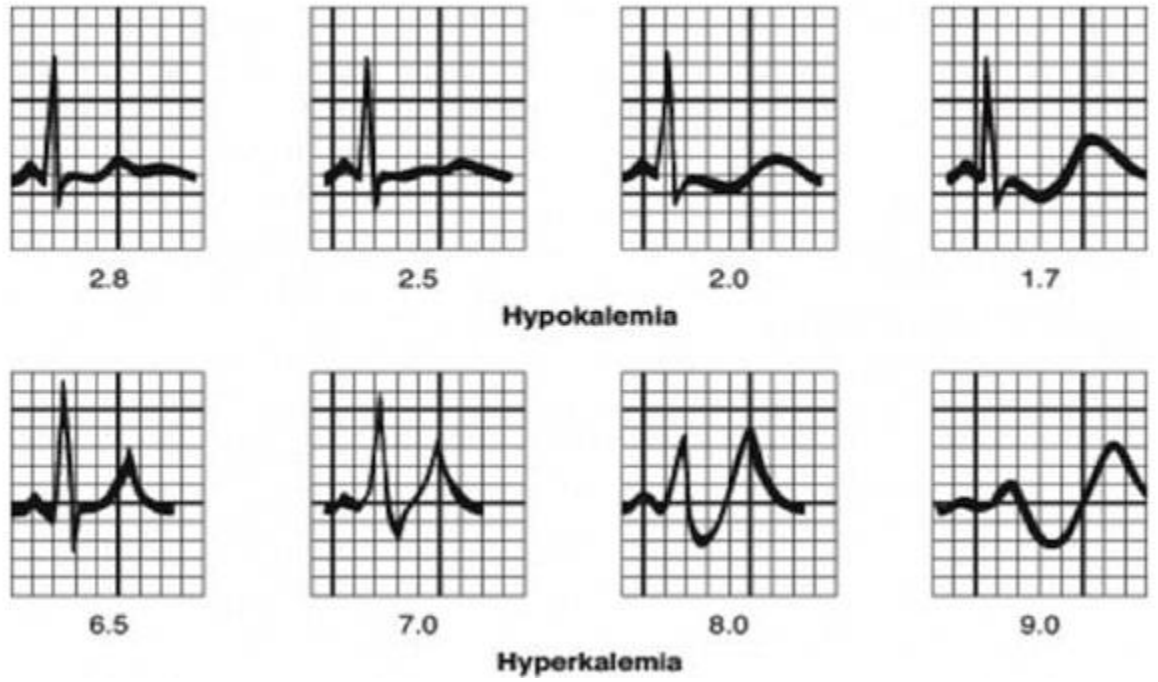

Figure 1. ECG Changes of Hyperkalaemia [7].

- **Treatment of Severe Hyperkalemia**

As a whole, the initial therapy of serious hyperkalemia is independent of the cause of the disruption, whereas the rational therapy of chronic hyperkalemia depends on an understanding of its pathogenesis. In considering when hyperkalemia makes up an emergency situation, a number of factors must be kept in mind. First, the electrophysiologic impacts of hyperkalemia are

directly proportional to both the absolute PK and its rate of increase [12]. Second, concurrent metabolic disruptions might alleviate (e.g., hypernatremia, hypercalcemia, alkalemia) or intensify (e.g., hyponatremia, hypocalcemia, acidemia) the electrophysiologic repercussions of hyperkalemia [13]. Third, although the EKG symptoms of hyperkalemia are generally dynamic and proportional to the PK, ventricular fibrillation might be the first EKG disruption of hyperkalemia; alternatively, a normal EKG may be seen even with extreme hyperkalemia [13].

With this in mind, it is apparent that neither the EKG nor the PK alone is a sufficient index of the seriousness of hyperkalemia, which the medical context needs to be thought about when analyzing a hyperkalemic patient. Hence, any kind of declaration on an outright PK value constituting an emergency has to be viewed as approximate. Nonetheless, since the treatment for acute hyperkalemia is risk-free if used properly and hyperkalemia is possibly and unpredictably lethal, it is prudent to keep a reduced threshold for setting up emergency situation therapy. Because a lot of patients materialize hyperkalemic EKG transformations at PK greater than 6.7 mmol/L, hyperkalemia needs to be dealt with emergently for 1) PK > 6.5 mmol/L or 2) EKG indications of hyperkalemia no matter the PK [14]. Treatment of acute or extreme hyperkalemia is routed at protecting against or relieving its unfortunate electrophysiologic results on the myocardium. The objectives of therapy, in chronologic order, are as follows (Table 2):.

1. Antagonize the effect of K on excitable cell membranes.

2. Redistribute extracellular K into cells.

3. Enhance elimination of K from the body.

Table 2. Emergency treatment of hyperkalemia [15-25]

Agent	**Dose**	**Onset**	**Duration**	**Complications**
1.Membrane stabilization				
Calcium gluconate (10%)	10 mL IV over 10 min	Immediate	30–60 min	Hypercalcemia
Hypertonic (3%) sodium chloride	50 mL IV push	Immediate	Unknown	Volume overload hypertonicity
2.Redistribution				
Insulin (short acting)	10 units IV push, with 25–40 g dextrose (50% solution)	20 min	4–6 hrs	hypoglycemia
Albuterol	20 mg in 4 mL normal saline solution, nebulized over 10 min	30 min	2 hrs	Tachycardia inconsistent response
3.Elimination				
Loop diuretics Furosemide Bumetanide	 40–80 mg IV 2–4 mg IV	15 min	2–3 hrs	Volume depletion
Sodium bicarbonate	150 mmol/L IV at variable rate	Hours	Duration of infusion	Metabolic alkalosis volume overload
Sodium polystyrene sulfonate (Kayexalate, Kionex)	15–30 g in 15–30 mL (70% sorbitol orally)	2 hrs	4–6 hrs	Variable efficacy intestinal necrosis
Hemodialysis		Immediate	3 hrs	Arrhythmias (?)

IV, intravenously.

Membrane Antagonism

Calcium. Calcium directly antagonizes the myocardial results of hyperkalemia without lowering PK [15]. It does so by reducing the threshold possibility of cardiac myocytes, therefore recovering the typical gradient with the relaxing membrane possibility, which is distorted by hyperkalemia [12]. Calcium is helpful also in patients who are normocalcemic. Calcium for injection is offered as the chloride or gluconate salt, both 10% by weight. The preferred agent is the gluconate salt, considering

that it is less likely than calcium chloride to cause tissue necrosis if it extravasates (34). The recommended dose is 10 mL intravenous over 10 mins. The beginning of action is <3 minutes. The EKG ought to be checked constantly. The dose may be repeated in 5 mins if there is no upgrade in the EKG, or if the EKG weakens after an initial enhancement. The duration of action is 30- 60 mins, during which time more actions might be taken on to lower PK [14].

Hypertonic Saline. Intravenous hypertonic sodium chloride has been shown to negate the EKG modifications of hyperkalemia in patients with concurrent hyponatremia [16]. This effect appears to be mediated by a transformation in the electric properties of cardiomyocytes instead of by a reduction in PK [16]. Whether hypertonic saline works in the treatment of eunatremic patients has actually not been established. Until such advantage has actually been demonstrated, making use of hypertonic (3%) saline must be limited to hyponatremic patients with hyperkalemia, with a recognition of the quantity overload that might take place.

Redistribution of Potassium into Cells

Insulin. Insulin reliably reduces PK in patients with end-stage renal condition, confirming its impact to change K right into cells. The effect of insulin on potassium is dose dependent from the physiologic through the pharmacologic array [17]. It is moderated by activation of Na, K-ATPase, evidently by employment of intracellular pump elements right into the plasma membrane. An intravenous dosage of 10 units of routine insulin offered as a bolus along with an intravenous bolus of dextrose (25 g as a 50% solution) to anephric grown-up patients lowers the PK by about 0.6 mmol/L [18]. The start of activity is< 15 mins and the result is optimum in between 30 and 60 minutes after a single bolus [18]. After the first bolus, a dextrose infusion needs to be begun, considering that a single bolus of 25 g of dextrose has actually been revealed to be poor to avoid hypoglycemia at 60 minutes (42). It is interesting to keep in mind that when insulin was provided by constant intravenous infusion for 4 hrs to normal volunteers, PK fell over the very first 90 minutes and increased afterwards [17]. Based upon that observation, there appears to be no advantage of a continual mixture over a bolus injection.

Insulin should be made use of without dextrose in hyperglycemic patients; without a doubt, the reason for the hyperkalemia in those patients might be the hyperglycemia itself [19]. The administration of hypertonic dextrose alone for hyperkalemia is not advised for 2 reasons: initially, endogenous insulin degrees are not likely to rise to the degree necessary for a healing effect; and 2nd, there is a risk of intensifying the hyperkalemia by causing hypertonicity [19].

B-adrenoceptor Agonists. An appreciation for the impact of catecholamines on inner potassium balance recently has been related to the medical clinic. Patients with renal failure given the selective B2-adrenoceptor agonist, albuterol, by intravenous mixture (0.5 mg over 15 minutes) show a substantial decrease in PK (about 1 mmol/L) that is maximal between 30 and 60 mins [20]. Because injectable albuterol is inaccessible in the United States, it is motivating to keep in mind that nebulized albuterol in a high dosage, carried out to patients with end-stage renal ailment, has a comparable result: PK declines by 0.6 mmol/L after breathing of 10 mg of albuterol, and by around 1.0 mmol/L after 20 mg. Note that the effective dosage is at the very least 4 times greater than that commonly used for bronchodilation, although a smaller decrease in PK (regarding 0.4 mmol/L after 60 mins) is seen despite a metered-dose inhaler [20]. The result of high-dose therapy is apparent at 30 mins and lingers for a minimum of 2 hrs [21]. The impact of insulin is additive with that of albuterol, with the combination reported to result in a decrease in PK by concerning 1.2 mmol/L at 60 minutes (42). A lot more recently, subcutaneous terbutaline (7 μg/ kg body weight) has actually been shown to minimize PK in picked dialysis patients by an average of 1.3 mmol/L within 60 minutes [22]. Moderate tachycardia is the most typical reported adverse effects of high-dose nebulized albuterol or terbulatine. Patients taking nonselective B-adrenoceptor blockers will be unlikely to manifest the hypokalemic impact of albuterol. Even amongst patients not taking B-blockers, as many as 40% appear to be resistant to the hypokalemic effect of albuterol [18]. The mechanism for this resistance is unidentified, and there is currently no basis for forecasting which patients will react. For that reason, albuterol needs to never ever be made use of as a solitary agent for the treatment of immediate hyperkalemia in patients with kidney failing.

Elimination of Potassium from the Body

Enhanced Renal Elimination. Hyperkalemia happens most often in patients with kidney insufficiency. Nonetheless, renal K excretion may be improved even in patients with significant kidney disability by increasing the transmission of solute to the distal nephron, the site of K secretion. Research

studies using acetazolamide reveal that bicarbonate delivery to this website in the nephron has a particular kaliuretic result, also in patients with kidney insufficiency [23]. It would certainly be risky to provide acetazolamide alone to many patients with hyperkalemia, since they tend to present with a concomitant metabolic acidosis that would certainly be intensified by the medication. However, a sodium bicarbonate infusion carried out throughout 4- 6 hrs at a rate designed to alkalinize the urine may boost urinary K discharging, and would certainly be preferable specifically in patients with metabolic acidosis [23]. The threat of volume expansion with the bicarbonate mixture can be alleviated by the use loop-acting diuretics, which would certainly be most likely to even more improve the kaliuretic effect. Loop-acting diuretics alone or in mix with a thiazide diuretic will cause a kaliuresis and will certainly be beneficial in the quantity broadened patient. Diureticinduced volume contraction must be avoided hence this will cause lowered distal nephron circulation and decreased K discharging [14].

Dialysis. Hemodialysis is the technique of option for elimination of potassium from the body. PK falls by over 1 mmol/L in the initial 60 mins of hemodialysis and a total of 2 mmol/L by 180 mins, after which it reaches a plateau [25]. Rebound constantly occurs after dialysis, with 35% of the decrease eliminated after an hour and almost 70% after 6 hr; the magnitude of the postrebound PK is proportional to the predialysis PK [24]. There is dispute regarding whether dialysis for severe hyperkalemia precipitates severe ventricular arrhythmias. Due to that opportunity, patients dialyzed for extreme hyperkalemia needs to have continual EKG monitoring [25]. The rate of potassium elimination with peritoneal dialysis is much slower than with hemodialysis. Without a doubt, a lot of the decrement in PK with peritoneal dialysis appears to be because of translocation of potassium right into cells as a result of the glucose load as opposed to extracorporeal disposal. This technique may be used for patients on upkeep peritoneal dialysis that have modest hyperkalemia [25].

CONCLUSION:

Hyperkalemia is a potentially life-threatening disease that can be difficult to detect as a result of a paucity of unique symptoms and signs. The medical professional must be quick to take into consideration hyperkalemia in patients that are at risk for this disorder procedure. Due to the fact that hyperkalemia can result in sudden death from cardiac arrhythmias, any type of recommendation of hyperkalemia calls for an instant ECG to ascertain whether electrocardiographic indications of electrolyte discrepancy exist.

If the hyperkalemia is known to be serious (potassium > 7.0 mEq/L) or if the patient is symptomatic, start therapy prior to diagnostic investigation of the underlying reason. Embellish therapy based upon the patient's discussion, potassium degree, and ECG.

Making use of good sense interpretation of the readily available studies, modest to extreme hyperkalaemia in the emergency situation department should be treated (after confirmation) with Calcium gluconate, favored agent to right away turn around the negative electrophysiologic impacts of hyperkalemia, although hypertonic saline may be made use of in selected scenarios. Insulin is the most reliable agent for translocating K into cells, but B-adrenoceptor agonists offer some fringe benefit in around 60% of patients. Terbutaline may have some utility hereof, but its use has never ever been examined in patients with heart problem. B-adrenoceptor agonists should never ever be utilized without insulin for this function, since around 40% of patients will have no reaction. Sodium bicarbonate appears to have no result to change K right into cells, also after several hours.

Dialysis is the definitive therapy in patients with kidney failure or in whom pharmacologic therapy is not adequate. Any kind of patient with substantially elevated potassium degrees need to go through dialysis, as pharmacologic treatment alone is not likely to effectively reduce the potassium levels in a prompt style. Hemodialysis continues to be one of the most trustworthy tool for removing K from the body in patients with kidney failure.

REFERENCE:

1. Boddy K, King PC, Hume R, Weyers E. The relation of total body potassium to height, weight, and age in normal adults. J Clin Pathol 1972;25:512–7.
2. Mount DB, Zandi-Nejad K. Disorders of potassium balance. In: Brenner and Rector’s The kidney. 9th edn. Philadelphia: WB Saunders & Company; 2011:640.
3. Weisberg LS. Management of severe hyperkalemia. Crit Care Med 2008;36:3246–51.
4. Fisch C. Relation of electrolyte disturbances to cardiac arrhythmias. Circulation 1973;47:408–19.
5. Amal Mattu A, Brady WJ, Robinson D. Electrocardiographic manifestations of

hyperkalemia. Am J Emerg Med 2000;18:721–9.
6. Dodge HT, Grant RP, Seavey PW. The effect of induced hyperkalemia on the normal and abnormal electrocardiogram. Am Heart J 1953;45:725–40.
7. Pasco, J. (2009). Electrolyte Disturbances. In Cameron, P., Et al (Eds), Textbook of Adult Emergency Medicine (pp.447-507).China: Elsiever.
8. Acker CG, Johnson JP, Palevsky PM, et al. Hyperkalemia in hospitalized patients: causes, adequacy of treatment, and results of an attempt to improve physician compliance with published therapy guidelines. Arch Intern Med 1998;158:917–24.
9. Szerlip HM, Weiss J, Singer I. Profound hyperkalemia without electrocardiographic manifestations. Am J Kidney Dis 1986;7: 461–5.
10. Durfey N, Lehnhof B, Bergeson A, et al. Severe hyperkalemia: can the electrocardiogram risk stratify for short-term adverse events? West J Emerg Med 2017;18:963–71.
11. Barold SS, Herweg B. The effect of hyperkalaemia on cardiac rhythm devices. Europace 2014;16:467–76.
12. Fisch C: Relation of electrolyte disturbances to cardiac arrhythmias. Circulation 1973; 47: 408–419.
13. Szerlip HM, Weiss J, Singer I: Profound hyperkalemia without electrocardiographic manifestations. Am J Kidney Dis 1986; 7:461–465.
14. Weisberg LS: Potassium homeostasis. In: Principles and Practice of Medical Intensive Care. Carlson RW, Geheb MA (Eds). Philadelphia, Saunders, 1993.
15. Semple P, Booth C: Calcium chloride; a reminder. Anaesthesia 1996; 51:93.
16. Ballantyne F III, Davis LD, Reynolds EW Jr, et al: Cellular basis for reversal of hyperkalemic electrocardiographic changes by sodium. Am J Physiol 1975; 229:935–940.
17. DeFronzo RA, Felig P, Ferrannini E, et al: Effect of graded doses of insulin on splanchnic and peripheral potassium metabolism in man. Am J Physiol 1980; 238: E421–E427.
18. Allon M, Copkney C: Albuterol and insulin for treatment of hyperkalemia in hemodialysis patients. Kidney Int 1990; 38:869–872.
19. Goldfarb S, Cox M, Singer I, et al: Acute hyperkalemia induced by hyperglycemia: Hormonal mechanisms. Ann Intern Med 1976; 84:426–432.
20. Montoliu J, Lens XM, Revert L: Potassiumlowering effect of albuterol for hyperkalemia in renal failure. Arch Intern Med 1987; 147: 713–717 .
21. Allon M, Dunlay R, Copkney C: Nebulized albuterol for acute hyperkalemia in patients on hemodialysis. Ann Intern Med 1989; 110: 426–429.
22. Sowinski KM, Cronin D, Mueller BA, et al: Subcutaneous terbutaline use in CKD to reduce potassium concentrations. Am J Kidney Dis 2005; 45:1040–1045.
23. Kamel KS, Ethier JH, Quaggin S, et al: Studies to determine the basis for hyperkalemia in recipients of a renal transplant who are treated with cyclosporine. J Am Soc Nephrol 1992; 2:1279–1284.
24. Zehnder C, Gutzwiller JP, Huber A, et al: Low-potassium and glucose-free dialysis maintains urea but enhances potassium removal. Nephrol Dial Transplant 2001; 16: 78–84.
25. Ahmed J, Weisberg LS: Hyperkalemia in dialysis patients. Semin Dial 2001; 14:348–356.