Hypokalemia in Chinese Peritoneal Dialysis Patients: Prevalence and Prognostic Implication

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• ***Background:*** **Abnormal potassium metabolism may contribute to the increased cardiac morbidity and mortality seen in dialysis patients. We studied the pattern of serum potassium levels in a cohort of Chinese peritoneal dialysis (PD) patients.** ***Methods:*** **We studied serum potassium levels of 266 PD patients during 3 consecutive clinic visits. Dialysis adequacy, residual renal function, and nutritional status also were assessed. Patients were followed up for 33.7 ± 20.7 months.** ***Results:*** **Mean serum potassium level was 3.9 ± 0.5 mEq/L (mmol/L). Five patients (1.9%) had an average serum potassium level less than 3 mEq/L (mmol/L), whereas 54 patients (20.3%) had a serum potassium level less than 3.5 mEq/L (mmol/L). Serum potassium levels correlated with overall Subjective Global Assessment score ($r = 0.276$; $P < 0.001$) and serum albumin level ($r = 0.173$; $P = 0.005$) and inversely with Charlson comorbidity score ($r = -0.155$; $P = 0.011$). There was no correlation between serum potassium level and daily PD exchange volume, total Kt/V, urine volume, or residual glomerular filtration rate. By means of multivariate analysis with Cox proportional hazard model to adjust for confounders, serum potassium level was an independent predictor of actuarial patient survival. PD patients with hypokalemia (serum potassium < 3.5 mEq/L [mmol/L]) had significantly worse actuarial survival (hazard ratio, 1.79; 95% confidence interval, 1.12 to 2.85; $P = 0.015$) than those without hypokalemia after adjusting for confounding factors.** ***Conclusion:*** **Hypokalemia is common in Chinese PD patients. Serum potassium level was associated with nutritional status and severity of coexisting comorbid condition. Furthermore, hypokalemia was an independent predictor of survival in PD patients. Additional studies may be needed to investigate the benefit of potassium supplementation for PD patients with hypokalemia.** ***Am J Kidney Dis*** **46:128-135.**

INDEX WORDS: Peritoneal dialysis (PD); continuous ambulatory peritoneal dialysis (CAPD); nutrition; cardiovascular disease.

PERITONEAL DIALYSIS (PD) is the treatment modality of 14% of the world's dialysis population.[1] Although the efficacy of potassium removal by PD is low, PD patients more commonly are hypokalemic than hemodialysis patients.[2] Hypokalemia is found in 10% to 36% of PD patients.[2-5] For example, Oreopoulos et al[3] reported that 10% to 15% of PD patients required potassium supplementation for hypokalemia. Spital and Sterns[4] noted that 36% of PD patients had a serum potassium level less than 3.5 mEq/L (mmol/L) at some time during their course and 20% required potassium supplementation.

Cellular uptake and bowel loss probably have important roles in the pathogenesis of hypokalemia. Muscle biopsy studies showed that muscle potassium content was increased in PD patients, presumably reflecting intracellular uptake.[6] However, ongoing losses of potassium in dialysate are an important contributing factor to hypokalemia. This is compounded further by poor nutritional intake, particularly of such potassium-rich foods as fruits and vegetables. For example, avoidance of fruits and vegetables as a result of ethnocultural food preference has been ascribed as the cause of the high prevalence of hypokalemia in the black race.[2] Although a traditional Chinese diet is rich in vegetables, the method of cookery involves extensive boiling and frying, resulting in a substantial reduction in potassium content in the dishes served. A recent survey in Hong Kong indicated that the average dietary potassium intake of elderly subjects with normal renal function taking a traditional Chinese diet was only 30 to 40 mmol/d.[7] Nevertheless, the prevalence of hypokalemia in Chinese PD patients has not been reported, and the long-term

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implication of hypokalemia in PD patients has not been studied.

METHODS

Patient Selection

We studied 266 unselected Chinese PD patients in the dialysis unit of a single university hospital in Hong Kong from April to June 1999. Baseline data, including age, sex, underlying renal disease, duration of dialysis, PD regimen, and time on dialysis therapy, were recorded. Because excessive glucose load could cause hyperinsulinemia, resulting in a transcellular shift of potassium, we further recorded use of a hypertonic PD exchange, defined as a glucose concentration of 2.27% or more. Total daily exposure to glucose was calculated further from the dialysis regimen as described by Davies et al.[8] Comorbid conditions, including coronary artery disease, heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disorder, peptic ulcer disease, liver disease, diabetes with and without complications, hemiplegia, malignancy, and acquired immunodeficiency syndrome, also were recorded. The modified Charlson Comorbidity Index, which was validated in PD patients,[9] was used to calculate a comorbidity score. Results of a peritoneal equilibration test (PET), usually performed a month after the initiation of PD therapy, also were reviewed.

Detection and Management of Hypokalemia

Serum potassium level was measured by means of a conventional method 3 times within 12 weeks. Hypokalemia is defined as an average serum potassium level less than 3.5 mEq/L (mmol/L). Use of medications that might affect potassium balance, including diuretics, potassium supplements, and angiotensin-converting enzyme (ACE) inhibitors, also were recorded. For the convenience of analysis, only long-term potassium supplementation was counted. In general, we aimed to keep serum potassium levels greater than 3.5 mEq/L (mmol/L) in our patients. Patients with hypokalemia generally were treated with supplemental doses of oral potassium chloride, typically 20 to 40 mmol/d for 1 to 3 days, followed by dietary advice to increase fresh fruit and vegetable intake.

Nutritional Assessment and Clearance Study

Nutritional status was assessed by means of Subjective Global Assessment (SGA), normalized protein nitrogen appearance (nPNA), anthropometric lean body mass (LBM), serum albumin level, and fat-free edema-free body mass (FEBM). SGA was performed by trained observers who were blinded to biochemical results of patients. The 4-item 7-point system was used.[10,11] The 4 items for assessment were change in body weight, degree of anorexia, amount of subcutaneous tissue, and muscle mass. The 4 individual item scores were combined to generate a global score, which also took into account the clinical judgment of the observers and thus did not represent the simple arithmetic aggregate of the 4 individual item scores. All SGA items were rated subjectively on a scale from 1 to 7, in which 1 or 2 is severe malnutrition, 3 to 5 is moderate to mild malnutrition, and 6 or 7 is mild malnutrition to normal nutritional status.[10]

Anthropometric measurements were performed by trained observers. Measurements included biceps, triceps, subscapular, and suprailiac skinfold thickness. Anthropometric LBM was computed using the formula described by Durnin and Rahaman.[12] Interobserver coefficient of variation of LBM was approximately 10%.

Routine serum biochemical tests were performed at the baseline study. Serum albumin level was measured using the bromcresol purple method. FEBM was calculated from 24-hour urine and dialysate biochemistry according to the formula described by Forbes and Brunining.[13] nPNA was calculated using the modified Bergstrom formula[14] and normalized by ideal body weight, which was determined by means of body height and sex according to a standard formula validated in southern Chinese patients.[15] Kt/V and weekly creatinine clearance were determined by using standard methods.[16] Residual glomerular filtration rate (GFR) was calculated as the average of 24-hour urinary urea and creatinine clearance, as described.[17]

Clinical Follow-Up

All patients were followed up until June 2004 (ie, up to 60 months). Clinical management and dialysis regimen were decided by individual nephrologists and not affected by the study. Clinical outcome in this study is actuarial patient survival. Censoring events for survival analysis include transfer to long-term hemodialysis therapy, kidney transplantation, loss to follow-up, and transfer to other dialysis centers.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows software, version 11.0 (SPSS Inc, Chicago, IL). Results are expressed as mean $\pm$ SD unless otherwise specified. Comparisons between parameters were performed using chi-square test, Student *t*-test, or Pearson correlation coefficient, as appropriate. *P* less than 0.05 is considered statistically significant. All probabilities are 2 tailed.

Actuarial survival between patients with and without hypokalemia (defined as serum potassium level $<$ 3.5 mEq/L [mmol/L]) was compared by using log-rank test. The Cox proportional hazards model was used further for statistical analysis of serum potassium level on actuarial patient survival.[18] For survival analysis, all patients who remained alive and on PD therapy at the end of the study were administratively censored on June 30, 2004. In addition to serum potassium level, the Cox models were constructed by age, time on dialysis, diabetic status, Charlson comorbidity score, overall SGA score, serum albumin level, anthropometric LBM, total Kt/V, nPNA, FEBM, and residual GFR. These parameters were selected for construction of the Cox model because of their importance in determining patient survival according to previous studies. The analysis was repeated to compare patients with and without hypokalemia, rather than actual serum potassium level.