Ventricular arrhythmias and serum potassium: is there a correlation in the arrhythmic patient?[1]

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Twenty-four hour electrocardiographic (ECG) recordings of 50 normokalemic patients with documented repetitive ventricular arrhythmias were reviewed retrospectively for the incidence and frequency of premature ventricular contractions, ventricular couplets, and runs of ventricular tachycardia. Serum potassium levels obtained in close temporal proximity to these recordings were examined. Only single premature ventricular beats correlated with low-normal serum potassium, and there was no association between repetitive ventricular ectopy and serum potassium level. Though serum potassium variations in the normokalemic range were not related to arrhythmia frequency, prospective studies of larger groups of patients are indicated.

Index terms: Arrhythmia, ventricular • Potassium
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Considerable controversy has surrounded the clinical significance of normokalemic variations in serum potassium and the use of potassium salts in the treatment of repetitive ventricular arrhythmias. Patients for whom the resolution of this controvery would have great potential benefit are those who, though normokalemic, suffer from repetitive ventricular ectopy irrespective of etiology. We know of no reported retrospective or prospective attempt to find an association between serum potassium and incidence of ventricular arrhythmias in this population. Since such an association would provide some support for the addition of potassium supplements to the therapeutic regimen of these patients, we reviewed one year's experience in our arrhythmia monitoring unit.

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Methods

Only patients with electrocardiographic (ECG) documentation of repetitive ventricular ectopy (couplets, triplets, longer runs of ventricular tachycardia) who were admitted to the Cleveland Clinic Hospital's arrhythmia unit in 1982 were included. Other inclusion criteria were a 24-hour Holter ECG recording done during the first 6 days in the unit and a serum potassium done in the same period. Patients were excluded if they had a serum potassium below 3.5 mEq/L, a serum creatinine above 2.0 mg/dl, or if they were suffering from an acute illness (myocardial infarction, pulmonary embolus, cardiogenic shock, pulmonary edema, respiratory insufficiency, and acidotic states).

Serum potassium levels were obtained by flame photometry. Twenty-four hour Holter ECG recordings were computer-scanned and overread by a physician. The Holter recording and the serum potassium done in closest proximity to one another during the initial 6 day period were chosen, and the number of runs of ventricular tachycardia, number of ventricular couplets, and premature ventricular contractions (PVCs) were recorded as well as the serum potassium values. The number of patients taking diuretics and potassium supplements during the three months preceding entry into the unit and while in the unit was also recorded as well as the type of heart disease and other medical therapy.

The distribution of ventricular tachycardia runs and ventricular couplets was skewed so that many subjects did not have one or the other of these arrhythmias. The patients were therefore divided according to whether or not they had experienced ventricular tachycardia and again according to whether or not they had ventricular couplets. The median serum potassium levels in the patients with either of these arrhythmias were compared with the median potassium levels in those without them by a Wilcoxon rank sums test with a 5% significance level. Since premature ventricular contractions were distributed in a less skewed fashion than in the more complex forms of ectopy, a more appropriate test, the Spearman rank correlation, could be used to uncover any association between potassium level and premature ventricular beats. To ensure that any association between these two variables was not spuriously introduced by the choice of statistical test, the Wilcoxon rank sums test was also performed for the mean potassium levels of subjects with premature ventricular beat frequency above and below the median value.

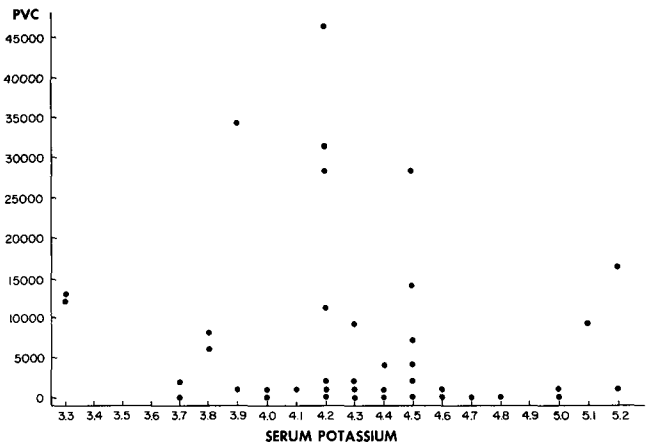
Results

Of 420 patients admitted to the arrhythmia unit, 50 fulfilled the criteria for inclusion in the study. There were 37 men and 13 women. The mean age was 59 years. The primary cardiac diagnoses were coronary artery disease (37, 3 with ventricular aneurysm), congestive cardiomyopathy (6), valvular heart disease (3), hypertrophic cardiomyopathy (1), and no heart disease (3). During the three months prior to their entry into the unit, 24 patients (48%) were taking diuretics, and 12 (24%) were taking potassium supplements. After admission to the unit only 13 (26%) and 8 (16%), respectively, were taking these medications. The most common anti-arrhythmic and cardioactive agents used in the unit were lidocaine, digitalis, procainamide, and mexiletine. Less frequently used agents included quinidine, amiodarone, and beta blockers. There was a mean of 1.26 days between the serum potassium determination used for the study and the start of Holter monitoring. The mean, median, standard deviation, and range of all of the pertinent variables are tabulated in *Table 1.* The relationship between serum potassium levels and incidence of ventricular tachycardia and ventricular couplets is shown in *Table 2.* No significant difference in mean potassium was found in the groups with and without ventricular tachycardia or in the groups with and without ventricular couplets.

The *Figure* illustrates the relationship between the number of premature ventricular contractions and serum potassium level. The Spearman rank test found a significant inverse relationship between these two variables ($r = -0.34$, $p = 0.02$). This correlation persisted when the calculations were repeated to include only patients with serum potassium levels above 3.8 mEq/L. The Wilcoxon rank sum test also showed a significant inverse correlation between these variables ($p = .04$).

Discussion

Our study sample of 50 patients was only large enough to demonstrate univariate associations, and, because of small numbers, no statement can be made about the relationship between arrhythmia incidence and use of diuretics or potassium supplements. The significant finding in this



Dots show the serum potassium (abscissa) and the number of premature ventricular contractions (PVCs) (ordinate) in a 24-hour period for each of 50 patients. A significant inverse relationship is evident.

group of patients with documented repetitive ventricular ectopy is that only single PVCs and not repetitive ventricular ectopy correlated with low-normal serum potassium. The tendency to discontinue potassium orders upon admission to the arrhythmia unit indicates that potassium was not used as a supplementary form of antiarrhythmic therapy.

Investigations of postcardiac surgery patients have also failed to demonstrate any correlation between serum potassium and the incidence of repetitive ventricular arrhythmias.[1,2] Nevertheless, vigorous potassium supplementation has been encouraged in postoperative subjects in order to prevent arrhythmias.[3] It is argued that demonstrated urine potassium losses make these patients susceptible to ventricular ectopy regardless of serum levels, although there is no experimentally verified correlation between dysrrhythmias and hyperkaluria. Most studies of acute myocardial infarction victims have produced data supporting a correlation between repetitive ventricular arrhythmias and low or low-normal potassium levels,[4–7] although there have been some conflicting reports.[8,9] Many of the reports of such a correlation included cases of serum potassium determinations after prolonged resuscitation from cardiac arrest. The gross metabolic derangements caused by circulatory arrest and resuscitation negate the value of correlating postarrest serum potassium levels with the arrhythmias causing the arrest. Holland et al[10] prospectively demonstrated a correlation between hypokalemia and single PVCs in individuals without a history of heart disease and without repetitive ventricular arrhythmias. Using 24-hour Holter recordings, they found an increase in premature ventricular contractions after diuretic-induced hypokalemia in 7 of 21 normokalemic hypertensives, and a return to baseline cardiac rhythm after normokalemia had been restored with spironolactone in the same 7 patients. This group of responders was small, and no significant change in the incidence of repetitive ventricular arrhythmias was demonstrated. By using spironolactone instead of potassium supplementation to restore normokalemia, these authors overlooked the possibility of an independent antiarrhythmic effect of this diuretic. Though the study thus failed to prove any antiarrhythmic benefit of potassium supplementation, it did provide some support for a hypokalemic etiology of single PVCs in this hypertensive population. Even if potassium were effective in reducing the incidence of these common and benign forms of ectopy,[11] the risk involved in its routine use might not be justified.[12]

Table 2. Mean potassium in those with and without repetitive ventricular ectopy

Ventricular tachycardia runs	Sample size	Mean potassium (mEq/L)	P-value
=0	26	4.35	0.30
>0	24	4.40	...
Couplets	*Sample size*	*Mean potassium (mEq/L)*	*P-value*
=0	19	4.44	0.44
>0	31	4.33	...

Table 1. Description of study variables

Variable	N	Mean	Median	Standard deviation	Range
PVC	50	6225	1208	10353	2–45573
Couplets	50	202	12	594	0–3992
Ventricular tachycardia runs	50	98	0	542	0–3826
Potassium, mEq/L	50	4.37	4.35	0	3.3–5.3

PVC = premature ventricular contraction.

Our retrospective analysis suggests that single premature ventricular contractions are more common in subjects with low-normal serum potassium, but that more malignant ventricular ectopy does not correlate with serum potassium in individuals with a history of documented repetitive ventricular arrhythmias. Though these results do not support the routine use of potassium supplementation for repetitive ectopy, they certainly do not negate a potential therapeutic effect, since the administered potassium is largely distributed in the intracellular compartment and may not be reflected in the serum level.[13] Furthermore, the problems inherent in retrospective analyses and the enormous spontaneous variability of ventricular arrhythmias[14,15] make the confirmation of an antiarrhythmic effect of potassium supplements exceedingly difficult without randomized prospective therapeutic trials. Such a planned prospective investigation will begin at our institution in the near future.

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