Transmural ventricular heterogeneities play a major role in determining T-wave morphology at different serum potassium levels

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Background and aim: End-stage renal disease (ESRD) affects more than 10% of the population. ESRD patients present impaired potassium homeostasis, which increases the risk for ventricular arrhythmias and sudden cardiac death. Preventive, noninvasive estimation of serum potassium, $[\mathrm{K}^+]$, is therefore of major importance. We investigated three T-wave morphological descriptors, assessed their relationship with $[\mathrm{K}^+]$and ascertained mechanisms responsible for their large inter-individual differences.

Methods: Electrocardiograms (ECGs) of twelve ESRD patients undergoing hemodialysis and ECGs calculated from simulated ventricular fibers were processed to quantify the T-wave width (T_w), slope-to-amplitude ratio (T_SA) and temporal morphological variability (d_w). $[\mathrm{K}^+]$ was measured at different time points during hemodialysis and simulated from 2 to 8 mmol/l in the modeled ventricular fibers.

Results: In ESRD patients, T_w, T_SA and d_w were closely related with $[K^+]$ during hemodialysis, with median Spearman correlation coefficients of -0.5, 0.8 and 0.65, respectively. However, the pattern of such relationships depended highly on the characteristics of each patient. This variability, more manifest at high $[\mathrm{K}^+]$, was reproduced in the simulations. Simulated descriptors were highly sensitive to the proportion of mid-myocardial cells, with 10% variations in this proportion leading to more than 15% changes in the T-wave descriptors.

Conclusions: Changes in $[\mathrm{K}^+]$ have remarkable effects on T_w, T_SA and d_w, but the pattern of the relationship is highly patient-dependent, particularly under elevated $[\mathrm{K}^+]$. Differences in the proportion of mid-myocardial cells may play a role in explaining such inter-individual variability.