Potassium Monitoring from Multilead T-wave Morphology Changes during Hemodyalisis: Periodic versus Principal Component Analysis

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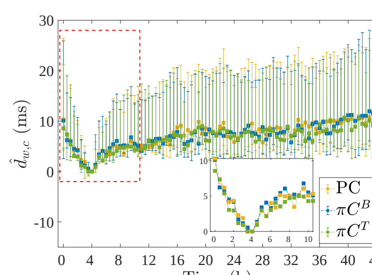
Background: End-stage renal disease (ESRD) patients undergoing hemodialysis (HD) experience blood potassium variations ($\Delta[K^+]$) reflected on the T-wave (TW) morphology. In a previous work, we applied principal component analysis (PCA) as the lead space reduction (LSR) technique to extract three markers of TW morphology changes (d_w^u, d_w and $\hat{d}_{w,c}$). However, periodic component analysis (πCA), computed using samples from the QRST complex, πCA^{B}, or using the TW only, πCA^{T}, might outperform PCA in tracking TW changes in ESRD-HD patients. The aim of this study was to compare the impact of using PCA, πCA^{B} or πCA^{T} as in prior to extracting d_w^u, d_w and $\hat{d}_{w,c}$.

Methods: We applied the three LSR techniques to 12-lead 48 h electrocardiogram (ECG) recordings from 24 ESRD-HD patients. We, next, derived the markers from the PCA, πCA^{B}- and πCA^{T}-transformed lead with the highest TW energy. Each marker was calculated by comparing an average TW derived every 30 min with that at the end of the HD. To assess the agreement among each LSR-specific marker, we used Bland-Altman plots. Finally, we used the fitting error (ϵ) to quantify the dispersion of each LSR-specific marker from a regression line (when $\Delta[K^+]$ is considered linear).

Results: The three series, d_w^u, d_w and $\hat{d}_{w,c}$ (Figure), derived after using the three LSR techniques, followed $\Delta[K^+]$ along the 48 h (the first 5 h correspond to the HD). They also showed a good degree of agreement (median bias values $\leq$ 0.5 ms) and a small dispersion (median $\epsilon \leq$ 3.3 ms).

Conclusions: PCA and πCA can be used interchangeably to track TW changes in ESRD-HD patients.



Temporal evolution of $\hat{d}_{w,c}$, one of the proposed markers, measured from the transformed lead using PCA (orange), πCA^{B} (blue) and πCA^{T} (green). Boxplots represent median and IQR values across patients. The detailed view (median only) focuses on the first 10 hours (red dashed rectangle).