Weighted Time Warping T-wave Analysis Robust to Delineation Errors: Clinical Implications

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Background: The T-wave (TW) morphology has been extensively investigated to develop specific markers of risk. However, TW boundaries delineation errors may jeopardise the diagnostic ability of TW-based morphological markers, like d_w, which quantifies the level of warping needed to temporally align a studied TW with respect to a reference one. To reduce the impact of these errors on the d_w calculation, we proposed and tested two TW-based weighting functions (WFs).

Materials and Methods: The two proposed WFs were (i) the reference TW ($\mathcal{T}$), and (ii) the absolute value of its first-derivative ($\mathcal{D}$). We, first, simulated TW boundaries delineation errors by shortening and widening two TWs with morphological variability. We, then, used the variation ratio ($\mathcal{R}$) to compare d_w derived applying the two WFs with that obtained in the control case (no weighting, $\mathcal{C}$). Next, we compared the ability of d_w, with and without WFs, in monitoring blood potassium concentration changes ($\Delta[K^+]$) by means of the Pearson's correlation (r) in 29 48-hour Holter recordings from hemodyalisis (HD) patients.

Results: The simulations showed that the $\mathcal{R}$ values for the two studied TWs, respectively, were 0.17 and 0.19 for $\mathcal{C}$, 0.05 and 0.08 for $\mathcal{T}$ and 0.07 and 0.10 for $\mathcal{D}$, indicating that both WFs reduce the effects of TW boundaries delineation errors. However, similar r median [interquartile range] values were found for $\mathcal{C}$ (0.90 [0.27]), $\mathcal{T}$ (0.90 [0.25]) and $\mathcal{D}$ (0.90 [0.29]) in the HD dataset, suggesting that the effects of TW boundaries delineation errors were small enough not to affect the d_w ability for $\Delta[K^+]$ monitoring.

Conclusions: Using WFs to compute d_w reduces the effects of TW boundaries delineation errors, but no improvements in $\Delta[K^+]$ monitoring in HD patients were observed. WFs impact on d_w risk prediction value remains to be evaluated.