KU MEDICAL CENTER
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# A NOVEL SIGNAL PROCESSING METHOD TO FILTER OUT PACING ARTIFACTS FROM ECG

***Improving Calculation of QRS Voltage Time Integration After CRT***

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## Background

- QRS 3D voltage time integral ($VTI_{QRS-3D}$) or QRS area is a novel marker of cardiac resynchronization therapy (CRT) response.
- Automated measurement of VTI from 12-lead ECG in patients receiving CRT is disrupted by pacing artifacts occurring within the QRS.
- We devised a two-step novel filter to eliminate pacing artifacts.

## Methods

- First, the novel filter finds the non-outlier peak within the QRS (peak below 98$^{th}$ percentile of the modified Z-score of detrended data plus 40). The outlier data above this value is deleted and the gap is filled with a hyperbolic cosine function. Subsequently, a median filter is applied to eliminate low level noise.
- We studied 90 ECGs with pacing artifacts within the QRS, and 90 normal ECGs without pacing artifacts as controls (Figure). We compared absolute change in $VTI_{QRS-3D}$ using pairwise t-tests.

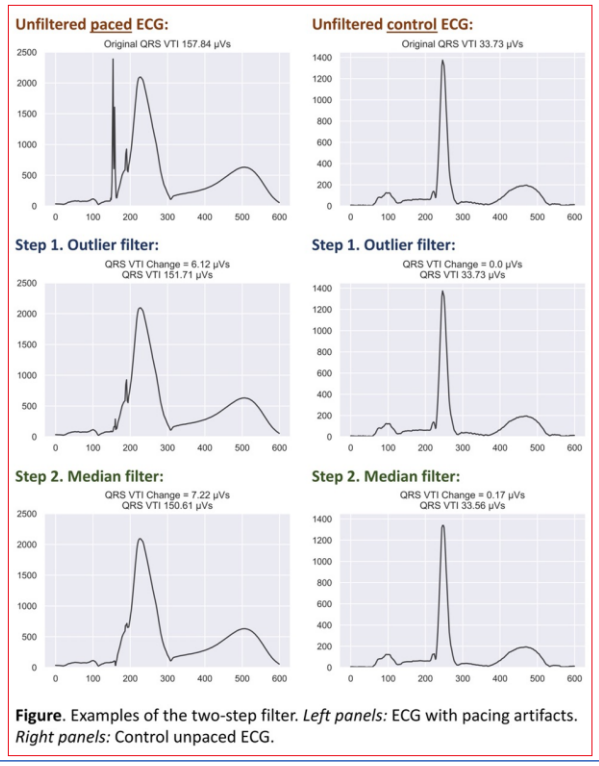


**Figure**. Examples of the two-step filter. *Left panels:* ECG with pacing artifacts. *Right panels:* Control unpaced ECG.

## Results

- In the paced group, the unfiltered $VTI_{QRS-3D}$ was 67.9 ± 32.7 µVs and decreased with outlier filtering to 67.2 ± 32.5 µVs (p=0.001).
- In the unpaced control group, the outlier filter did not affect VTIQRS-3D (both 41.8 ± 10.4, p=0.7).
- With subsequent median filtering, the paced $VTI_{QRS-3D}$ slightly changed to 67.6 ± 32.5 ($p=1x10^{-9}$) and the control $VTI_{QRS-3D}$ to 41.4 ± 10.4 ($p=2x10^{-6}$).

## Conclusion

**Our novel outlier filter is precisely able to remove and backfill pacing artifacts that distort the ECG, without impacting the true ECG signal.**

**This improves accurate automated processing of ECGs in patients receiving CRT.**

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