Estimation of Systemic vascular resistance from Peripheral pulse waveforms using *In Silico* and real data

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Aims: Peripheral pulse waves contain rich hemodynamic information and can be acquired noninvasively with ease. However, estimating systemic vascular resistance from peripheral waveform morphology remains challenging because vascular resistance is influenced by multiple interacting cardiovascular factors. *In Silico* pulse wave databases provide a controlled framework for developing waveform-based resistance models, but external validation in real-world recordings is essential for clinical translation. Therefore, we investigated whether pulse wave models trained on a virtual database can capture resistance-related variation in Mobil-O-Graph waveform data.

Methods: Four waveform-based models were developed using the in silico Pulse Wave Database (PWDB) to estimate systemic vascular resistance (SVR) from brachial and radial pressure waveforms: ridge regression, elastic net, support vector regression, and an optimized multilayer perceptron. For external validation, peripheral pulse wave images from Mobil-O-Graph recordings were processed to extract beat-level waveforms, from which segment-level median templates were constructed. Each median template was then amplitude-calibrated using the corresponding systolic and diastolic blood pressure values to generate pressure-scaled waveforms. The calibrated Mobil-O-Graph templates were subsequently input into the PWDB-trained models to obtain predicted SVR values, which were compared with device-derived total vascular resistance (TVR) to assess external agreement.

Results: Among the four regression models, elastic net showed the best overall agreement with device-derived TVR. The mean difference between predicted_SVR_z and TVR_z was near zero, indicating minimal bias. The median z-score difference was 0.035, with MAE_z of 0.955, RMSE_z of 1.219, and median absolute z-difference of 0.809. In threshold-based analysis, 32.9% of segments were within 0.5 SD, 60.8% within 1.0 SD, 80.4% within 1.5 SD, and 89.3% within 1.96 SD. These findings suggest that the PWDB-derived elastic net model captured resistance-related variation in Mobil-O-Graph waveforms with moderate but consistent agreement with TVR.

Conclusion: Elastic net best captured resistance-related variation, supporting translational use of PWDB-trained models in Mobil-O-Graph waveforms.