Elimination of the Respiratory Effect on the Thoracic Impedance Signal with Whole-body Impedance Cardiography

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Introduction: We are presenting technology for elimination of the respiratory effect on the thoracic impedance signal and stroke volume computing beat-to-beat. We used a multichannel bioimpedance monitor to measure the impedance signal from the thorax, neck and extremities simultaneously. Thoracic impedance cardiography (TIC) is a widely-used method for noninvasive stroke volume computation. Unfortunately, breathing not only modulates systemic blood pressure, but also strongly affects the impedance signal (IS). Consequently, we measure an artificial variability. In such circumstances it is not possible to evaluate stroke volume beat-to-beat, and averaging over a larger number of heartbeats is necessary. TIC provides completely incorrect results in the case of the Valsalva or Mueller maneuver.

Methods: We used measurements with 18 simultaneously scanning impedance signal locations, each left and right: carotid artery, chest, thigh, calf, abdomen and the abdominal artery, the upper part of the chest, arm, forearm, and the chest at the level of the heart. Simultaneously with IS, we also recorded 12-lead ECG, continuous blood pressure, phonocardiography, and breathing rate and depth. We filtered IS in the pass band 0.514 Hz. We detected maxima dZ/dtmax from negative derivative IS. We obtained a time series of maxima from the thorax, neck and extremities. Elimination of breathing is based on the assumption that neck and limb IS measures only the variability in systemic blood pressure and is not affected by respiration.

Results: Mean -dZ/dtmax variability (six subjects) from thorax = 100%, neck 60, arm 57, forearm 31, thigh 64, calf 31. Respiration increases the variability of

-dZ/dtmax parameter from thorax 1.7 times in comparison with neck, forearms and thigh.

Conclusion: Whole-body IS measurements and processing reflect changes in the hemodynamic system not affected by respiration. By using retrospective reconstruction we can eliminate the influence of respiration on the impedance signal from the chest.