

# Wireless Non-Invasive Cardiovascular Reactivity Measurement

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## INTRODUCTION

INTRODUCED is a wireless, multi-variable, recording system for the purposes of physiological research and education. Measurement variables include ECG, EEG, EGG, EOG, EMG, Skin Temperature, Respiratory Effort, Electrodermal Activity, Pulse Plethysmography, Tri-axial Acceleration, Radial Velocity and Impedance Cardiography. The system was evaluated for performance when ensemble averaging impedance cardiograms for the purpose of determining cardiovascular reactivity to stress.

## MATERIALS AND METHODS

The BIOPAC Systems "BioNomadix" series of wireless physiological transmitters were used for the evaluation. Two transmitters were used, ECG/Respiration and Non-Invasive Cardiac Output. The variables recorded were Respiratory Effort, ECG, Thoracic Impedance (Z), Derivative of Thoracic Impedance (dZ/dt). Derived variables were BPM and dZ/dt maximum. All data was

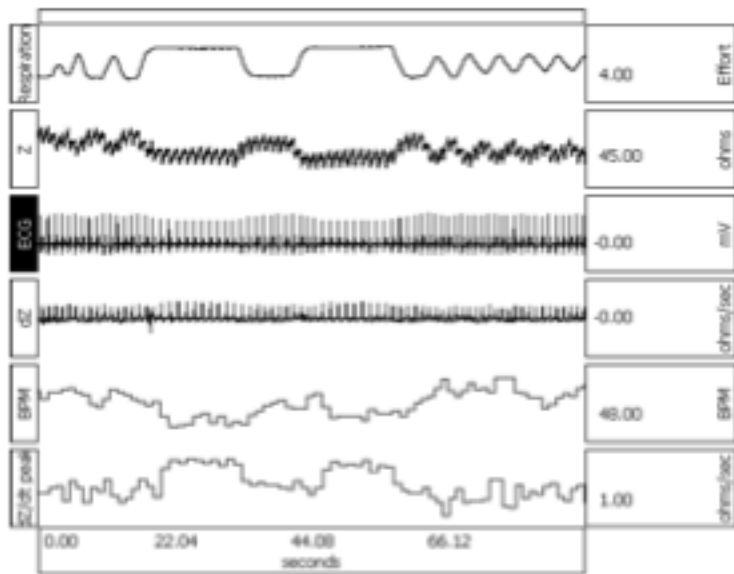


Fig. 1. Recorded and derived data from wireless physiological transmitters.

sampled at the rate of 2000 Hz, using a 16-bit A/D converter (BIOPAC - MP150WSW). The subject wore a specially designed shirt that held small amplifier/wireless transmitters close to the torso.

Data was collected for approximately 90 seconds, during which time the subject was seated and performing breathing

exercises which involved active and inactive periods of respiratory effort. The data was sectioned into 20-second intervals for ensemble averaging. Ensemble averages were performed in post-processing using BIOPAC AcqKnowledge software. R-wave peaks were located via ECG classifier and these events were used to synchronize the averaging process. A time window of approximately 900 msec was used.

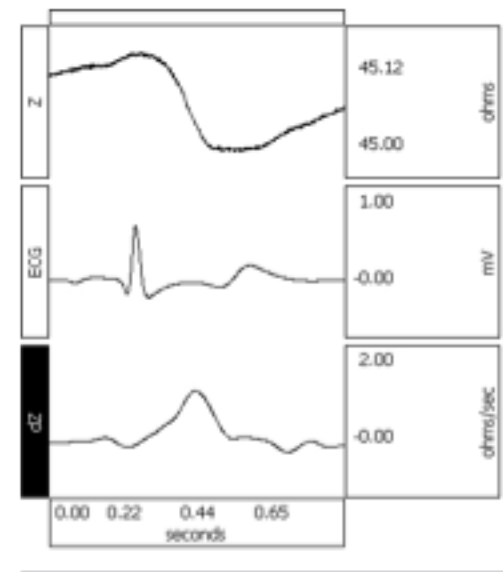


Fig. 2. Ensemble averaged 20-second interval.

## RESULTS

A significant methodological concern in impedance cardiography is related to the impact of movement artifacts on recorded data. Ensemble averaging methods provide a strategy to remove these artifacts. Wearable and ubiquitous technology for physiological recording will likely be required to make use of these types of signal averaging techniques.

The system was able to perform real-time, beat-by-beat and ensemble averaged measurements related to cardiovascular reactivity, including Heart Rate (bpm), Left Ventricular Ejection Time (B-X ms), Pre-ejection Period (Q-B ms), Electromechanical Systole (Q-X ms), Stroke Volume (ml) and Cardiac Output (l/min).

## REFERENCES

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