IMPEDANCE CARDIOGRAPHY

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Objective Statement

The object of this project is to design and test a spatially specific impedance cardiography system to measure cardiac output. This system should be more reliable and easier to implement than comparable methods currently used or proposed.

Problem

Impedance cardiography is a non-invasive procedure used to assess an individual's cardiac output. The current method of impedance cardiography (figure 1) utilizes four dual electrodes placed on the neck and abdomen. Placing the electrodes across such a large distance, however, results in an inaccurate and weak output signal difficult to find or use[1].

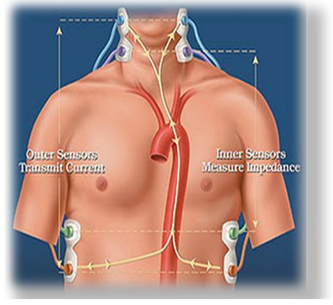
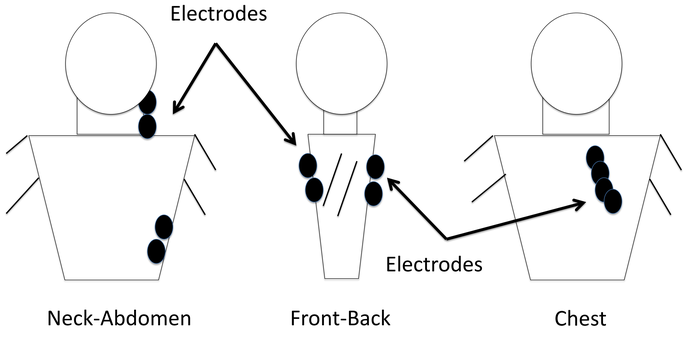


Figure 1: Current method of taking impedance measurements

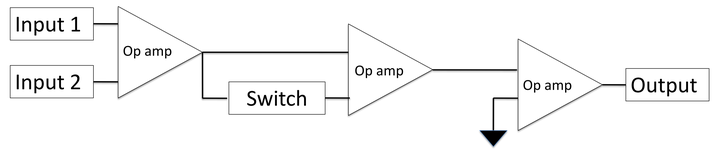
Adapted from Noninvasive Hemodynamic Monitoring, impedanceCardiography.com

Current and Proposed Methods of Electrode Placements to Test[2]

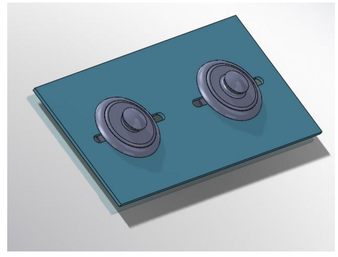


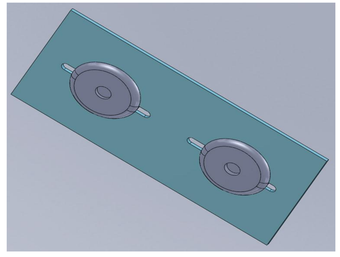
Final Design for Testing

Impedance Circuit Block Diagram



Electrode Pads





Two silicone pads hold electrodes in place without adhesive surfaces. The electrodes snap into metal buttons that can slide in slits for fine adjustment.

Cardiac Output[3]

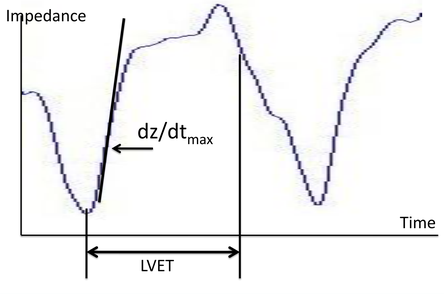
Cardiac Output = Stroke Volume x Heart Rate

Stroke Volume = VEPT x LVET x VI

VEPT= $L^3/4.2$

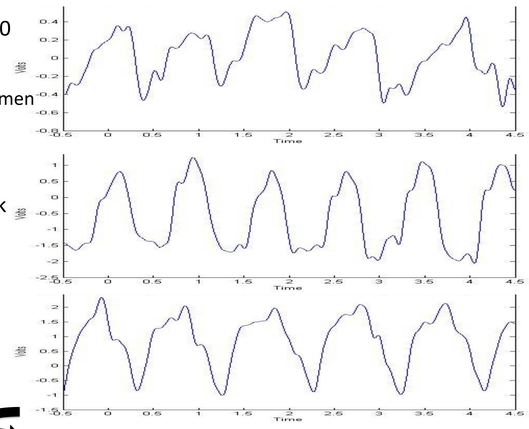
LVET= Ventricular Ejection Time

VI= $\frac{dz/dt_{max}}{Z_0}$



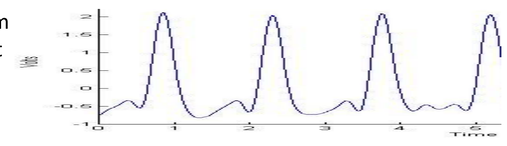
Results

Waveform results from 20 year old male subject



CO = [3.5L/beat x 0.4s x $0.05s^{-1}$] x 72 bts/min = 5.04 L/min

Chest method result from older adult male subject



Future Work

We plan to continue this project by collecting more measurements from a greater number of subjects. Ultimately the results need to be compared to MRI or thermodilution measurements on patients.

References

1. Van De Water, Joseph M, MD. Et al. "Impedance Cardiography: The Next Vital Sign Technology?". Chest. June 2003, vol. 123, pgs. 2028-2033.
2. Babbs, Charles F. "Anterior-posterior impedance cardiography: a new approach to accurate, non-invasive monitoring of cardiac function." Department of Basic Medicine
3. Bernstein, Donald P. "A new stroke volume equation for thoracic electrical bioimpedance"*Critical Care Medicine* 1986

Acknowledgements

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