Utility and Economic Benefit of Thoracic Bioimpedance in Critical Care Patients

Faheem Ahmad, MD, Lakshmi Parvathaneni, MD, Marc A. Silver, MD
Heart Failure Institute & Department of Medicine, Christ Hospital and Medical Center, Oak Lawn, Illinois

Journal of Cardiac Failure, Supplement 1, Volume 5, Sept. 1999.

Introduction

Patients in critical care units (CCU) of acute care hospitals often require determination and monitoring of central hemodynamics in order to make critical decisions regarding patient status and therapeutic interventions. Traditionally, over the past 20 years, clinicians often place a pulmonary artery catheter (PAC) to help decide on a patient's clinical status and to make important therapeutic decisions. While the data obtained using a PAC is usually accurate and effective, it is not, however, without significant risk. These risks are related to multiple factors including the severity of the disease, host-related factors, and operator training and experience.

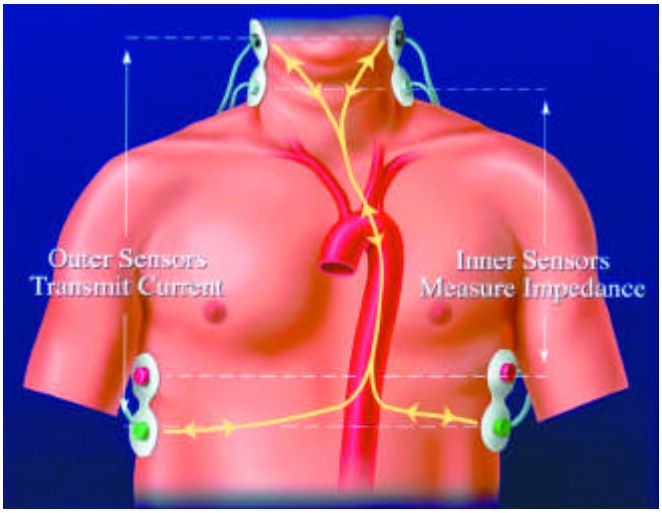
Thoracic Electrical Bioimpedance (TEB) is a well validated,[1,2,3,4] noninvasive technique to obtain central hemodynamics. It can be applied quickly and may be left attached to a patient for an extended period of time. While validations exist between TEB and invasively determined hemodynamics, our goal was to estimate how often TEB could reasonably replace invasive hemodynamics in our critical care unit patients.

Methods

Thoracic Electrical Bioimpedance (TEB) offers a simple, convenient noninvasive method of determining 12 hemodynamic parameters, including Cardiac Output (CO), Stroke Volume (SV), Systemic Vascular Resistance (SVR), Contractility (ACI, VI) and Thoracic Fluid Content (TFC). TEB utilizes four dual sensors placed at the neck and thorax to transmit a 2.5mA, 70kHz signal (Figure 1). Similar to the pulmonary artery catheter measuring a change in temperature over time, TEB measures a change in impedance over time to calculate flow.

To determine how often TEB might effectively be used instead of a PAC we performed a non-randomized, prospective trial of 107 patients (avg. age 71 yrs.) who were admitted to our CCU during the 21 day period of study. For each of these patients, when clinical consideration for central hemodynamic monitoring arose, we queried whether TEB could provide either substantial hemodynamic or adjunctive information, and whether this information improved patient care/outcome and/or attenuated placement of a PAC. On rounds when the discussion of measurement of central hemodynamics arose, one of the authors simply asked whether TEB could be used as the primary determination of central hemodynamics. When TEB was not the primary method, the reason for not using it was queried. When it was used, a determination of its impact was made and when it was used with the use of a PAC, the correlation between data obtained with PAC and TEB was compared.

Figure 1: Thoracic Electrical Bioimpedance



- An alternating current is transmitted through the chest
- The current seeks the path of least resistance: the blood filled aorta
- The BioZ Systems measure the baseline impedance to this current
- With each heartbeat, blood volume and velocity in the aorta changes
- The BioZ Systems measure the corresponding change in impedance
- The BioZ Systems use the baseline and changes in impedance to measure and calculate hemodynamic parameters

The BioZ.com™ System

The BioZ.com (CardioDynamics International Corporation, San Diego, California) collects, processes, and displays real time ECG and Impedance waveforms, calculating 12 hemodynamic parameters including: CI/CO, SI/SVR, Indices of Contractility and Thoracic Fluid Content.

Results

Of 107 patients in CCU, the potential need for PAC arose in 14 (13%). Among these patients, TEB measurements were the primary measurement of central hemodynamics in 10 patients. Five patients did not use TEB as the primary determination but had subsequent PAC placement. Based on patient outcomes at the time of ICU discharge, the following data emerged:

Result	%
TEB data aided decision	100
Pt. course/outcome improved by TEB data	60
Subsequent PAC placed (n=5)	50
Due to insufficient TEB data	0
Due to physician preference	60
PAC and TEB data correlated	100

Conclusions

Our data helped clarify the role of TEB today in the critical care unit. The data shows that useful hemodynamic data may be obtained from TEB; this determination is rapid, without risk, and of markedly lower cost. Importantly, TEB data attenuated PAC placement in at least 71% of patients; of the PACs placed, most were due to physician preference alone and in each case, the data obtained with the PAC corresponded to data obtained TEB measurement. As physicians become more comfortable with the use of TEB, safer and more cost-effective care can be delivered in critical care setting without the cost and risk of a PAC.

References

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