

Title: RIGHT VENTRICULAR STROKE VOLUME MEASUREMENT BY AN INTRACARDIAC IMPEDANCE METHOD: CLINICAL EVALUATION

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Introduction. Continuous measurement of intrathoracic blood volume by electrical impedance techniques has been possible for many years but has had limited clinical application. Using similar technology, an experimental pulmonary arterial catheter system has been developed which continuously measures right ventricular volume. We report the preliminary evaluation of this system on human subjects.

Methods. Following approval by the Human Investigations Committee, ten patients scheduled for elective coronary artery revascularization gave informed consent and were studied. The experimental pulmonary arterial catheter was inserted prior to surgery in all patients. It is a thermodilution flow-directed catheter modified with six circumferential electrodes which lie within the right ventricle. A combined signal generator and processor delivered an electrical current to and sensed impedance changes within the right ventricle. Electrical impedance changes were recorded on a multichannel recorder (figure 1). Multiplication by a calibration factor converted the recorded impedance signals to impedance-derived stroke volumes (ISV). The values were compared with stroke volumes obtained by simultaneous measurement of thermodilution cardiac outputs (TSV). Linear regression analysis was used to compare TSV and ISV.

Results. The catheter was inserted in nine patients without difficulty; in another patient the catheter could not be inserted. Ventricular premature contractions were noted in 7/9 patients without clinical significance. In 6/9 patients meaningful data were obtained; in the other three the data were uninterpretable due to signal processing malfunction. The correlation between stroke volumes determined simultaneously by the two methods described was excellent for observed TSV between 37 and 101 ml. ($r=0.90$, $p<.001$, figure 2).

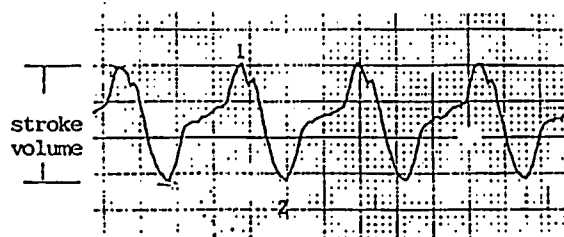
Discussion. These data confirm the excellent correlation between changes in electrical impedance within the right ventricle and changes in ventricular volume. The prototype unit we evaluated required off-line conversion of impedance signals to stroke volume. However, animal studies in progress confirm the feasibility of on-line computerized signal processing and continuous display of cardiac output, right ventricular end-systolic, end-diastolic and stroke volumes and pressure-volume relationships. This relatively simple,

radiation-free device holds promise as a tool for elucidating the dynamics of the human right ventricle and pulmonary circulation and as a useful addition to the armamentarium for patient monitoring.

References.

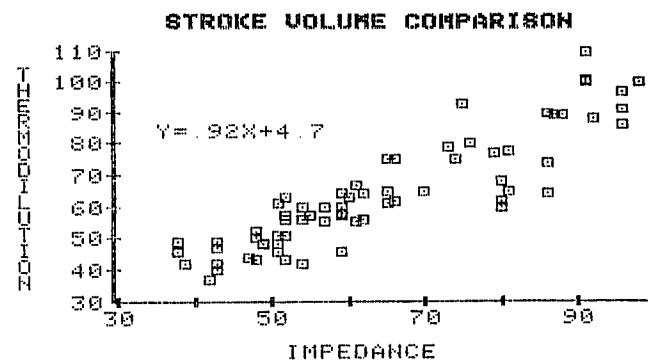
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Figure 1



Instantaneous right ventricular volume changes are represented by the analog signal shown. Waveform amplitude represents stroke volume. End-diastole (1) and end-systole (2) are identified.

Figure 2



The correlation between right ventricular stroke volume values (in ml.) calculated from thermodilution cardiac output measurements and those derived from right ventricular impedance changes is shown.