TITLE: TECHNOLOGY IMPLEMENTATION AND PERFORMANCE IN ANESTHETIC GAS ANALYSIS

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In anesthesia practice today, we have seen a rapid increase in the use and standardization in monitoring oxygen and carbon dioxide (1). Germany has already implemented a standard for anesthetic gas analysis and Belgium will do so before 1995. The current trend is to integrate the monitoring and display of all gas parameters by a single device (2). The present work describes the implementation of a technology based on acoustics to provide the accurate and stable measurement of required anesthetic gases.

Acoustic Spectroscopy is a measurement technique based on the effect of infrared (IR) light and a magnetic field on respiratory gases and anesthetics (3). Switched IR energy is absorbed by CO2, N2O and anesthetic agents, giving an acoustic response directly proportional to the concentration of the gas. A switched magnetic field provides the same type of acoustic response for oxygen, based on its concentration in the presence of the magnetic field.

The comparison of this technology with other methods has been completed, based on published specifications and our own testing. Other measurement methods are based on a indirect measurement of the amount of infrared energy absorbed by CO2, N2O and anesthetic agent versus a reference. Oxygen is measured by a polarographic fuel cell or the pressure differential based on differential magnetic response. For values in the normal range of clinical measurements, comparison of the technologies implemented are:

	CO_2	O_2	N_2O	Agent	Response Time
Reference value	38.0 mmHg	30 vol%	70 vol%	2.5 vol%	
Acoustic Spectroscopy	±0.75 mmHg	±0.75 mmHg	±1.3 vol%	±0.1 vol%	< 0.25 sec
Infrared Absorption	±0.76 mmHg	n/a	±1.3 vol%	±0.3 vol%	< 0.75 sec
Paramagnetic	n/a	±1.8 vol%	n/a	n/a	< 0.45 sec
Polarographic	n/a	±2.0 vol%	n/a	n/a	< 6.0 sec

Note: Measurements made 48 hours after calibration referenced to 37° C with 2.5 m sample tube

With this technology, we have been able to meet our objectives for stability, response, and accuracy in the measurement of anesthetic and respiratory gases. Performance of this technique is comparable to other measurement methods.

References:

1. ASA Newsletter, 1989, pp.6-7.
2. Biomedical Instrumentation and Technology, 1989, p.461.
3. Biomedical Instrumentation and Technology, 1989, pp.495-497.

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Title: Pulse contour continuous cardiac output
When does vascular compliance change?

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The interaction between the cardiac and the vascular function creates pressure and flow. Mean blood pressure and cardiac output are correlated by the vascular resistance . Pulsatile blood pressure and stroke volume are correlated by the arterial wall compliance.

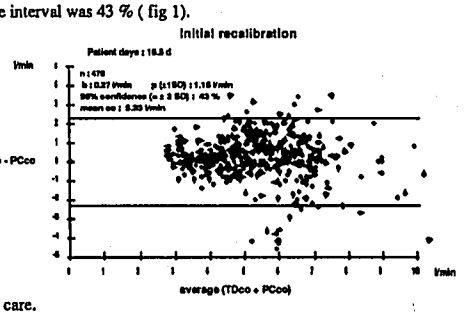
Systolic pressure waveform analysis, frequent referred to as 'Pulse contour method' is an attractive monitoring system for the determination of the cardiac output as it operates continuously and automatic with no extra invasive technique needed. Stroke volume is calculated from the systolic pressure change as this is influenced only by the compliance.(1)

The compliance is dependent on the wall structure, the transmural pressure and the frequency. By automatic correction for blood pressure and heart rate according to age an averaged characteristic impedance for the total arterial tree system can be defined. This parameter seems to be quit stable and is patient specific what allows its use for stroke volume calculations. However initial prediction or measurement of this factor is difficult. By comparing with another method of cardiac output measurement this averaged characteristic impedance can be corrected by the calibration factor necessary to make both measurements identical.

16 Patients undergoing different major cardiovascular operations were investigated pre- , intra- and post- operatively for one day. Correlation and agreement with thermodilution are investigated. The mean of four thermodilution measurements with 10 ml ice saline are injected automaticly at even spread over the respiratory cycle. The mean pulsed contour cardiac output is compared at the same time. Disagreement between both methods can be due to poor quality of the arterial pressure signal, unvalid reference method for true cardiac output measurement and changes in arterial compliance.

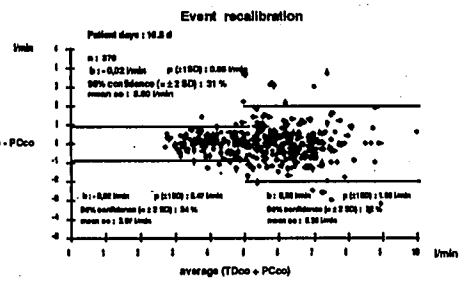
With initial recalibration (before induction) a correlation factor r of 0.70 was obtained. The 95 % confidence interval was 43 % (fig 1).

Events that might change vascular compliance have been investigated. Significant compliance change was measured at: induction, opening of the thorax, weaning of extracorporeal circulation and admission to the intensive care.



With recalibration at these events the correlation factor r improved to 0.83. The 95 % confidence interval was 31 %. For a cardiac output under 5 l/min 24 % was reached(fig 2).

Conclusion: Recalibration is needed at specified moments. However further investigation is needed to identify drugs and other events that change the compliance.



References: 1. K.H.Wesseling et al. A simple device for the continuous measurement of cardiac output. Advances in Cardiovascular Physics 5, 16-52, 1983