TITLE: **REAL-TIME PULMONARY SHUNT FRACTION IN HUMANS**

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Introduction. Quantitative measurement of intrapulmonary shunt (Qs/Qt) aids in the management of respiratory failure. Estimates of Qs/Qt based only upon arterial blood gas analysis fail[1] to adequately reflect intrapulmonary shunt. Recently, a technique using dual oximetry [combined pulse and pulmonary artery (PA) oximetry] to quantitatively monitor pulmonary gas exchange has been developed; however, as PaO_2 increases, the technique correlates less well with Qs/Qt.[2] This clinical study was designed to show that the dual oximetry technology can be modified to accurately predict conventionally calculated Qs/Qt over a wide range of clinically occurring conditions.

Methods. In a study approved by the Clinical Research Practices Committee, 10 consenting patients undergoing elective open heart surgical procedures had oximetry PA catheters and radial artery catheters inserted preoperatively as part of their routine perioperative care. After postoperative stabilization in the ICU, each patient was studied for a one-hour period. Paired arterial and mixed venous blood samples were collected anaerobically at 5-minute intervals and analyzed immediately with an Instrumentation Laboratories Model 282 Cooximeter and Model 1306 pH/Blood Gas Analyzer. The data thus obtained were used to calculate conventional Qs/Qt using the equation:

$$Qs/Qt = \frac{Cc'O_2 - CaO_2}{Cc'O_2 - CvO_2} \qquad \text{(Eq. 1)}$$

Output from the pulse oximeter (Ohmeda Biox 3700) and oximetry PA catheter (Edwards Critical Care Division, Baxter Healthcare Corp.) was collected by a microcomputer at a sampling interval of 2 seconds. The patient's FiO_2, percent abnormal Hgb, barometric pressure, $PaCO_2$, and an assumed respiratory quotient of 0.8 were manually entered into the data base. The real-time Qs/Qt calculations were performed by a computer algorithm based on the classical Qs/Qt equation (Eq. 1). Pulmonary capillary content was calculated using the alveolar gas equation to approximate PAO_2. If PAO_2 was >150 mmHg, $Sc'O_2$ was assumed to be 100%. $Cc'O_2$ was then corrected for the presence of abnormal Hgb. Mixed venous content was calculated from the saturation value obtained from the oximetry PA catheter, with the dissolved component derived from a modification of Hill's equation.[3] Arterial content was calculated from the pulse oximeter saturation values, with the dissolved component again approximated from the modified Hill equation.[3] The real-time Qs/Qt was computer averaged over 1-minute intervals and compared with the corresponding Qs/Qt values obtained from calculations using the blood gas and cooximetry data. The results were analyzed by regression analysis.

Results. Figure 1 displays the comparison of real-time Qs/Qt with the conventional Qs/Qt. The real-time measurement of Qs/Qt correlates highly with the conventional calculations over a wide range of Qs/Qt values. Figure 2 displays a typical single-patient comparison over the duration of the study.

Discussion. This study demonstrates that real-time dual oximetry calculation of Qs/Qt is a clinically accurate measurement which may aid in the management of respiratory failure. Intrapulmonary shunt was reliably predicted with the current apparatus and algorithm. The ability to track Qs/Qt in real-time may permit early detection of deterioration in pulmonary gas exchange, allowing for prompt alteration in therapy. It may also allow for more precise titration of therapy, possibly limiting complications associated with oxygen administration and positive pressure ventilation.

References.

1. Dean JM, et al: Crit Care Med 13:1029, 1985
2. Rasanen J, et al: Crit Care Med 15:1058, 1987
3. Severinghaus JW: J Appl Physiol 46:599, 1979