

TITLE: EVALUATION OF PULMONARY ARTERY OXIMETRY AS A PREDICTOR OF CARDIAC OUTPUT

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**Introduction.** Mixed venous oxygen saturation ( $\text{S}\bar{\text{V}}\text{O}_2$ ) has been used to follow or predict the clinical course of patients with a variety of medical problems. However, until recently this was done using intermittent measurements only. With the advent of *in vivo* oximetry capabilities (PAC-OX from Oximetrix), continuous monitoring of  $\text{S}\bar{\text{V}}\text{O}_2$  became possible. The full spectrum of clinical application of this capability has not been delineated. A recent study documented a correlation between changes in  $\text{S}\bar{\text{V}}\text{O}_2$  and cardiac output (C.O.) during anesthesia for elective coronary artery bypass grafting (CABG).<sup>1</sup> The purpose of this study was to evaluate the usefulness of continuously monitoring  $\text{S}\bar{\text{V}}\text{O}_2$  in the postoperative cardiac surgery patient and to determine if changes in  $\text{S}\bar{\text{V}}\text{O}_2$  could be correlated with changes in cardiac output.

**Methods.** After receiving approval from the Human Investigation Committee and informed consent, patients undergoing cardiac surgery (valve replacement or CABG) were chosen at random for insertion of the PAC-OX, a flow directed thermodilution pulmonary artery catheter which has two fiberoptic filaments to permit continuous measurement of  $\text{S}\bar{\text{V}}\text{O}_2$ . The catheter was inserted preoperatively and recording of  $\text{S}\bar{\text{V}}\text{O}_2$  was begun when the patient arrived in the Surgical Intensive Care Unit (SICU). Thermodilution C.O.'s (Edwards Lab 9520) were then obtained hourly for eight hours and the time of each C.O. was noted on the  $\text{S}\bar{\text{V}}\text{O}_2$  chart recorder for later analysis. On successive days if the catheter was used clinically, additional data points were collected. At 0, 2, 4, 6, and 8 hours *in vitro*,  $\text{S}\bar{\text{V}}\text{O}_2$ , arterial saturation, and Hgb determinations were also made (IL 282). Initiation of pharmacologic interventions, pacemaker activity, RBC transfusion and other clinical events were recorded and correlated with changes in  $\text{S}\bar{\text{V}}\text{O}_2$ . Since the Fick equation predicts a non-linear relationship between  $\text{S}\bar{\text{V}}\text{O}_2$  and C.O., we compared the change in cardiac output as measured by thermodilution to the change in cardiac output predicted mathematically by a change in saturation, using linear regression analysis.

**Results.** A total of twelve adult patients were studied after cardiac surgery. Four patients underwent valve replacement and eight patients had CABG. The average age was 57 years, and average SICU length of stay was 3 days. One hundred forty-three separate measurements of C.O. and simultaneous  $\text{S}\bar{\text{V}}\text{O}_2$  values were obtained. The measured C.O. and the C.O. calculated from the change in measured  $\text{S}\bar{\text{V}}\text{O}_2$  were compared. The correlation coefficient of the entire set of data was .60 ( $p < .001$ ). The correlation for the data obtained in the first 8 hours after surgery was poor,  $r = .44$  ( $p < .01$ ), as compared to those obtained later (usually greater than 12 hours after surgery) whose correlation was considerably better,  $r = .86$  ( $p < .001$ ). (See Figure below.)

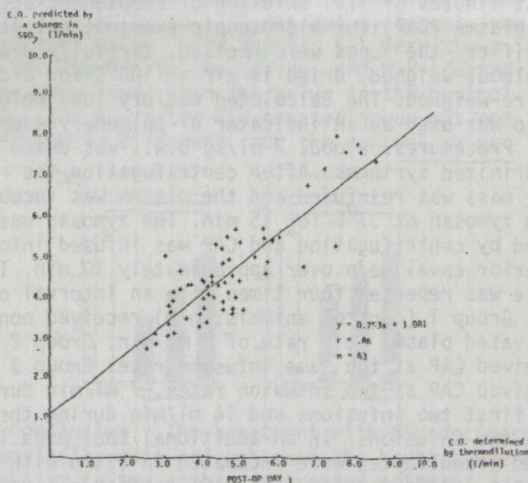
There were four patients who demonstrated sustained postoperative shivering associated with

large increases in C.O., large decreases in  $\text{S}\bar{\text{V}}\text{O}_2$ , and marked increases in  $\text{O}_2$  consumption (calculated by the Fick equation). With resolution of the shivering, C.O. fell and  $\text{S}\bar{\text{V}}\text{O}_2$  rose. If the shivering points are excluded from the data obtained immediately post-op, the correlation for that period improves notably with  $r = .75$  ( $p < .001$ ).

Large decreases in  $\text{S}\bar{\text{V}}\text{O}_2$  were occasionally observed during changes in patient position. This was not uniformly accompanied by decreases in C.O. or decreases in arterial saturation although  $\text{S}\bar{\text{V}}\text{O}_2$  often fell to less than 40%. These changes were transient, lasting less than 10 minutes, and were not associated with, nor were they a predictor of, untoward events.

During the continuous monitoring period, several unexpected, potentially disastrous events were heralded by an unexpected change in  $\text{S}\bar{\text{V}}\text{O}_2$ . Two cases of permanent wedging, one case of endotracheal tube obstruction, and one case of medication disruption, were first discovered by investigation of a changing  $\text{S}\bar{\text{V}}\text{O}_2$ .

**Conclusion.** Continuous *in vivo* measurement of  $\text{S}\bar{\text{V}}\text{O}_2$  can be used to monitor hemodynamic stability in postoperative cardiac patients. In the absence of shivering, the PAC-OX offers the physician a continuous index of cardiac output and allows the rapid evaluation of pharmacologic and other manipulations in the postoperative period. In cases where a discrepancy between  $\text{S}\bar{\text{V}}\text{O}_2$  and thermodilution C.O. exists, valuable information regarding oxygen consumption and oxygen carrying capacity is obtained.



**References.**

1. Waller JL, Kaplan JA, Bauman DI, Craver JM: Clinical evaluation of a new fiberoptic catheter oximeter. *Anesthesiology* 55(3):A133, 1981