Clinical Evaluation of a New Saturation/Hematocrit Monitor

Mark F. Miller, MS, CCP, Jeff Luckenbach, BS, CCP, Chao Chen, PhD
Deborah Heart and Lung Center, Browns Mills, NJ

Keywords: cardiopulmonary bypass, in-line monitoring, hematocrit, venous oxygen saturation

Abstract

The purpose of this study was to evaluate the utility of the Cobe SAT/HCT Monitor, an in-line device which continuously displays hematocrit and venous oxygen saturation. A fiber optic cable was used to connect the monitor to a “window” on the blood inlet of a venous reservoir (Cobe CML). Sixty venous blood samples were drawn from 20 patients undergoing cardiopulmonary bypass. Statistical correlations were performed comparing monitor readings with controls measured by an IL 482 co-oximeter and a TRIAC centrifuge. Results showed a high degree of correlation between the monitor and control values for both venous saturation (r = .96) and for hematocrit (r = .94). Although this device has some minor deficiencies, it is a useful tool which enables the perfusionist to monitor two important components of oxygen consumption.

Recall that \( \Delta VO_2 \) difference contains the parameters \( SaO_2 \) (arterial oxygen saturation), \( SvO_2 \) and hemoglobin. If one is willing to assume that \( SaO_2 \) equals about 100%, then a venous saturation/hematocrit monitor adds the necessary parameters for continuous monitoring of oxygen consumption. Cobe Cardiovascular Inc. has recently developed an in-line “sat-crit” monitor to be used during cardiopulmonary bypass (CPB). This device continuously displays \( SvO_2 \) and Hct during bypass. A fiber optic cable connects the monitor to a “window” on the venous inlet of the Cobe CML Excel oxygenator. Although the \( SvO_2 \) function is precalibrated, the Hct function cannot be calibrated until after initiating CPB. After going on bypass, the perfusionist presses the “store” button while drawing a blood sample. Upon receipt of the hematocrit result from that sample, the “recall” button is pressed, and the monitor is calibrated by entering the known hematocrit.

The purpose of this study was to evaluate the utility of the Cobe SAT/HCT Monitor when used clinically, and in accordance with the manufacturer’s instructions.

Materials and Methods

Approval was obtained from the Institutional Review Board for this study. The subjects included 20 adult patients who underwent cardiopulmonary bypass with hypothermia.
All patients were determined to have a body surface area of 1.90 meters squared or greater (standard procedure for using the Cobe Excel oxygenator\(^a\) at Deborah Heart and Lung Center).

For each patient, blood samples were drawn at three different intervals during CPB. The first sample was drawn within ten minutes after going on bypass, the second sample was taken during hypothermia, and the third sample was drawn just prior to terminating CPB. For each sample, a control value was recorded for both hematocrit and for \(SvO_2\). Controls for Hct were determined using capillary tubes and a TRIAC centrifuge\(^c\). Controls for \(SvO_2\) were measured with an IL 482 co-oximeter\(^b\). While the blood samples were being drawn, readings were recorded from the Cobe SAT/HCT monitor\(^a\) for \(SvO_2\) and Hct (the first sample from each patient was used to calibrate the Hct function and, thus, was not included in the Hct data).

In order to aid in the evaluation of the Cobe monitor a Bentley OxySat\(^d\) sensor was inserted into the venous line of each perfusion circuit. The OxySat is an in-line \(SvO_2\) monitor that has been evaluated (3,4) and has been used clinically for several years (5). The \(SvO_2\) was recorded from the OxySat at the same intervals as data was taken from the SAT/HCT. The data set was entered into a computer and analyzed by the SAS system\(^e\).

The means of the experimental values and of the control values for each patient were first determined, then Spearman correlation coefficients (\(r\)) were computed.

**Results**

All the correlation coefficients were significantly different from zero (\(p < 0.001\)). A scattergram (Figure 1) depicts a positive correlation (\(r = 0.96\)) between the \(SvO_2\) readings from the SAT/HCT monitor and controls from the co-oximeter. Figure 2 demonstrates a positive relationship between the \(SvO_2\) readings from the OxySat and the co-oximeter (\(r = 0.97\)). Figure 3 shows a positive correlation between the hematocrit readings from the SAT/HCT and the control values of the centrifuge (\(r = 0.94\)). For \(SvO_2\), there is a statistically significant (\(p < .01\)) bias with both the Cobe SAT/HCT and the Bentley OxySat. The mean bias (monitor minus co-oximeter) is -.94\% for the SAT/HCT. The mean bias for the OxySat is -3.3\%. The Hct function of the SAT/HCT has no significant bias.

**Discussion**

We found the Cobe SAT/HCT monitor to be a useful and accurate tool for monitoring oxygen transfer. The \(SvO_2\) values correlated extremely well with the controls. The "mean bias" reported above merely indicates that the SAT/HCT consistently reads an \(SvO_2\) that is about one point low. The Bentley monitor,
which continues to be used clinically in many institutions, reads about three points low, on the average.

Hematocrit values were consistent with Cobe's claims of accuracy (plus or minus one Hct %). We found in-line Hct to be most helpful in instances where it was necessary to add large amounts of volume in a short span of time. The absence of a pre-calibration capability for Hct is a minor deficiency. If the perfusionist has neither the time nor the inclination to calibrate the Hct function, monitoring in-line SvO₂ alone is valuable. For example, if the SvO₂ is low, such as 50%, tissue extraction of oxygen is relatively high, resulting in possible hypoxia and lactic acidosis (7). The perfusionist could immediately employ strategies to increase oxygen transfer, reduce oxygen consumption, or some combination of both. If low SvO₂ persists, a point may be reached where the oxygenator cannot fully saturate the hemoglobin. Arterial oxygen saturation then begins to drop, and a vicious cycle of hypoxia may ensue. In summary, the Cobe SAT/HCT monitor is a useful tool which enables the perfusionist to monitor two important components of oxygen consumption.

References

2. Yang S, Bentivoglio L, Maranhao V, Goldberg H. From cardiac catheterization data to hemodynamic parameters.