

DETERMINING BLOOD OXYGEN SATURATION

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IT is routinely necessary to obtain oxygen saturation data from several sites in the circulation during diagnostic cardiac catheterization procedures. Van Slyke determinations are time consuming and require as much as ten milliliters of blood per test. Duplicate samples are frequently needed and from one to two hundred milliliters of blood may be drawn which, along with blood needed for other purposes, can become quite a significant amount to be withdrawn from a small patient. It is especially prohibitive in pediatric cardiology.

Several techniques have been devised utilizing various pieces of electronic equipment to reduce the amount of blood necessary and to shorten the amount of post-procedure laboratory time without sacrificing accuracy. The following technique is used in the Cardiac Catheterization Laboratory at Miller Hospital.

Equipment

The equipment consists of a Waters cuvette oximeter with single and double scale galvanometers, a Beckman spectrophotometer with photomultiplier,

and a three-chambered Instrumentation Laboratories tonometer. Each unit fulfills a particular function in the overall system.

In the oximeter, the amount of light passing through blood drawn into the cuvette is measured by photocells and the ratio of red to infra-red light is related to the oxygen saturation of that sample. The tonometer saturates three blood samples with known gas mixtures yielding samples with 0%, 50%, and 100% oxygen content. Finally, the spectrophotometer reads the optical density of chemically hemolyzed blood samples giving, after the necessary calculations, an accurate saturation figure.

Sampling

During the catheterization procedure, with the catheter tip lying in the inferior vena cava in the vicinity of the diaphragm, blood is drawn through the oximeter cuvette to adjust the electronics to the hemoglobin content of the patient's blood. This blood is then returned to the patient. Now as many oxygen saturation readings as necessary may be taken from as many sites as necessary at a rate of one or two

samples per minute, always returning the blood to the patient (of course sterile technique is used throughout). The red and infra-red light transmittance is read on the double scale galvanometer while the reading from the single scale galvanometer gives a direct readout in percent.

Standardization

Simultaneously, two samples are drawn from the pulmonary artery and two are drawn from a systemic artery. All are read on the oximeter and are then capped and refrigerated until after the procedure. At this time the globes of the tonometer are filled with about five milliliters of blood and are mechanically swirled in a body temperature water bath during their exposure to the known gas mixtures. Obviously, the sampling and handling of the samples requires the utmost care to preserve the integrity of the sample and prevent contamination from extraneous gases.

Now, these known blood samples, as well as the pulmonary artery and systemic artery samples, are hemolyzed with Triton X-100 (33%), 0.04 milliliter with blood to one milliliter total volume, and are placed in cuvettes for reading in the spectrophotometer. Readings are taken of the absorbance of blue light at a wavelength of 660 Angstroms while the red readings are taken at 805 Angstroms. The slit opening used is 0.02 millimeters wide. To derive the percent of oxygen in each sample, first the red reading is divided into the blue reading. Then, these figures are placed into this formula: 0% minus sample (50%, pulmonary artery, or systemic artery) divided by 0% minus 100%. The answer is the percentage of oxygen saturation.

Results

Using these saturations, the single scale oximeter readings are corrected and the double scale readings are plotted on a graph as a cross check. The 50% sample is a cross check on the spectrophotometry. The maximum blood loss has been about forty milliliters and the total expenditure of time for sampling and calibration has been less than one hour. This technique has been found to be accurate and highly compatible with the catheterization procedure.