Title: IN-VIVO EVALUATION OF A MICRO-INTRAVASCULAR BLOOD-GAS PROBE.

Authors: R.T. Chilcoat, Ph.D., B. Goodwin, Ph.D., E.J. Jumneu, B.S., T.R. Clapham, and F. Harris, M.D.


Introduction. The availability of arterial blood-gas measurements for the differential diagnosis of pulmonary and cardiovascular problems in critically ill patients is highly desirable. However, the results returned by conventional blood-gas analyzers are frequently too late to be useful except in retrospect. The pulse oximeter, while helpful in many patients, is of little use in patients breathing high PO\(_2\)'s. This paper describes a comparison in dogs between measurements made using a conventional blood-gas analyzer and those made with a miniature intravascular probe.

Methods. A miniature intravascular probe, of 350 micrometers diameter, has been developed (1). This is a passive collector of gases in equilibrium with the blood and, by means of a suitable gas analyzer, can return values every two minutes of the equilibrium partial pressures of oxygen and carbon dioxide, and, simultaneously, nitrous oxide and the inhalation anesthetic. To test the device in vivo, three pure-bred beagles were anesthetized with pentobarbital, intubated and initially permitted to breathe spontaneously. A probe was inserted through a 22 ga. arterial cannula placed in the left carotid artery by cutdown, and used to measure the arterial PO\(_2\) and PCO\(_2\). These values were altered respectively by controlling the inspired oxygen concentration, and by controlled hyperventilation or rebreathing. At points of approximately steady-state PO\(_2\) and PCO\(_2\), three arterial blood samples were taken from a femoral artery, timed to coincide with the ends of three successive 2-min probe equilibration cycles. The samples were analysed for PO\(_2\) and PCO\(_2\) with a laboratory blood-gas analyzer. Comparison was made between corresponding measurements by correlation and analysis of variance.

Results. The PO\(_2\) measurements made by both methods are shown in the figure, with blood-gas analyzer measurements plotted on the X-axis and corresponding probe measurements on the Y-axis. Also shown are the regression line and equation, and the 95% confidence limits for the regression. The correlation coefficient was 0.982, with a coefficient of determination of 0.964. Similar data were obtained for the PCO\(_2\) measurements, with a correlation coefficient of 0.856 and a coefficient of determination of 0.733. The variability of the sets of three measurements made by the blood-gas analyzer was significantly larger than those made by the probe.

Discussion. It can be seen that corresponding PO\(_2\) measurements are very similar. The coefficient of determination of 0.964 indicates excellent correlation. The tight confidence limits indicate that a given probe measurement will correspond (with 95% confidence) to a blood-gas result within about 10 mmHg. PCO\(_2\) results also show a high degree of correlation. The higher variability in the analyzer measurements indicates that some of the residual error is due to these measurements. The trends displayed by the computer are valuable in diagnosing difficulties. During one of the experiments an apneic episode was detected by the precipitous reduction in PO\(_2\) seen on the trend display. Because the probe is merely a passive collector of gases in equilibrium with the blood, calibration requires little more than recording the volume of the gas bolus. Because of the uniformity of the design, even this may be unnecessary. In two experiments defective probes were withdrawn and new ones inserted within five minutes. In summary, this device provides reliable, accurate measurements of PO\(_2\), PCO\(_2\), and partial pressure of nitrous oxide and the volatile anesthetics virtually in real time with a clear and useful indication of trends.