EVALUATION OF A NEW INTRA-ARTERIAL BLOOD GAS SYSTEM IN DOGS AND HUMANS

B. Shapiro, M.D., R. Cane, M.D., C. Chomka, M.D. and J. Gehrich, Ph.D.
Department of Anesthesia, Northwestern University Medical School
250 East Superior, Chicago, Il. 60611

An optical fluoresence intra-arterial blood gas system (IBGS) has been developed (1) that consists of a probe which can be placed in a 20g arterial catheter without compromising electronic monitoring of blood pressure. The computer controlled IBGS continuously reads pH, PCO_2 and PO_2 and differentiates between "steady state" conditions and circumstances where physiologically significant changes are occurring. Under non-steady state conditions up and down arrows showing the occurrence and direction of change for pH, PCO_2 and PO_2 are displayed. We compared the IBGS with conventional arterial blood gas measurements (ABG) in an animal model and in selected human subjects.

Ten IBGS probes were placed in the femoral arteries of 6 pentobarbital anesthetized, mechanically ventilated mongrel dogs. The continuous IBGS blood gas values were noted every 30 seconds and arterial blood samples drawn from a brachial artery every one to two minutes while minute ventilation, oxygenation and/or H^+ concentration were varied over wide ranges. The arterial blood samples were analyzed on an IL1301 blood gas analyzer under standard quality control conditions. With Institutional Review Board approval, an IBGS probe was inserted through 20g radial artery catheters in six patients under 40 years old. Three patients were administered general anesthesia (without Halothane) for neurosurgical procedures and three patients were being treated in the Neurosurgical or Spinal Cord Trauma ICU. 36 sets of pH, PCO_2 and PO_2 were compared to the blood gas values obtained from our Central Blood Gas Laboratory. All samples were obtained during steady state conditions. Paired IBGS and ABG values of pH, PCO_2 and PO_2 were analyzed by linear regression. PO_2 of > 150 mmHg were excluded from analysis for dog studies.

Table 1 shows the mean (± S.D.) values and linear regression analysis for steady state values in the six dogs. The pH was varied from 7.05 - 7.57, PCO_2 from 18 - 92 mmHg and PO_2 from 27 - 313 mmHg. Under conditions of physiologic change in this animal model, system lag times were noted to be similar to the < 2 minutes previously demonstrated in an in vitro model (1). Table 2 shows the mean (± S.D.) values and linear regression analysis for steady state values in the 6 patients. The pH ranged from 7.31 - 7.59, PCO_2 from 20 to 42 mmHg, and PO_2 from 65 - 559 mmHg. No interference with blood pressure monitoring was noted.

TABLE 1

PARAMETER (n)	ABG (X,S.D.)	IBGS (X,S.D.)	LINEAR REGRESS.
pH (n=421)	7.34(±0.12)	7.36 (±0.12)	R = 0.97
PCO_2 (n=359)	34.0 (±11.0)	33.9 (±12.0)	R = 0.95
PO_2 (n=172)	107.1 (±30.2)	103.1 (±32.2)	R = 0.92

TABLE 2

PARAMETER (n)	ABG (X,S.D.)	IBGS (X,S.D.)	LINEAR REGRESS.
pH (n=36)	7.43(±0.06)	7.43 (±0.07)	R = 0.92
PCO_2 (n=36)	35.1 (±4.2)	32.4 (±5.5)	R = 0.83
PO_2 (n=36)	157.16(±101.6)	163.25(±113.3)	R = 0.98

We conclude that this intra-arterial blood gas system accurately reflects arterial blood gases under steady state conditions. In non-steady state conditions the IBGS reliably indicates the presence and direction of change. Human clinical studies are in progress. The clinical availability of continous ABG monitoring would improve respiratory monitoring and titration of oxygenation and ventilatory therapy in the O.R. and ICU in critically ill patients. This system does not interfere with blood pressure monitoring or ability to obtain blood samples via the 20g arterial catheter.

(1) Gehrich JL, Lubbers DW, Opitz N, et al: Optical fluoresence and its application to an intravascular blood gas monitoring system. IEEE Trans Biomed Eng 1986; 33:117-132.