Arterial Blood Gas Measurement

The existence of gases in the arterial blood has been known since the last century, and the first measurement of arterial blood gas levels was made over four decades ago; however, the routine use of arterial blood gas measurements in clinical medicine is of fairly recent origin, coming into general use only within the last two decades. Originally, these were difficult and tedious measurements, and therefore, were in the domain of research work, requiring meticulous attention to detail to produce accurate results; they are now routine hospital laboratory measurements, no longer demanding the physician’s close attention to the accuracy or reproducibility of the measurement technique itself. Thus, realization of the relatively wide range of reproducibility of some of these measurements comes as a surprise to many clinicians.

Although the blood gas analysis machines currently available are presented as one unit, the electrodes for PO2 measurement, PCO2 measurement, and pH measurement are separate. When the physician or physiologist performs or requests an arterial blood gas analysis, he does so in order to assess the subject/patient’s ventilatory, gas exchange, and acid-base status. It follows, therefore, that the observer must be fully aware of the accuracy and reproducibility of these measurements in his laboratory, as well as the accuracy and reproducibility of these measurements under the most optimal conditions. Unfortunately, few clinicians are aware that, even under the most rigorous conditions, the measurement and reproducibility of the PO2 when compared for example to measurement of the blood hemoglobin, is poor. Thus, the same blood based control sample (mean PO2 64.9 mm Hg) analyzed in 11 different laboratories with the most meticulous calibration and preparation, had a standard deviation of ±5.2 mm Hg. While it cannot be stated with certainty that a similar variability would be present with arterial blood, these data do suggest that, even under the most rigorously calibrated conditions, there is a wide variability in blood PO2 measurements. The implications for the management of patients on artificial ventilation, patients being assessed for pulmonary disability, etc. are obvious. The situation for pH and Pco2 measurements is somewhat better in that, in the same study, the coefficient of variation of pH and Pco2 measurements in the same sample between different laboratories was 0.2 percent and 4.5 percent, respectively, compared to 12 percent for PO2. These data clearly indicate that clinical judgments, as well as medicolegal judgments, based on arterial blood gas data must take into account the reproducibility of the measurements.

Thus, the quality control of arterial blood gas measurements is clearly a matter of great importance.

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REFERENCES

1. Koretz RL. Breathing and feeding: can you have one without the other? Chest 1984; 85:298-99
3. Askanian J, Rosenbaum SH, Hyman AI, Silverberg PA, MilicEmili J, Kinney J. Respiratory changes induced by the large glucose loads of total parenteral nutrition. JAMA 1980; 243:1444-47
8. McCamish MA, Dean RE, Ouellette TR. Assessing energy requirements of patients on respirators. JPEN 1981; 5:513-16
11. MacFie J. Active metabolic expenditure of gastroenterological surgical patients receiving intravenous nutrition. JPEN 1984; 8:371-76
The majority of laboratories performing these analyses have passed within the purview of the pathologists. However, a large number of such laboratories remain under the direction of those most concerned with the application of these data: pulmonary physicians, physiologists, and anesthesiologists. It is these laboratory directors who must ensure a high quality of performance. In addition to the daily calibration and maintenance of the blood gas analysis machines, an excellent program which assists in this regard is the ATS Blood Gas Proficiency Testing Program. Enrollment in this program not only assists with quality control, but provides scientific data on the performance characteristics of the control samples used, as well as the performance of the various blood gas analysis machines. An additional minor benefit is the defensive armamentarium it provides against territorial assaults from hospital bureaucrats and rival, expansionist laboratory directors.

Given the above information on the accuracy and reproducibility of arterial blood gas measurements, as well as the currently available noninvasive techniques, the question arises, is too much use made of the former? The answer is almost certainly, yes. Noninvasive techniques of estimating arterial blood gases developed in the years before the improvement and simplification of the blood gas electrodes. Improvements in the latter overshadowed interest in noninvasive techniques; however, the continuing revolution in the electronics field has resulted in major improvements in the instruments available for noninvasive estimations of arterial blood gases. These techniques have recently been reviewed. It is now perfectly feasible to continuously observe changes in arterial $O_2$ saturation with a high degree of accuracy, similarly, changes in end-tidal $P_{CO_2}$, which accurately reflect changes in arterial $P_{CO_2}$, can be continuously monitored with rapid responding instruments; furthermore, arterial $P_{CO_2}$ can be accurately estimated by simple rebreathing techniques. On the other hand, the accuracy with which measured skin $P_O_2$ and $P_{CO_2}$ reflect arterial $P_O_2$ and $P_{CO_2}$, remains poor. Thus, it is quite feasible to monitor arterial blood gases noninvasively with a very acceptable degree of accuracy. This has particular application to patients in the intensive care unit, where the application of these techniques would reduce patient discomfort and the complications associated with indwelling arterial catheters, while allowing a more continuous assessment of the arterial blood gas status. This is not to suggest that direct arterial blood gas measurements can be dispensed with completely (measurements would still be required to calibrate the noninvasive measurements and to measure the absolute arterial $P_{CO_2}$ and $pH$), but certainly the frequency of such measurements could be drastically reduced. In the interests of patient comfort and cost, it behooves all physicians concerned with these measurements to give serious consideration to more extensive use of noninvasive estimates of arterial blood gases, while at the same time ensuring a high quality of accuracy of the blood gas analysis machines.

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**REFERENCES**

5. ATS arterial blood gas proficiency testing program. New York: American Thoracic Society

**Persistence of Pneumocystis**

The pneumonia caused by *Pneumocystis carinii* in patients with the acquired immunodeficiency syndrome (AIDS) is usually believed to represent activation of a latent infection acquired in early life. Seroepidemiologic studies show that, by four years of age, at least three-fourths of normal individuals have developed antibodies to *P carinii*. Furthermore, discernible disease (pneumonia) occurs almost exclusively in the immunocompromised host. Our current concept is that clinical disease expressed as a severe life-threatening pneumonia is dependent on the host’s degree of immunocompetence.

Both animal and human studies have indicated that specific antimicrobial therapy for *P carinii* does not completely eradicate the organism from the lungs, even though clinical cure rates of up to 75 percent can be achieved. Second episodes of acute *P carinii* pneumonia occur in about 14 percent of cancer patients and at least one-third of AIDS patients who have clinically recovered completely from an initial episode. Also, the duration of episodes is generally longer in AIDS.