Technical communications

Is it necessary to transport arterial blood samples on ice for pH and gas analysis?

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We evaluated whether arterial blood samples for pH and blood gas analysis need to be transported on ice. We found that although the changes in pH, pCO_2 and pO_2 were greater in samples kept at room temperature versus those kept on ice, the difference was probably not of clinical significance until the period of time after arterial puncture exceeded 20 minutes. We recommend that arterial blood samples do not need to be kept on ice if the analysis for pH and gases is performed within 20 minutes of blood being drawn.

Key words
MEASUREMENT TECHNIQUES: blood gases.

There is some controversy in previous studies regarding stability of pH, pCO_2 and pO_2 in arterial blood samples kept at room temperature versus samples stored on ice. Ishikawa *et al.* found no significant changes in pH, pCO_2 or pO_2 in samples chilled initially and then kept at room temperature for up to two hours.[1] Madeido *et al.*, however, have found that samples kept at room temperature for greater than 20 minutes are unsuitable for blood gas analysis;[2] Biswas *et al.* felt that blood should not be left longer than ten minutes at room temperature. We studied this matter further to decide whether it was necessary to store, on ice, arterial blood samples for analysis of pH, pCO_2 and pO_2.

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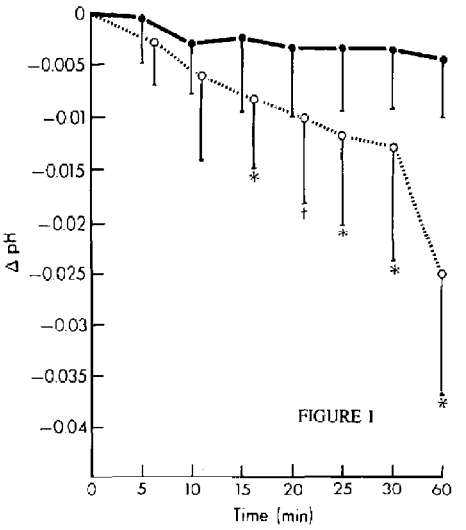
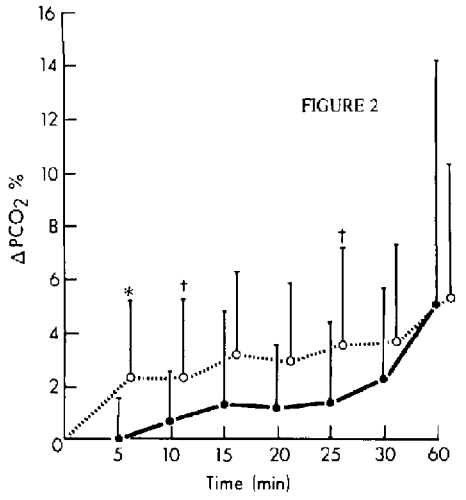
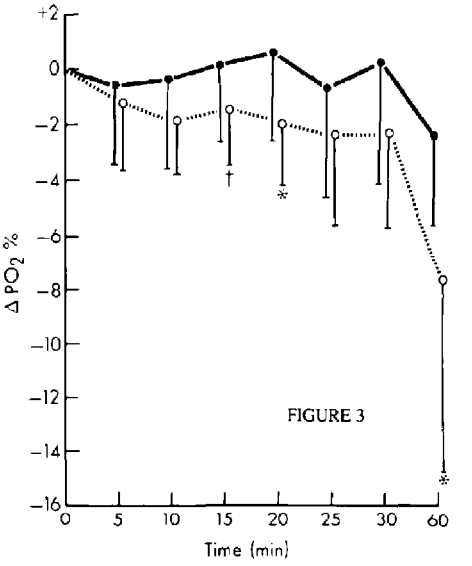
Methods

Arterial blood samples were obtained from an arterial line in duplicate in heparinized 20 ml plastic syringes from 21 patients in an intensive care unit. The volume of heparin in the syringe was about 0.1 ml and the volume of blood obtained was 5–6 ml. The dilution effect of this amount of heparin is well below the level at which dilution produces a measurable effect on pressures of carbon dioxide (pCO_2) oxygen (pO_2) and pH. Any entrapped air bubbles were removed immediately. None of the patients had elevated white counts (> 12,000/cu.mm) and their haematocrit values were within normal limits (35–45 per cent). One of the above samples was stored on crushed ice at 0° C whilst the other was kept at room temperature (22° C). Analysis for pH, pCO_2 and pO_2 was performed on both samples at 0, 5, 10, 15, 20, 25, 30 and 60 minutes after obtaining blood. Analysis was done using a Corning 175 Blood Gas Analyzer. The change in pH, pCO_2 and pO_2 from the original baseline value was calculated for each time interval for each sample. The changes in pCO_2 and pO_2 from the original baseline value were calculated for each time interval as a percentage. The difference







FIGURES 1–3 Comparison of changes in pH (Fig. 1) pCO_2 (Fig. 2) and pO_2 (Fig. 3) in samples kept at room temperature (22° C) (·····) versus those stored on ice (0° C) (——). *Indicates a statistically significant difference ($p < 0.01$). †Indicates a statistically significant difference ($p < 0.05$).

between values obtained for each of the above parameters from samples stored on ice and those kept at room temperature was compared using Student's paired t test. The comparison of differences in the precision of the respective method was used for clinical appraisal of the various changes. The coefficients of variation for pH, pCO_2 and pO_2 in our laboratory at the time the experiment was carried out were: 0.06 units, 2.5 and 3.1 per cent respectively.

Results

The patients had a wide range of pH values (7.17–7.64), pCO_2 (24–77 mmHg) and pO_2 (54–230 mmHg). Figures 1, 2, and 3 show the changes that occur with time for pH, pCO_2 and pO_2. Each point represents the average difference of the 21 samples at respective times with a ±1 SD range. The decrease in pH occurred with samples on ice and at room temperature, the decrease being greater at room temperature (Fig. 1). Figure 2 shows the expected upward trend increase in pCO_2, the change being greater in specimens at room temperature. The decrease in pO_2 is also greater at room temperature, the change being highly significant ($p < 0.01$) from 20 minutes onwards. The Table shows the range of changes seen at each of the above time intervals. Since the resolving power of statistics in these types of application (i.e., use of pH, pCO_2 and pO_2) exceeds the practical clinical

TABLE I Range of changes in samples kept at room temperature (22° C) or stored on ice (0° C)

Time (min)	pH (units)		pCO_2 (%)		pO_2 (%)	
	22° C	0° C	22° C	0° C	22° C	0° C
5	0 to −0.01	0 to −0.01	−2 to +6	−2 to +4	+4 to −4	+2 to −4
10	0 to −0.02	0 to −0.01	−2 to +6	−2 to +4	+1 to −5	+3 to −4
15	0 to −0.02	0 to −0.02	−4 to +8	−2 to +5	+1 to −6	+3 to −6
20	0 to −0.03	0 to −0.02	−2 to +6	−2 to +6	+1 to −6	+3 to −6
25	0 to −0.04	0 to −0.02	−2 to +10	−4 to +8	+1 to −8	+2 to −8
30	0 to −0.05	0 to −0.02	−2 to +10	−4 to +8	+2 to −8	+2 to −8
60	0 to −0.06	0 to −0.02	0 to +24*	0–40†	0–22	+2 to −10

$\mu = 21$.
(−) indicates decrease.
(+) indicates increase.
*Only one sample had a change of 24%, the range for the remaining 20 samples was 0–12%.
†Only one sample had a change of 40%, the range for the remaining 20 samples was 0–12%.

application of the method, the clinical appraisal of changes in pH, pCO_2 and pO_2 with storage is better considered relative to the respective method precisions.

Discussion

There is a general belief that arterial blood samples for pH and gas analysis should be stored on ice. The reason for this is that at 0° C, the rate of cell metabolism is slowed down considerably. Ishikawa *et al.* found no significant changes in pO_2, pH and pCO_2 in samples kept at room temperature up to two hours.[1] Madeido *et al.* found pO_2 measurements in samples kept at room temperature to be acceptable only if analysis was performed within 30 minutes of blood drawing.[2] Biswas *et al.* showed that pO_2 fell significantly by 20 minutes in samples kept at room temperature whilst pH and pCO_2 did not change significantly for up to 30 minutes.[3]

In our study, although the changes in pH, pCO_2 and pO_2 are statistically greater in samples kept at room temperature, those changes do not appear to have major clinical significance until the time of analysis after arterial puncture exceeds 20 minutes. For example, until this time the change in pCO_2 between 0–6 per cent is in most cases of no practical clinical significance. Beyond this time period, the changes in pCO_2 in most samples far exceed the precision for the pCO_2 method. For pO_2 the range of changes seen are similar for up to 30 minutes. These changes in the blood gas and pH parameters observed in our study are smaller than those seen by others. In contrast to the recommendation of Newball[4] who stated that arterial samples for blood gas analysis should be stored on ice, we believe that storage on ice is not necessary if the sample is to be analyzed within 20 minutes of arterial puncture. This applies only to patients who do not have extremely high white cell counts (e.g., leukemics). These patients blood samples have high white cell counts and therefore have an excessive rate of oxygen metabolism and carbon dioxide production.[5] Our data supports the contention that in most cases, arterial blood for pH, pCO_2 and pO_2 analysis can be kept for up to 20 minutes at room temperature. If medical staff have direct access to a blood gas analyzer and can be sure of injecting the blood within 20 minutes, it is acceptable to transport the sample at room temperature. If there is reason to expect delay, syringes should be stored on crushed ice in the time period between obtaining the sample and injection into the machine. However, it is of great importance that the collection and handling of blood samples is done anaerobically.

Differences in pO_2 values have been observed between samples collected in glass and plastic syringes. The pO_2 of samples in plastic syringes may decrease because of diffusion of oxygen into and through the walls of the syringe.[6] The degree of change is dependent on the composition of the plastic; polystyrene syringes show greater changes than those made of polypropylene.[6] However, for

most day-to-day clinical work, plastic syringes are acceptable except for samples with very high pO_2 values.

References

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5 *Hess CE, Nichols AB, Hunt WB.* Pseudohypoxemia secondary to leukemia and thrombocytosis. N Engl J Med 1979; 301: 363–5.

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Résumé

Les échantillons pour gazométrie doivent-ils être transportés dans un baquet de glace? Nous nous sommes posés cette question et avons trouvé que même si les valeurs de pH, de pCO_2 et de pO_2 étaient plus élevées dans les échantillons gardés à la température de la pièce, les différences observées sont probablement sans signification clinique à condition que l'analyse s'effectue moins de 20 minutes après le prélèvement. Nous croyons donc qu'il n'est pas nécessaire de garder ces échantillons sur la glace si l'analyse peut s'effectuer en moins de 20 minutes après le prélèvement.