Short Report

The effect of a time delay on the measurement of capillary blood gases

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Patients using domiciliary nasal ventilation, or long-term oxygen, require regular assessment which could be carried out in the home. Blood gas analysis may be regarded as an essential part of the assessment. The present study investigated the effect of a 1-h time delay on the measurement of capillary blood gases. Four samples of arterialized earlobe blood were collected from 15 outpatients. One sample was analysed immediately, the other three were stored on crushed ice and analysed at intervals of 30, 45, and 60 min post-collection. In order to examine any range effect, a wide range of PaO₂ values were examined.

The delay, at all levels, resulted in minor changes in the measurement of PaO₂, which would be unlikely to alter clinical management. The technique might be used for the reliable assessment of patients in the home.

Introduction

There are increasing numbers of patients receiving assisted ventilation, or long-term oxygen therapy (LTOT), at home. Such patients require periodic assessment, but they are often severely disabled and require ambulance transport to attend hospital appointments. Overnight oximetry is desirable for patients using nasal ventilation. In these situations, assessment at home may be more convenient and cost-effective than a clinic appointment or a night in hospital.

Arterial blood gas analysis may be regarded as an essential part of the assessment, but it requires a practised physician and it is not without risk and discomfort to the patient. Earlobe capillary blood gas analysis is a reliable, alternative method of measuring blood gases (1–3). It does not require a medical practitioner and produces only minor transient discomfort. Therefore, it may be a more suitable method for home assessment. The effect of a time delay before analysis is important if the technique is to be used in this situation.

It is generally the accepted practice to avoid delays before analysis of arterial blood gas samples, thus minimizing any effect from continuing metabolism, and from gaseous diffusion through the walls of the syringe. The extent to which both of these factors effect blood gas tensions and pH has been examined in a number of studies (2–7). Glass syringes and capillary tubes appear to be impermeable to carbon dioxide and oxygen diffusion (2,4), whilst diffusion of oxygen occurs through plastic syringes (2,7). The effects of metabolism (the potential reduction of PaO₂ and increase in PaCO₂) are reduced in samples stored at low temperatures (2,4,7), with the greatest reduction occurring at 0°C (5).

The aim of this study was to measure the effect of a time delay on capillary blood gas analysis and examine any range effect from the initial level of PaO₂.

Methods

Fifteen patients attending the Outpatient Department for routine lung function studies and capillary blood gas analysis were selected to give a wide range of values. The purpose of the study was carefully explained and all selected patients agreed to have additional blood samples collected. This involved collection of a further 300 μL of blood from the earlobe incision, made for the routine test.

The method of sample collection was updated from that described in previous studies (3,8). The earlobe was vasodilated by a liberal application of methyl nicotinate cream (Algipan, Wyeth Laboratories) 10–15 min prior to sampling. Once the lobe was hot, the cream was removed, a rubber bung was
placed behind the lobe and an incision made approximately 3 mm above the lower border using a lancet. The first drop of blood was wiped away, then blood was collected in four pre-heparinized 100 μl glass capillary tubes. If the blood was not free-flowing, a further incision was made. This avoided squeezing the lobe and the risk of contamination by extra-cellular fluid. The blood was collected without air bubbles or gaps, and the tubes were then sealed at both ends with plastic sealing caps.

One sample was analysed immediately. To control for fluctuations in ambient temperature, and minimize any possible effect from continuing metabolic processes, the three remaining samples were stored in crushed ice contained in an ice bucket. These were analysed at 30, 45 and 60 min post-collection. The blood gas machine (Corning 170, Ciba Corning U.K.) had regular, automatic calibration cycles and full quality control checks each day.

The differences between the immediate and delayed analysis were analysed according to the methods described by Bland and Altman (9). Samples with a low PaO₂ (≤8.5 KPa) were compared to those with a higher PaO₂, using the Mann-Whitney U-test. A 5% level of significance was adopted.

Results

A total of 60 samples were collected from 15 patients. The range of values obtained from the immediate analysis were 5.83–11.86 KPa for PaO₂, 4.07–6.91 KPa for PaCO₂, and 7.343–7.481 for pH. The delayed analysis was compared to the immediate analysis and the mean differences and 95% limits of agreement (95% LA) are shown in Table 1. The range of differences at 60 min for PaO₂ and PaCO₂ are illustrated in Fig. 1. The error is consistent across the time intervals, suggesting a systematic error.

The 95% confidence intervals for the mean differences at 60 min were -0.19–0.17 KPa for PaO₂, -0.04–0.55 KPa for PaCO₂ and -0.018–0.034 for pH. These are narrow in comparison to the limits of agreement which define the widest deviation from the mean. There was no significant difference between the samples with a higher PaO₂ (>8.5 KPa, n=8) and

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>+30</th>
<th>+45</th>
<th>+60</th>
</tr>
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<tbody>
<tr>
<td>PaO₂ (KPa)</td>
<td>0.07 (-0.90–1.05)</td>
<td>-0.10 (-0.92–0.72)</td>
<td>-0.01 (-0.72–0.70)</td>
</tr>
<tr>
<td>PaCO₂ (KPa)</td>
<td>0.33 (0.75–1.41)</td>
<td>0.24 (-0.50–0.97)</td>
<td>0.26 (-0.91–1.43)</td>
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<tr>
<td>pH</td>
<td>0.007 (-0.097–0.111)</td>
<td>0.011 (-0.065–0.087)</td>
<td>0.008 (-0.092–0.108)</td>
</tr>
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Mean differences (delayed minus immediate analysis) and 95% limits of agreement for blood gas and pH analysis at 30, 45 and 60 min post-collection.
the samples with a lower $\text{PaO}_2$ (<8.5 KPa), ($P>0.05$) at 60 min.

Discussion

The effect of a time delay before analysis on capillary blood gas and pH measurement has been examined. The results show that a delay of 60 min causes only minor changes in $\text{PaO}_2$ over a wide range of values. These changes would be unlikely to alter clinical judgement. The delay had a more deleterious effect on $\text{PaCO}_2$ and pH, but the tendency to overestimate $\text{PaCO}_2$ is the safer option when considering changes in therapy. As the error is consistent across the time intervals, a correction factor might be applied to obtain the true value.

Several studies have shown that the rate of decline of $\text{PaO}_2$ in stored samples is reduced if the sample, collected in glass, is maintained on ice (2,4,5). The storage medium of crushed ice in an ice bucket rapidly reduces the temperature of small volume capillary samples, and it might easily be used during a domiciliary visit. The samples analysed after the time delay did not clot, therefore the use of a metal stirring rod and magnet to mix the sample to improve anticoagulation, as previous methods have suggested (3), is unnecessary.

The technique of capillary blood gas analysis is simple to perform after a period of practice, and is relatively safe so long as the appropriate precautions are followed (latex gloves should always be worn, disposal of sharps etc.). A 1-h delay before analysis may be reasonably expected for domiciliary visits within urban hospital catchment areas. This study demonstrates that analysis of capillary samples even after 1 h is possible without deterioration in $\text{PaO}_2$, and the technique might be used to make a reliable assessment in the home.

References