A Comparison of Physical and Chemical Methods for the Determination of Respiratory Quotient

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Received January 5, 1970

Summary. An experiment was carried out in which oxygen content, carbon-dioxide content and R.Q.'s obtained on expired air samples by the Haldane technique, were compared with those obtained by means of paramagnetic and infrared analysis. No significant bias was found between Haldane and paramagnetic analysis of oxygen content. Infrared analysis yielded more consistent results for CO₂ than did the Haldane apparatus.

R.Q.'s calculated from the chemical and physical methods were almost identical. Physical methods, when properly used and frequently calibrated, can be regarded as being just as accurate as the accepted standard chemical method.

Key-Words: R.Q. Determination — Analysis of Exhaled Air.

Introduction

In many laboratories where physiological research is done, accepted physical methods are used as the standard procedure for the analysis of expired air. Analysis of air for oxygen content by means of paramagnetic methods [4] has been shown to be more consistent [5, 6] than the conventional chemical analysis and therefore more suitable for routine laboratory work.

Infrared analysis of expired air for carbon-dioxide has become increasingly popular for routine analysis. To date, no information is available on the consistency and reliability of this method of analysis. This applies particularly to R.Q. determinations, because the oxygen and carbon-dioxide content of expired air have equal weightings in the R.Q. equation.

An experiment was carried out to compare the R.Q. values obtained by means of physical methods with those obtained on the same sample by means of a standard Haldane apparatus.

Method

Haldane Apparatus

Two operators with several years experience performed the analysis on two standard Haldane gas analysers. The method they used was, with minor modifications, essentially the same as that described by Douglas and Priestley [3].
Paramagnetic Gas Analyser

Two Beckman Model E2 oxygen analysers were used. All expired air samples were dried by passing the air through anhydrous calcium sulphate. The arrangement of the apparatus was the same as that described by Strydom et al. (1965). The two operators had several years experience in routine gas analysis with this type of instrument. This type of arrangement, where duplicate analysis is performed by two operators, has been shown to eliminate the operator instrument bias [6].

Infrared Analysis

The Beckman L.B. 1 infrared carbon-dioxide analyser, fitted with a breathing-through cell, was used. Zero was set with high purity nitrogen and the instrument was calibrated with approximately 4.0% CO₂ in air [1, 2]. The arrangement was such that both calibration points could be easily checked before and after each analysis. CO₂ concentrations were read directly from the log scale. The CO₂ content of the calibration mixture was obtained from a series of Haldane determinations.

The operator had extensive experience with this instrument.

Sampling Procedure

Expired air samples were collected in Douglas bags, during work experiments on a bicycle ergometer.

Samples to be analysed were first introduced into three small Butyl rubber bladders of about 2--2½ litres capacity in which the air was at a slight positive pressure. They were immediately analysed for CO₂ and O₂ content, after which the chemical analysis was performed.

Results

Fifty-two determinations of oxygen and carbon-dioxide content were used for statistical treatment. A summary of results is given in Table 1.

Oxygen Analysis

The mean difference between the Haldane and Beckman E2 determinations was \(-0.034\%\) \(O₂\), with a standard error of \(0.012\%\).

Carbon-Dioxide Analysis

The mean difference between the Haldane and Beckman L.B. 1 determinations was \(+0.048\%\) \(CO₂\), with a standard error of \(0.0093\%\). The consistency of the infrared analyses exceeded that of the Haldane apparatus.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean difference</th>
<th>Standard error</th>
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<tbody>
<tr>
<td>Haldane-physical methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% (O₂)</td>
<td>(-0.034%)</td>
<td>(0.0124%)</td>
</tr>
<tr>
<td>% (CO₂)</td>
<td>(+0.048%)</td>
<td>(0.0093%)</td>
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<tr>
<td>R.Q.</td>
<td>(+0.0007)</td>
<td>(0.0027)</td>
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