WHICH pH PAPER?†

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In anaesthetic practice it is occasionally necessary to make a rapid and accurate measurement of the pH of the gastric contents. A simple and convenient method is to use paper impregnated with a suitable indicator, the change in colour being read against a comparison chart provided with the paper.

The purpose of this study was to compare the accuracy of interpretation of five different indicator papers when used by anaesthetists to test the pH of buffer solutions in the clinically important pH range 2–6.

MATERIALS AND METHODS

Five different indicator papers were assessed (table I), each taken from stock in current use within the hospital.

Four buffer solutions of pH 2, 3, 4 and 6 were made up in the quality control section of the hospital pharmacy. The pH of each was verified again at the conclusion of the investigation to ensure that no significant alteration had occurred during testing.

Each anaesthetist tested four solutions with each of the five indicator papers, with the jars rearranged between each paper. The results were recorded by a separate observer to remove any bias. Twenty anaesthetists participated in the study; none was colour-blind. The readings were taken with glasses, if worn, against a white background.

<table>
<thead>
<tr>
<th>Indicator paper</th>
<th>Brand</th>
<th>pH range</th>
<th>Number of colours</th>
<th>Special instructions</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Camlab</td>
<td>1–11</td>
<td>Three</td>
<td>None</td>
<td>£4.80/reel</td>
<td></td>
</tr>
<tr>
<td>2 Whatman</td>
<td>1–14</td>
<td>One</td>
<td>Read at 30 s</td>
<td>£4.05/refill</td>
<td></td>
</tr>
<tr>
<td>3 Merck Acilit &amp; Neutralit</td>
<td>0–6</td>
<td>Three</td>
<td>Check while still moist</td>
<td>£5.10/4 reels</td>
<td></td>
</tr>
<tr>
<td>4 Whatman (BDH)</td>
<td>1–5</td>
<td>One</td>
<td>Read at 30 s</td>
<td>£3.50/100 strips</td>
<td></td>
</tr>
<tr>
<td>5 Narrow range</td>
<td>3–7</td>
<td>One</td>
<td>None</td>
<td>£5.10/4 reels</td>
<td></td>
</tr>
<tr>
<td>6 Universal</td>
<td>1–11</td>
<td>One</td>
<td>None</td>
<td>£5.30/4 reels</td>
<td></td>
</tr>
</tbody>
</table>

The results were analysed using the Chi square test.

RESULTS

No solution had deteriorated during the period of the investigation (table II).

SUMMARY

Five different brands of pH indicator paper were used by 20 anaesthetists to test four buffer solutions. There were significantly fewer correct answers with two papers than with the other three. The worst paper in the study (Whatman full range) gave only 20% correct answers, compared with 92.5% from the best (Merck).
Table II. Buffer solutions composition and pH check. All buffers were McIlvaine Buffers. The pH meter was a Radiometer 26 standardized against pH 7.0 and 4.0 buffers.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Composition</th>
<th>pH before testing</th>
<th>pH after testing</th>
</tr>
</thead>
</table>
| pH 2     | Citric acid monohydrate 2.058 g  
Disodium hydrogen  
Orthophosphate anhydrous 0.057 g  
Distilled water to 100 ml. | 1.90 | 2.00 |
| pH 3     | Citric acid monohydrate 1.668 g  
Disodium hydrogen  
Orthophosphate anhydrous 0.584 g  
Distilled water to 100 ml. | 2.83 | 2.90 |
| pH 4     | Citric acid monohydrate 1.290 g  
Disodium hydrogen  
Orthophosphate anhydrous 1.095 g  
Distilled water to 100 ml. | 3.98 | 4.03 |
| pH 6     | Citric acid monohydrate 0.774 g  
Disodium hydrogen  
Orthophosphate anhydrous 1.793 g  
Distilled water to 100 ml. | 6.08 | 6.00 |

A correct answer was taken to be one within 0.5 pH unit of the known pH of the solution. The number of correct answers given by the 20 anaesthetists when each paper was used to test each solution is shown in Table III. The total number of correct answers for each paper is also expressed as a percentage of possible correct answers.

Paper 2 resulted in significantly fewer correct answers than the other papers ($P < 0.001$). Nine participants spontaneously remarked that it was most difficult to distinguish colour change in the pH range 3–6 with this paper.

Paper 5 gave significantly fewer correct answers than papers 1, 3 ($P < 0.001$) and 4 ($P < 0.01$). There was no significant difference in the number of correct answers given with papers 1, 3 and 4.

On questioning as to which paper was found easiest to read, 12 anaesthetists preferred paper 1, five paper 3 and two liked 1 and 3 equally. One found paper 5 easiest to read.

Table III. The number of correct answers given when 20 anaesthetists read each pH paper for each solution.

<table>
<thead>
<tr>
<th>pH 2</th>
<th>pH 3</th>
<th>pH 4</th>
<th>pH 6</th>
<th>Total correct</th>
<th>% correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper 1</td>
<td>16</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>71</td>
</tr>
<tr>
<td>Paper 2</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Paper 3</td>
<td>17</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>74</td>
</tr>
<tr>
<td>Paper 4</td>
<td>13</td>
<td>17</td>
<td>19</td>
<td>17</td>
<td>66</td>
</tr>
<tr>
<td>Paper 5</td>
<td>20</td>
<td>12</td>
<td>14</td>
<td>3</td>
<td>49</td>
</tr>
</tbody>
</table>

Discussion

Acid aspiration syndrome has been recognized as a cause of anaesthetic-associated mortality, and may occur without obvious regurgitation or vomiting in both general and obstetric practice (Mendelson, 1946; McCormick, 1966; Blitt et al., 1970; Harrison, 1978). It has been shown that the aspiration of fluid of pH less than 2.5 and of volume greater than 25 ml causes severe pulmonary damage (Mendelson, 1946; Teabeaut, 1952; Vandam, 1965), although a case of pulmonary damage occurring with an aspirate of pH 3.5 has been reported (Taylor, 1975). If regurgitation occurs, after intubation, the pH of the regurgitated fluid may be tested. If it is sufficiently low, treatment may be instituted which may prevent the onset of the acid aspiration syndrome or ameliorate its course.

pH can be very accurately measured using a pH electrode or complex indicator techniques based on the measurement of colour and utilizing absorptiometers and spectrophotometers. However, in the clinical situation, a rapid and simple method—which can be made available in the anaesthetic room—is more likely to be used and acted upon. Indicator paper, if accurate in this important range, would appear ideal.

This study has shown that the degree of accuracy obtained from five different papers varied widely, from a low of 20% to a maximum 92.5% correct answers. Two papers were shown to be accurate and were liked by those taking part.
in the study: the Camlab paper and the Merck (Acilit and Neutralit) strips. Both of those had a combination of three colour changes which were compared to obtain a result. Therefore, if one colour change was subtle, it was less important than with a single colour change paper. Of the single colour change papers, those giving a more definite colour change were easiest to read and gave more accurate values. The worst paper had only subtle shade changes in the test range, making it more difficult to distinguish differences in pH. This was remarked upon by almost half those participating in the testing (nine out of 20).

Both papers giving the best results were stored in plastic boxes—the Camlab paper as a reel, and the Merck papers as 100 strips per box, so both would be protected from damp and spillage on an anaesthetic machine. The use of a single test (Camlab) rather than a two-strip test (Merck) may be considered to be a marginal advantage.

In conclusion, if an indicator paper is to be kept in the anaesthetic room to test the pH of regurgitated fluid, it should be a paper known to give as high a degree of accuracy as possible when read by anaesthetists.

ACKNOWLEDGEMENTS

I would like to thank Drs G. Lyons and Karen Simpson for their help and encouragement with this work, Mr A. Cawood for making up the buffer solutions, and all those anaesthetists who took part in this study.

REFERENCES


