Collaborative teaching strategies lead to retention of skills in acid-base physiology: a 2-yr follow-up study

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A BASIC UNDERSTANDING of acid-base physiology is critical for the correct assessment of arterial blood gases in the clinical setting (1). In this context, collaborative teaching strategies in the undergraduate classroom setting may be useful, since it has been reported to enhance both transfer and retention of learned material in a time-efficient fashion (3). In a previous study (4), we investigated whether different collaborative teaching strategies would improve medical students’ skills in acid-base physiology. Students received a 45-min ex cathetra class on acid-base physiology, which was followed by a 20-min interactive session, where students assessed eight different arterial blood gases. The latter was either done by conventional group work, where students worked in pairs and spent 2 min on each arterial blood gas, or by Mazur’s peer instruction technique (2), where students worked individually for 1 min and then in pairs of two for 1 min. We found that conventional group work and peer instruction equally enabled second-year medical students to diagnose common acid-base disorders immediately after class, indicating successful transfer of the learned material (4). In the present 2-yr followup study, we investigated whether these collaborative strategies also lead to long-term retention of the learned skills.

We obtained institutional approval for the present study from the Faculty of Health Sciences of the University of Copenhagen, and participation was voluntary. Twenty-four months after our initial study on collaborative teaching strategies for diagnosing common acid-base disorders was conducted (4), we recruited 31 of the 41 students who had originally participated (“collaborative group”), of which 14 students had been subjected to conventional group work and 17 students had been subjected to the peer instruction technique. Furthermore, 58 other fourth-year medical students that had participated in the same physiology course 2 yr earlier, but without any collaborative elements, were recruited (“control group”). The two groups were similar with regard to age, sex, and previous experience with diagnosing acid-base disorders (data not shown). All students underwent an individual written test, in which they were to diagnose acid-base disorders by assessing four arterial blood gases (Table 1). During the test, students received a sheet with normal ranges for all arterial acid-base variables, and for each of the four arterial blood gases, they were to provide a diagnosis and report how confident (0-100%) they felt that their diagnosis was correct. Students completed the test in <5 min. In the analysis of test results, one point was awarded for each correctly diagnosed arterial blood gas, and a maximum of 4 points was awarded for each student.

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Table 1. Arterial blood gases

<table>
<thead>
<tr>
<th>Arterial blood gas</th>
<th>Arterial PO2, kPa</th>
<th>Arterial O2 Saturation, %</th>
<th>Arterial PCO2, kPa</th>
<th>pH</th>
<th>HCO3, mM</th>
<th>Base Excess, mM</th>
<th>Correct diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial blood gas 1</td>
<td>12.0</td>
<td>98</td>
<td>6.7</td>
<td>7.32</td>
<td>24.0</td>
<td>0</td>
<td>Respiratory acidosis without compensation</td>
</tr>
<tr>
<td>Arterial blood gas 2</td>
<td>11.0</td>
<td>96</td>
<td>3.7</td>
<td>7.22</td>
<td>12.9</td>
<td>-15.2</td>
<td>Metabolic acidosis with partial respiratory compensation</td>
</tr>
<tr>
<td>Arterial blood gas 3</td>
<td>11.7</td>
<td>98</td>
<td>6.4</td>
<td>7.53</td>
<td>38.9</td>
<td>15.3</td>
<td>Metabolic alkalosis with partial respiratory compensation</td>
</tr>
<tr>
<td>Arterial blood gas 4</td>
<td>19.3</td>
<td>99</td>
<td>8.5</td>
<td>7.15</td>
<td>18.4</td>
<td>-6.3</td>
<td>Combined respiratory and metabolic acidosis</td>
</tr>
<tr>
<td>Normal range</td>
<td>11.0–14.0</td>
<td>93–98</td>
<td>4.5–6.0</td>
<td>7.35–7.45</td>
<td>22.0–26.0</td>
<td>-2.0 to 2.0</td>
<td></td>
</tr>
</tbody>
</table>

Overall difference between the collaborative and control groups: **P < 0.01.

Fig. 1. Total test scores. Overall difference between the collaborative and control groups: **P < 0.01.
Acid-base disorder. IBM SPSS Statistics for Macintosh (version 22.0, IBM, Armonk, NY) was used to compare test scores and confidence levels by nonparametric statistics (Mann-Whitney U-test). Unless otherwise stated, data are reported as medians with corresponding interquartile ranges.

The collaborative group reached higher total test scores than the control group (P < 0.01; Fig. 1). For three of the four acid-base disorders, a higher proportion of students in the collaborative group reached the correct diagnosis and generally did so with a higher level of confidence (Table 2). Within the collaborative group, there were no differences between test scores or confidence levels of students that had learned acid-base physiology by conventional group work or the peer instruction technique (data not shown).

Our findings indicate that collaborative teaching strategies may both enhance confidence and long-term retention of skills for diagnosing common acid-base disorders, regardless of whether conventional group work or the peer instruction technique is used. Such strategies may therefore be beneficial for conveying the complexity of acid-base physiology to undergraduate students in a time-restricted setup.

**DISCLOSURES**

No conflicts of interest, financial or otherwise, are declared by the author(s).

**AUTHOR CONTRIBUTIONS**

Author contributions: J.P.H. performed experiments; J.P.H., L.N.T., and R.M.G.B. analyzed data; J.P.H., L.N.T., and R.M.G.B. interpreted results of experiments; J.P.H., L.N.T., and R.M.G.B. edited and revised manuscript; J.P.H., L.N.T., and R.M.G.B. approved final version of manuscript; L.N.T. prepared figures; R.M.G.B. conception and design of research; R.M.G.B. drafted manuscript.

**REFERENCES**