Using an essay competition as an alternative tool for enhancing the “learning from learners” teaching approach

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When teaching the cardiac cycle to second-year medical students, we have often experienced that students are puzzled by the occurrence of the dicrotic notch (or aortic incisura) and dicrotic wave (Fig. 1), which is observed in the aortic blood pressure signal as the aortic valve closes and left ventricular systole ends.

Even though the dicrotic notch and wave were first demonstrated in invasive blood pressure recordings as far back as the mid-19th century (2), their exact origin was largely disputed until about 40 yr ago (3). Hence, some primarily considered the dicrotic notch a result of transient expansion of the aorta, whereas the dicrotic wave was thought to reflect the consequent rebound of the aortic wall; others argued that stretch of the distensible aortic leaflets back into the left ventricle at the onset of diastole contributed to the dicrotic notch by transiently expanding the aortic root, while the elastic recoil of the valve was involved in the subsequent dicrotic wave (2, 3). Several lines of evidence indicate that it is primarily the latter that causes the dicrotic notch and wave (3). In brief, the aortic diameter decreases during the dicrotic notch and increases during the dicrotic wave, that is, the opposite of what would be expected if aortic diameter changes were to cause these phenomena (3). The aortic valve leaflets do indeed appear to bulge into the left ventricle due to the aortic-left ventricular pressure differential as the dicrotic notch appears. Furthermore, the valve subsequently recoils back out toward the aorta, at which time the dicrotic wave is observed (3). The onset of the aortic dicrotic notch is thus an accurate marker of the end of systole and onset of diastole, which is extensively used both experimentally and clinically, for example, to synchronize cardiac assist devices with the cardiac cycle in patients suffering from cardiogenic shock.

The dicrotic notch and wave encompass a valuable opportunity for a plenary discussion of the interplay between left ventricular and aortic pressures during the cardiac cycle. In an attempt to enhance “learning from learners” in our cardiovascular physiology classes (4), we often encourage curious medical students to seek information on the origin and physiological significance of the dicrotic notch and wave themselves and then present it to their peers in the following class and/or write an essay on the matter. However, in our experience, it is extremely difficult to get students involved in such activities, unless it is directly relevant to their forthcoming exam.

We therefore attempted an alternative approach by arranging an essay competition for all 223 second-year medical students enrolled at the cardiovascular physiology course in the spring of 2013, which was announced in the medical school journal. Participants were to write a two-page essay on the origin and physiological significance of the aortic dicrotic notch and wave and submit it to a designated e-mail address that was established for the occasion.

Essays were evaluated blindly and ranked by us, specifically focusing on 1) the students’ ability to integrate the appropriate physiological concepts (0–10 points), 2) that the physiological analysis was systematic and concise (0–10 points), 3) clinical perspectives (0–10 points), and 4) an overall assessment of the essay (0–10 points). The essay with the highest cumulated score would win the competition, and, in case of a draw, the essay with the highest rank score would win. An online medical equipment business (www.stetoskop.dk) sponsored a stethoscope for the winner, and the winning essay would subsequently be published in the medical school journal.

Six of the two hundred twenty-three medical students participated in the essay competition, yielding a total of five essays. All essays were of a high quality and thus received high cumulated scores (Table 1). The participation was thus expectedly low; yet, by publishing the winning essay (1) after appropriate editing and with an editorial written by us, the information on the dicrotic notch and wave that was presented in a peer-to-peer manner in the essay was made available as a learning opportunity to all students.

After publication of the essay, 70 second-year medical students participated in a Facebook poll regarding its utility as a teaching tool; 77% acknowledged that they found the essay useful for understanding the physiological basis of the dicrotic notch and wave, whereas 19% were unsure, and 4% did not.

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Fig. 1. The dicrotic notch and wave in the aortic blood pressure signal. [Modified from Ref. 3 with permission.]
find it useful. Notwithstanding that this may to some extent be related to the Hawthorne effect, that is, that the essay was so well received because of the novelty of this teaching practice in our medical school, the published winning essay will be used in future cardiovascular physiology courses for second-year medical students. Hence, students will receive a home assignment on the origin of the dicrotic notch and wave at the end of the class on the cardiac cycle. Some students may then find the published winning essay online when working on the home assignment, and, in any event, all students will receive a copy of it in the following class, in which the Wiggers diagram will be the subject of a plenary discussion. In this manner, the winning essay may serve as an alternative tool for enhancing the “learning from learners” teaching approach. A similar approach may be used on various other physiological concepts that students traditionally find difficult, for example, the impact of gravity on ventilation-perfusion relationships in the upright lung when teaching pulmonary gas exchange and the importance of counter-current multiplication when teaching the tubular transport of Na\textsuperscript{+}, Cl\textsuperscript{−}, and water in renal physiology.

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AUTHOR CONTRIBUTIONS

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

REFERENCES


Table 1. Essays on the dicrotic notch and wave

<table>
<thead>
<tr>
<th>Essay</th>
<th>Cumulated Score</th>
<th>Ranks*</th>
<th>Age and Sex of the Student(s)</th>
<th>Total Time Spent on the Essay</th>
<th>Search Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>88</td>
<td>1, 1, 4</td>
<td>22 yr, female</td>
<td>&gt;8 h</td>
<td>PubMed, Google scholar, Google, medical textbooks</td>
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<tr>
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<td>23 yr, female</td>
<td>4–8 h</td>
<td>PubMed, Google scholar, Wikipedia, medical textbooks</td>
</tr>
<tr>
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<td>22 yr, male</td>
<td>4–8 h</td>
<td>Google</td>
</tr>
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<td>23 yr, male</td>
<td>4–8 h</td>
<td>Medical textbooks</td>
</tr>
<tr>
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<td>62</td>
<td>5, 5, 5</td>
<td>25 yr, male; 22 yr, female</td>
<td>&gt;8 h</td>
<td>Pubmed, Google, medical textbooks</td>
</tr>
</tbody>
</table>

The cumulated score was based on scores of 0–40 from the three evaluators. *Ranks were based on individual scores given by each of the evaluators (R. M. G. Berg, L. N. Toksvang, and R. Jabbari), where 1 = highest score and 5 = lowest score.