Self-Directed Deliberate Practice vs. Lecture for Teaching Cardiac Auscultation: a Randomized, Controlled Trial

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Background

- Medical students, residents have substandard auscultation skills that do not improve with training/experience\(^1\)
- Lecture/seminar has been preferred teaching method for > 90% surveyed

Theoretical framework

**Multimedia lecture**
- Uses multiple sensory inputs (audio with visual, diagrams) to imprint to memory

**Deliberate practice self-study**
- Shorter exposure-feedback cycles
- Can be dispersed over time
- Learner can focus on areas of weakness
- Lower intrinsic cognitive load (less to process!)

Auscultatory findings in aortic stenosis:

1) Mild aortic stenosis causes a mid-systolic murmur loudest over the aortic valve
2) More severe aortic stenosis results in a prolonged systolic murmur with a quiet A2 and reverse splitting of the second sound
Methods

• Design
  – RCT of two methods (lec vs self-study)
  – Improvement in posttest score vs. pretest was primary outcome at 4 and 12 weeks

• Participants
  – 83 non-cardiologist physicians, single institution
    • 57 practicing physicians, 26 residents in training
Measure

- 15-question audio recognition test
  - 1 normal, 7 abnormal sounds
    - Represented 7 most important described by IM PD’s
    - Sounds from digital recordings validated previously
  - 10 seconds (8 beats) of each heard
  - Multiple choice selection from 9 choices

- Identical sounds used for pretest, posttest and both training groups
Interventions

Control

• Given one-time multimedia (audio, diagrams) lecture
• Grouped in syst, dia, extra heart sounds, compare-contrast format
• 1280 beats heard thru stereo speakers
• Given iPod with no audio files as honoraria

Intervention

• Given iPod with eight, 15-second files- sound (8 beats) followed by identification of sound
• Told to practice on own
• Playcounts interrogated to determine exposure
## Baseline characteristics of participants

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Control n=40</th>
<th>Intervention n=43</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>34.8 (9)</td>
<td>36.7 (9)</td>
<td>.32</td>
</tr>
<tr>
<td><strong>Training status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resident</td>
<td>13 (33)</td>
<td>13 (30)</td>
<td>.82</td>
</tr>
<tr>
<td>Physician</td>
<td>27 (68)</td>
<td>30 (70)</td>
<td>.82</td>
</tr>
<tr>
<td><strong>Years since medical school graduation</strong></td>
<td>8.8 (10)</td>
<td>10.2 (9)</td>
<td>.46</td>
</tr>
<tr>
<td><strong>Self-rated auscultation proficiency</strong></td>
<td>2.97 (1)</td>
<td>2.91 (1)</td>
<td>.75</td>
</tr>
<tr>
<td><strong>Raw Pre-Test Score</strong></td>
<td>4.48 (2.4)</td>
<td>5.09 (2.4)</td>
<td>.25</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Control (Lecture) Mean (SD)</td>
<td>Intervention (Self-Study) Mean (SD)</td>
<td>p-value*</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>-----------------------------</td>
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</tr>
<tr>
<td><strong>Exposure to training</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of beats heard during formal training</td>
<td>1280 (0)</td>
<td>1980 (1609)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Total time spent training, minutes</td>
<td>60.0 (0)</td>
<td>51.75 (40.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Primary outcome: change in score from pre- to posttest</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 weeks</td>
<td>1.35 (3.08)</td>
<td>3.65 (3.61)</td>
<td>.003</td>
</tr>
<tr>
<td>12 weeks</td>
<td>1.13 (3.23)</td>
<td>4.42 (3.41)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Effect size of educational intervention (in SD units)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect size</td>
<td>0.40 SD units</td>
<td>1.48 SD units</td>
<td></td>
</tr>
<tr>
<td>Learner satisfaction</td>
<td>Control (Lecture)</td>
<td>Intervention (Self-study)</td>
<td>p-value</td>
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<tr>
<td>Would recommend modality to a friend (6-point Likert)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 weeks</td>
<td>4.49 (1.37)</td>
<td>5.12 (1.19)</td>
<td>.03</td>
</tr>
<tr>
<td>12 weeks</td>
<td>4.23 (1.59)</td>
<td>5.19 (0.94)</td>
<td>.002</td>
</tr>
<tr>
<td>Learner Self-Rated Proficiency (6-point Likert)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 weeks</td>
<td>2.79 (0.92)</td>
<td>3.26 (1.09)</td>
<td>.04</td>
</tr>
<tr>
<td>12 weeks</td>
<td>2.94 (1.13)</td>
<td>3.35 (1.13)</td>
<td>.10</td>
</tr>
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</table>

Self-rated proficiency correlated better with actual in intervention group (r=.59) than control (.37)
Change in Auscultation Score Versus Exposure to Heart Sounds

Change in score from pretest to week 12 posttest

Total number of heart sound exposures in 12 weeks

- 1280 (control group)
- <1000
- 1000-2000
- 2000-3000
- >3000

n=14
n=14
n=5
n=10
n=40
Discussion

• Auditory recall using self-study is quite effective compared to control using lecture
  – Feasible in group that included busy full-time docs
  – More likely to be recommended to friend
  – Comparable total study time (51 (int) vs 60 min (control)
Comparison with literature

• 24 other interventions in literature (see handout)
  – 17 used multimedia interventions
  – 19 with no control or no intervention in control-
    • Markedly positive results
  – 5 with active control interventions (4 RCT’s)
    • Modest positive or no effect seen

• Avg. training exposure: 6.42 ± 7 hours
Strengths and Limitations

• Strengths
  – No dropout, feasible on practicing docs
  – Able to fully characterize exposure to self-study

• Limitations
  – Single center
  – Recognition of *identical sounds* tested, not in vivo
  – Lecture done as *one-time* intervention
  – Longer duration from exp->retest in control grp
  • Subgroup analysis (n=11) no use, weeks 4 and 12: revealed no significant difference between 4-week and 12-week raw posttest score (7.00 ± 3.8 versus 6.8 ± 2.3, \( p = .87 \)).
Conclusions

• Heart sounds: varying quality, pitch, all <1 sec
  – Need large quantity of repeat, feedback
    • Deliberate Practice theory
    • ‘Like knot tying!’ (Barrett)

• Student-centered, feedback-rich, technology-harnessed interventions are our future
  • Khan Academy

• Intercollation with lecture?

• Educational technology should be tested by RCT to further advance the field

Questions?

• Thank you!

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