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Determining Effectiveness of EBM Education in Otolaryngology Residents Using Modified Fresno Test

Shahin Bastaninejad, MD; Akbar Soltani, MD; Soheila Dabiran, MD; Amin Amali, MD; Suzan Adil, MD; Pedram Borghei, MD; Alireza Mazarei, MD

Objectives: To determine the effectiveness of education in evidence-based medicine (EBM) on the knowledge, competency, and skills of otolaryngology residents of Tehran University of Medical Sciences (TUMS) at Amir-Alam and Imam Khomeini Hospitals.

Methods: In a quasi-experimental (before-and-after) study, all ear, nose, and throat residents of TUMS (n = 41) entered the study. The residents underwent the modified Fresno test. Then, two EBM workshops with a similar content were held on 2 separate days in each hospital, with each session lasting 6 hours. The learned material was practiced in weekly journal clubs. Six months after the workshop, the modified Fresno test was applied again, and the results were analyzed.

Results: A significant improvement in the modified Fresno test score was observed. The mean score of the modified Fresno test was 57.43 ± 22.07 before the workshop and 79.26 ± 22.48 after the workshop (P < 0.001).

Conclusion: The results of the study show that EBM education and practice of the learned materials in journal clubs can improve the knowledge and skills of residents. Further research with larger samples is needed to improve the precision of our findings and to increase confidence in the results.

Key Words: Evidence-based medicine, Fresno test, otolaryngology residents.

Level of Evidence: 2

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INTRODUCTION

Evidence-based medicine (EBM) is defined as the integration of best human-oriented clinical research evidence, decision maker’s clinical expertise, and patient preferences and conditions (concerns, expectations, and values).1-2 EBM is a competency that allows physicians to optimize patient care based on scientific evidence.3,4

The Accreditation Council for Graduate Medical Education (ACGME) endorses the availability of evidence-based medical skills for all residents;5 however, despite such endorsement, the quality of EBM education is not acceptable.6 The goal of EBM teaching in residency programs is to facilitate incorporation of EBM practice in their postgraduate period.7 EBM is usually taught through journal clubs,8-15 It is widely accepted that EBM should be integrated into actual clinical practice rather than classroom training.16 The health professional students’ estimation of their own competency in EBM is often exaggerated. For example, medical students usually overrate their knowledge and skills about searching and evaluating the medical literature. Therefore, objective assessment of EBM is important.17

Researchers have designed a five-step curriculum for evidence-based practice as the core principles of its learning,18 including Ask, Acquire, Appraise, Apply, and Assess.18

To assess and guide posteducation changes, the educators require valid, practical, and comprehensive instruments to measure the learners’ knowledge and skills.18 Although more than 100 models have been developed to assess the effectiveness of the EBM curriculum,19 only the Fresno test20 is valid and reliable enough to measure a broad range of evidence-based knowledge and skills.18,21

Considering the ever-increasing importance of EBM, and because no study has investigated methods of improving EBM principles in otolaryngology residents around the world, we decided to teach EBM core principles to ear, nose, and throat (ENT) residents of Amir-Alam Hospital and Imam Khomeini Hospital Complex, Tehran, Iran, and to assess them using the standard modified Fresno tests before and after practicing them regularly in weekly journal clubs. The aim of this project was to enhance the knowledge and skills of otolaryngology residents related to EBM for better management of patients, using the latest medical information.
MATERIALS AND METHODS

All first- to third-year otolaryngology residents of Tehran University of Medical Sciences (TUMS) working in Amir-Alam and Imam Khomeini Hospitals (n = 41) were included in a quasi-experimental before/after study. Before the study, the subjects participated in a briefing session to receive information on the research objectives. Participation was voluntary.

The protocol of the study was approved by the Ethics Committee of TUMS and the Research Committee of the ENT Department (IR.TUMS.VCR.REC.1395.1008). Demographic data, including sex and level of residency, were obtained from the residents. Residents who did not participate in the educational session were removed from the study.

The modified Fresno test was used to assess the residents’ competence in EBM. The modified Fresno test contains two clinical scenarios, seven short-answer questions, and five fill-in-the-blank questions. The special scoring system of the modified Fresno test was applied as suggested by test developers.18 The test was graded by two researchers. The maximum score of the test is 224.18 With respect to domains, question 1 is related to Ask; questions 2 and 4 are related to Acquire; questions 3, 5, 6, 8, and 10 through 14 are related to Appraise; and question 7 is related to Apply.19 The domain of Assess is not evaluated by the modified Fresno test.

The modified Fresno test lacked a Persian version; therefore, after obtaining the permission of the test developer in writing, backward-forward translation was performed. The test was translated from English to Persian by two translators and then translated back from Persian to English by two other translators. Finally, a moderator provided the final version using the English and Persian versions. The experts’ comments were applied to enhance the content validity of the final version. To determine its validity, the comments of 10 ENT and community medicine professors were collected, and a content validity ratio of 0.7 was obtained.

To test the reliability, the Persian version of the test was used in 30 first-year internal medicine residents. These residents only participated in a pilot study to determine the reliability of the translated version of the modified Fresno test and were not included in the main study. In the pilot study, the sample size was calculated as 10 participants, but all ENT residents were included due to their interest. We asked all the residents about participation in any previous training course of EBM and made sure none of them had EBM training before this study.

The split-half method was used to test the reliability of the modified Fresno test, which showed a reliability coefficient of 0.645. In terms of internal consistency, the Cronbach’s alpha of the test was 0.694.

The modified Fresno test was applied to all ENT residents in both hospitals. Then, two EBM educational sessions with a similar content were held in Amir-Alam Hospital and Imam Khomeini Hospital Complex on 2 separate days, each lasting 6 hours, in coordination with the Medical Education Development Office. For prevention of teaching to the test bias, we asked an expert in the field of EBM to design our course based on core principles of EBM. During a 6-hour session, according to the EBM curriculum, the core principles were taught to residents and professors of both centers through interactive lectures and problem-solving methods. After the session, questions were raised relating to EBM in weekly journal clubs. Six months before the study started, the professors of Imam Khomeini Hospital Complex and Amir-Alam Hospital agreed to follow a uniform protocol for journal clubs and planned the agenda of journal clubs to meet various objectives (keeping a current journal, evidence-based journal, and grand round journal). The core principles of EBM were questioned and reviewed in all journal clubs. Six months after the educational session, the modified Fresno test was applied, and the results were analyzed. The participants were assured of data confidentiality at each stage of the study.

The results of the modified Fresno test, before and after the educational intervention, were compared using SPSS version 22. A paired t test was applied to compare the results before and after the intervention, and an analysis of variance was used to compare different groups of participants. Quantitative data were described by mean and standard deviation (SD), and qualitative data were presented by frequency and percentage. Nonparametric tests, such as the Wilcoxon test, were used if necessary. P values less than 0.05 were considered significant.

RESULTS

Forty-one ENT residents completed the study: 14 were male and 27 were female. Level of residency was as follows: 16 residents were in first year; 13 residents were in second year; and 12 residents were in third year. The results of the study show a significant improvement in the total score of the modified Fresno tests, as well as the scores of all domains except for Ask after the educational intervention.

Table I shows the mean, SD, mean change score, confidence interval (CI), and standardized mean difference (SMD) of the total score, as well as the scores of different domains before and after the educational intervention. There was no significant difference in the test score between male and female residents. Despite a lack of difference in the test score between different residency levels before education, there was a significant difference in the test score between the third-year and second-year residents (P < 0.001) and between the third-year and first-year residents (P = 0.02). Table II presents

<table>
<thead>
<tr>
<th>Preintervention score, Mean (SD)</th>
<th>Postintervention score, Mean (SD)</th>
<th>Mean Change Score</th>
<th>P Value</th>
<th>CI Lower Limit</th>
<th>CI Upper Limit</th>
<th>SMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask</td>
<td>8.48 (4.51)</td>
<td>9.65 (5.27)</td>
<td>1.17</td>
<td>0.24</td>
<td>-0.16</td>
<td>0.63</td>
</tr>
<tr>
<td>Acquire</td>
<td>14.29 (8.09)</td>
<td>18.04 (9.02)</td>
<td>3.75</td>
<td>0.00</td>
<td>0.15</td>
<td>0.71</td>
</tr>
<tr>
<td>Appraise</td>
<td>30.58 (15.53)</td>
<td>44.59 (17.78)</td>
<td>13.98</td>
<td>0.00</td>
<td>0.46</td>
<td>1.19</td>
</tr>
<tr>
<td>Apply</td>
<td>4.07 (4.78)</td>
<td>7 (4.52)</td>
<td>2.93</td>
<td>0.00</td>
<td>0.27</td>
<td>0.97</td>
</tr>
<tr>
<td>Total</td>
<td>57.43 (22.07)</td>
<td>79.26 (22.48)</td>
<td>21.83</td>
<td>0.00</td>
<td>0.62</td>
<td>1.32</td>
</tr>
</tbody>
</table>

CI = confidence interval; SD = standard deviation; SMD = standardized mean difference.

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the mean preintervention and postintervention score, SD, P value, CI, and SMD for each question (Table II).

**DISCUSSION**

The present study was carried out as a before-and-after (quasi-experimental) study to evaluate the effect of education in EBM on the knowledge and skills of otolaryngology residents of TUMS in 2016 using the modified Fresno test. As in a study by Dinkevich et al.,22 the core principles of EBM were discussed in a brief educational session. The results confirmed the effectiveness of the intervention considering the significant improvement in scores after the intervention. Previous studies have also shown that core EBM principles can be taught to residents22,23 and students.24,25

In our study, the presented material was practiced in weekly journal clubs, including the current, evidence-based, and grand round journal clubs. In the evidence-based journal, the residents had to consider the core principles of EBM in the journal, such as designing a specific clinical question, search techniques, appraisal, and how to implement the journal conclusions in the clinical situations. In keeping the current journal, residents searched valid journals for up-to-date ENT articles and presented them. In the ground round journal, residents searched different reference books and articles for certain topics and presented them. The aim of the variety of journals, in addition to teaching the principles of EBM and enabling learners to select the best articles, appraise them, and use them in the clinical setting, was to improve the residents’ reading habits through searching valid journals to keep them up-to-date. Lai et al.16 and Herur et al.26 also used the journal club method. In the study conducted by Lai et al., each journal club presentation included a relevant clinical question, search strategies, and a critical appraisal of the retrieved articles, followed by discussion on how the findings apply to patients. The journal club presentations were based on the students’ portfolio. Herur et al.26 concluded that integration of EBM into journal club sessions is effective in improving the residents’ clinical decision making. We also agree with Herur et al. that regular practice of EBM principles in journal clubs can enhance the residents’ clinical decision-making abilities.

To increase the participation of residents in the EBM class, this class was held as a 6-hour session on 2 separate days in the two hospitals. The participants took the modified Fresno test before and 6 months after the intervention. During these 6 months, the learned material was practiced in weekly journal clubs. McClusky and Lovarini27 applied the tests before, immediately after, and 8 months after the educational intervention. During the 8 months, instead of journal clubs, they used e-mail, telephone contact, and workplace visits for support and follow-up. Their results also showed significant changes.

We noticed a significant improvement in the total score of the modified Fresno test, as well as the scores of all domains except for Ask. The power of the study considering the preintervention and postintervention score and a significance level of 0.05 was 0.99, whereas the power of the domain of Ask was 0.2, indicating the need for a larger sample size to show the difference. Smith et al.24 also reported a significant improvement in the total score and the scores of all domains except for Appraise. They only included first-year residents, whereas we recruited first- to third-year residents. Moreover, we assessed the association of EBM and its results with the residents’ sex and level of residency; the results showed no association with sex, whereas a significant improvement was seen in third-year residents as compared with second-year and first-year residents.

---

**TABLE II.**

<table>
<thead>
<tr>
<th>Question Number and Area of Knowledge Tested (format)*</th>
<th>Total Score Allocated</th>
<th>Mean (SD)</th>
<th>Mean (SD)</th>
<th>P Value</th>
<th>CI Lower Limit</th>
<th>CI Upper Limit</th>
<th>SMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ask: Formulation of clinical questions</td>
<td>24</td>
<td>8.48 (4.51)</td>
<td>9.65 (5.27)</td>
<td>0.24</td>
<td>−0.16</td>
<td>0.63</td>
<td>0.23</td>
</tr>
<tr>
<td>2. Acquire: Sources of evidence</td>
<td>24</td>
<td>6.73 (3.7)</td>
<td>7.96 (5.85)</td>
<td>0.17</td>
<td>−0.03</td>
<td>0.53</td>
<td>0.24</td>
</tr>
<tr>
<td>3. Apprise: Study design to answer clinical question in No. 1</td>
<td>24</td>
<td>9.29 (5.31)</td>
<td>10.17 (5.44)</td>
<td>0.28</td>
<td>−0.10</td>
<td>0.42</td>
<td>0.16</td>
</tr>
<tr>
<td>4. Acquire: Search techniques</td>
<td>40</td>
<td>7.56 (5.8)</td>
<td>10.09 (5.26)</td>
<td>0.00</td>
<td>0.14</td>
<td>0.76</td>
<td>0.44</td>
</tr>
<tr>
<td>5. Apprise: Relevance</td>
<td>24</td>
<td>3.24 (4.08)</td>
<td>4.41 (3.67)</td>
<td>0.19</td>
<td>−0.12</td>
<td>0.72</td>
<td>0.29</td>
</tr>
<tr>
<td>6. Apprise: Internal validity</td>
<td>24</td>
<td>6.21 (5.72)</td>
<td>7.29 (7.52)</td>
<td>0.17</td>
<td>−0.15</td>
<td>0.47</td>
<td>0.15</td>
</tr>
<tr>
<td>7. Apply: Magnitude of effect</td>
<td>24</td>
<td>4.07 (4.78)</td>
<td>7 (4.52)</td>
<td>0.00</td>
<td>0.27</td>
<td>0.97</td>
<td>0.61</td>
</tr>
<tr>
<td>8. Apprise: Study design study on prognosis</td>
<td>16</td>
<td>3.46 (2.96)</td>
<td>6.92 (5.65)</td>
<td>0.00</td>
<td>0.31</td>
<td>1.20</td>
<td>0.75</td>
</tr>
<tr>
<td>10. Apprise: Statistical expression on the value of diagnosis/screening tools</td>
<td>12</td>
<td>3.12 (3.4)</td>
<td>3.80 (3.74)</td>
<td>0.3</td>
<td>−0.15</td>
<td>0.52</td>
<td>0.18</td>
</tr>
<tr>
<td>11. Apprise: Statistical expression on the value of therapeutic tools</td>
<td>16</td>
<td>2.21 (3.14)</td>
<td>5.9 (5.65)</td>
<td>0.00</td>
<td>0.35</td>
<td>1.25</td>
<td>0.79</td>
</tr>
<tr>
<td>12. Apprise: Understanding of 95% confidence interval</td>
<td>4</td>
<td>0.09 (0.62)</td>
<td>1.26 (1.88)</td>
<td>0.00</td>
<td>0.39</td>
<td>1.27</td>
<td>0.82</td>
</tr>
<tr>
<td>13. Apprise: Study design study on diagnosis</td>
<td>4</td>
<td>0.58 (1.43)</td>
<td>1.85 (2.01)</td>
<td>0.00</td>
<td>0.35</td>
<td>1.09</td>
<td>0.71</td>
</tr>
<tr>
<td>14. Apprise: Study design study on prognosis</td>
<td>4</td>
<td>2.34 (1.99)</td>
<td>2.92 (1.79)</td>
<td>0.15</td>
<td>−0.12</td>
<td>0.73</td>
<td>0.30</td>
</tr>
</tbody>
</table>

*Question number 9 was dropped from the final version of the modified Fresno test due to poor psychometric performance by the creator of the modified Fresno test.

CI = confidence interval; SD = standard deviation; SMD = standardized mean difference.
In this study, a significant improvement was seen in the scores of questions 4, 7, 8, 11, 12, and 13, four of which related to Appraise, whereas one question related to Apply and one to Acquire. There were no marked changes in the five questions related to Appraise compared with one question related to Ask and one question related to Acquire.

In comparison, Lai and Teng\textsuperscript{16} used the 12-question version of the Fresno test, with a maximum score of 212. In their study, significant improvement was observed in seven questions, and the scores for five out 12 questions did not improve significantly after the intervention. We believe that, although changes in all questions are not as meaningful as in Lai et al.’s study and most of these questions are located in the domains, the improvement of domain was significant—except for the domain of Ask, which contains only question number 1. It seems that nonsignificant result in the domain of Ask is related to the resident’s familiarity with formulating a clinical question in other fields of the medicine.

Farihan et al.\textsuperscript{25} used the 12-question version and reported a significant increase in the scores of all domains. It seems that the domain of Appraise requires more education. Moreover, Population, Intervention, Comparison, Outcome (PICO) principles should be practiced with residents, and EBM principles should be applied in actual situations at the patient bedside.

**Limitations and Recommendations**

It is better to conduct a postintervention test immediately after the EBM workshop to assess the effectiveness of journal clubs. The core principles of EBM taught as a brief intervention increased the mean score of the modified Fresno test from 57.43 to 79.26. Although the increase was significant, indicating the progress of the residents, a greater improvement was expected to be achieved through education, which may be because the intervention was presented in a single session. We suggest that the number of EBM workshops be increased. Another limitation of the study was lack of a control group.

Although our results are statistically significant, the broad confidence intervals limit our certainty in the results and in many cases cannot exclude trivial or small effect sizes that may not be clinically relevant or important. Further research with larger samples is needed to improve the precision of our findings and to increase confidence in the results.

**CONCLUSION**

The results of the current study show that EBM educational sessions and practicing the learned material in journal clubs can improve the knowledge and skills of EBM among otolaryngology residents.

**Acknowledgment**

We would like to thank Professor Tilson for generous permission to use her valuable article\textsuperscript{18} and the modified Fresno test in our research. This study was part of the MD thesis of Dr. Suzan Adil, ENT Resident, supported by TUMS (grant 95-02-48-32592).

**BIBLIOGRAPHY**


