

A Cross-Sectional Study of Medical Student Knowledge of Evidence-Based Medicine as Measured by the Fresno Test of Evidence-Based Medicine.

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Smith, A. B., Semler, L., Rehman, E. A., Haddad, Z. G., Ahmadzadeh, K. L., Crellin, S. J., & ... Kane, B. G. (2016). A Cross-Sectional Study of Medical Student Knowledge of Evidence-Based Medicine as Measured by the Fresno Test of Evidence-Based Medicine. *The Journal Of Emergency Medicine, 50*(5), 759-764. doi:10.1016/j.jemermed.2016.02.006.

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Ultrasound in Emergency Medicine



A CROSS-SECTIONAL STUDY OF MEDICAL STUDENT KNOWLEDGE OF EVIDENCE-BASED MEDICINE AS MEASURED BY THE FRESNO TEST OF EVIDENCE-BASED MEDICINE

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Abstract—Background: Evidence-based medicine (EBM) has been included in the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Emergency Medicine (ABEM) milestones project as a required component during emergency medicine (EM) residency training. Milestone Level One states that graduating medical students must be able to “describe basic principles of EBM.” **Objective:** We sought to identify the EBM skills of third- and fourth-year medical students. **Methods:** Our institution, a network with 17 different residencies, hosts U.S. osteopathic and allopathic medical students. As a part of orientation, students are required to complete an entry Fresno Test of EBM (FTEBM). **Retrospectively,** medical student FTEBM scores from 2011 were assessed using descriptive statistics. **Results:** Four hundred seventeen FTEBM scores were analyzed. Participants represented 40 medical schools, including 17 allopathic (MD) and 23 osteopathic (DO) schools. Fifty percent of participants ($n = 210$) were female, and 51.6% ($n = 215$) were from a DO medical school. Overall mean performance for the FTEBM was 47.2%. Exploring the results by individual question were (individual EBM question topics are in parentheses): 1A (study question), 62.0%; 1B (study question), 64.4%; 2 (sources of evidence), 67.6%; 3 (study design), 57.1%; 4 (search strategies), 53.2%; 5 (relevance), 41.2%; 6 (internal validity), 43.6%; 7 (magnitude), 37.8%; 8 (two-by-two grids), 30.0%; 9 (number needed to treat), 16.9%; 10 (confidence intervals), 34.3%; 11 (diagnosis), 5.0%; and

12 (prognosis), 43.4%. **Conclusions:** As measured by the FTEBM, senior medical students demonstrate understanding of about half of EBM. EM residencies can anticipate the need to instruct their residents in EBM concepts in order to meet ACGME/ABEM milestone requirements. © 2016 Elsevier Inc.

Keywords—EBM; Fresno

INTRODUCTION

The Accreditation Council on Graduate Medical Education’s (ACGME) milestone project, also known as the next accreditation system (NAS), went into effect July 1, 2013, setting an expectation that medical students will graduate medical school at milestone Level One (1). This project replaced the six core competencies with more explicit definitions of expected results with measurable outcomes (2). For emergency medicine (EM), the former “practice-based performance improvement” competency has been supplanted by Milestone 19, which defines the Level One milestone as: “Describe basic principles of evidence-based medicine” (3). Since the milestone project is new, definitions of the “basic principles” of evidence-based medicine (EBM) have not been completely established. Likewise, a strict definition of

RECEIVED: 3 November 2015; FINAL SUBMISSION RECEIVED: 28 January 2016;
ACCEPTED: 4 February 2016

what constitutes an adequate level of ability required has not been put forth.

The Fresno Test of EBM (FTEBM) is a previously published, validated metric of EBM knowledge (4). Our network has required clinically rotating third- and fourth-year medical students to complete the FTEBM as part of their orientation. The goal that all medical students will graduate medical school with at least a milestone Level One knowledge base has not been validated. Here, we used existing cross-sectional educational data to quantify the knowledge of basic EBM principles of medical students as measured by the FTEBM.

METHODS

This was a retrospective, expedited network, institutional review board–approved assessment study of FTEBMs taken by third- and fourth-year medical students while completing a clinical rotation at a community health network in Pennsylvania with 17 different residencies and fellowships that host medical students from allopathic and osteopathic medical schools from across the United States. At the preference of the administrator of the division of education, rotating students for all rotations were required by the Division of Education (DOE) to complete the FTEBM during orientation for each rotation. While the network offered monthly recurring EBM lectures to fourth-year students rotating on EM, this occurred after orientation. The FTEBM is a 12-question instrument that measures knowledge of basic EBM principles including how to frame a research question, how to search for evidence to answer this question, understanding of the hierarchy of evidence, being able to interpret its magnitude, internal and external validity of the evidence, and basic statistical and methodological concepts (4). At the time of the study, the network was not a primary training site for a single medical school; therefore, these FTEBMs represent a cross section of medical students from multiple allopathic and osteopathic medical schools.

FTEBMs from a single, selected calendar year were scored, and results were entered anonymously into the study database. Participant information included sex, name of medical school, current year in that medical school, rotation being completed for the test being entered, and (if available) any advanced training (i.e., Masters of Public Health [MPH]). The calendar month in which the FTEBM was completed was also recorded to assess any potential secular trends in test scores as the academic year progressed. If the student had multiple rotations at Lehigh Valley Hospital and Health Network, only the initial FTEBM score was included for analysis.

Each question was graded using the grading rubric form A by a single, trained evaluator (5). The graders

were trained by the study investigator, who resolved any questions brought forth during the scoring process. Graders included EM residents. For quality assurance, 10% percent of the tests were graded in their entirety by a doctoral-level subject matter expert.

All tests from 2011 that met the criteria were included in the final dataset for analysis. Criteria for exclusion included nonmedical students (e.g., physician assistant or dental students), and repeat rotators (i.e., students who took the FTEBM more than once in 2011). Participant characteristics were evaluated and summarized using descriptive statistics, such as relative frequencies. FTEBM scores for the 12 individual questions were calculated as the sum of graded subcomponents for each question. An overall FTEBM score was created as an unweighted sum of the 12 individual questions. Proportion of correct responses was also calculated for the individual FTEBM questions and as an overall proportion. Mean differences in overall FTEBM scores and for individual questions by academic training year (third- vs. fourth-year) and medical school type (allopathic vs. osteopathic) were assessed via *t* tests. The test for linear trend in FTEBM test scores by academic month was estimated using linear regression. A sensitivity analysis was performed to assess the overall effect of missingness on the test scores. The sensitivity analysis explored differences in missingness by participant characteristics and quantified the overall effect after controlling for the characteristics. All data analyses were performed using Stata software (version 12.1; Stata Corp, College Station, TX).

RESULTS

For the calendar year 2011, 507 FTEBM scores were on file with our Department of Education. Ninety FTEBM tests were dropped from analysis after application of inclusion and exclusion criteria (76) and removal of those that were missing data related to program year (14), leaving 417 discrete initial FTEBM participant scores for analysis (Figure 1). Participants represented 40 different medical schools, including 17 allopathic (MD) and 23 osteopathic (DO) schools. Fifty percent of participants ($n = 210$) were female, and 51.6% ($n = 215$) were from a DO medical school.

Overall mean performance for the FTEBM was 47.2%. Exploring the results by individual question is as follows (the individual EBM question topics are in parentheses): 1A (study question), 62.0%; 1B (study question), 64.4%; 2 (sources of evidence), 67.6%; 3 (study design), 57.1%; 4 (search strategies), 53.2%; 5 (relevance), 41.2%; 6 (internal validity), 43.6%; 7 (magnitude), 37.8%; 8 (two-by-two grids), 30.0%; 9 (number needed to treat), 16.9%; 10 (confidence intervals), 34.3%; 11 (diagnosis), 5.0%; and 12 (prognosis),

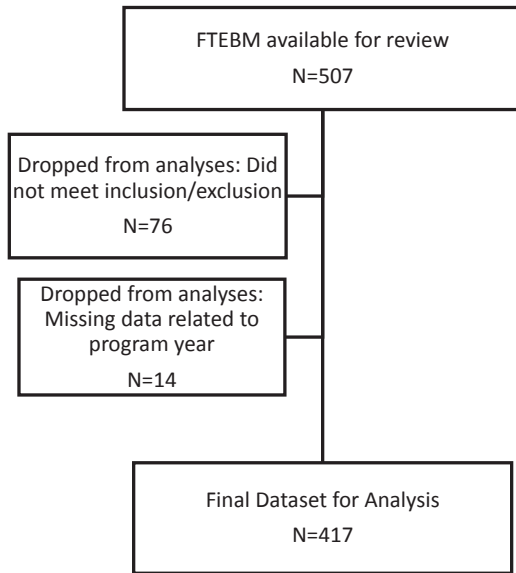


Figure 1. Consort. FTEBM = Fresno Test of Evidence-Based Medicine.

43.4%. Because the data were gathered from a single academic year, the results were assessed by month. No secular trend was observed for the data corresponding to the traditional July to June academic year (Figure 2), with the lowest overall scores observed in December (38.7%) and the highest in April (53.0%).

There were a number of incomplete responses to specific questions. Of the 417 FTEBM tests identified, only

Table 1. Distribution of the Questions Answered (Zero Skipped Denotes a Completed Fresno)

Total No. of Questions Skipped	Frequency (%)
0	143 (34.29)
1	100 (23.98)
2	64 (15.35)
3	59 (14.15)
4	33 (7.91)
5	14 (3.36)
6	3 (0.72)
7	1 (0.24)
Total	417 (100)

143 (34.3%) were complete, with all 12 questions answered. A total of 217 (65.7%) FTEBM tests were submitted with one or more questions left unanswered. The distribution of unanswered questions is presented in Table 1. Table 2 presents the overall and question-specific FTEBM scores. Although not statistically significant, third-year students tended to do better than fourth-year students both on the overall score and a majority of questions. Only on questions 2 ($p = 0.02$) and 7 ($p = 0.17$) did the more senior students perform better.

When stratified by degree type, allopathic students outperformed osteopathic students. The largest difference between allopathic and osteopathic students was observed for questions related to health numeracy (questions 8–10), with allopathic students scoring significantly higher. Statistically significant differences were also noted for the question related to search strategies (question 4) and study relevance, also referred to as external validity (question

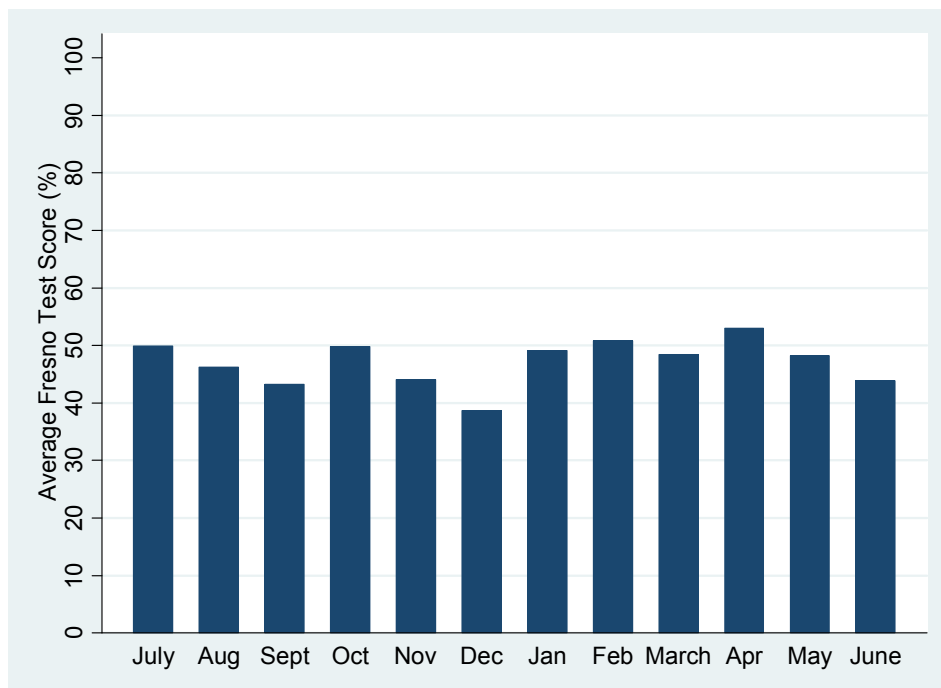


Figure 2. Average Fresno Test of Evidence-Based Medicine score by month.

Table 2. Fresno Test Scores by Individual Question, Stratified by Medical School Year (Third of Fourth) and Degree Program (allopathic [MD] or osteopathic [DO])

Fresno Question No.: Description	Total Score Possible	Overall (n = 417) Mean (SD)	Medical School Year		<i>p</i> Value	Degree Program		<i>p</i> Value
			Third (n = 189) Mean (SD)	Fourth (n = 228) Mean (SD)		DO (n = 215) Mean (SD)	MD (n = 202) Mean (SD)	
Q1A: Writing a research question	12	7.4 (2.1)	7.6 (2.0)	7.3 (2.1)	0.15	7.3 (2.1)	7.6 (2.1)	0.21
Q1B: Writing a research question	12	7.7 (2.1)	7.9 (2.0)	7.6 (2.2)	0.21	7.4 (2.1)	8.1 (2.0)	0.0007
Q2: Sources of evidence	24	16.2 (6.2)	15.4 (6.1)	16.9 (6.2)	0.02	16.6 (6.0)	15.8 (6.4)	0.17
Q3: Study design	24	13.7 (6.2)	14.0 (6.6)	13.5 (5.9)	0.42	13.5 (6.6)	14.0 (5.9)	0.41
Q4: Search strategies	24	12.8 (5.4)	13.3 (5.5)	12.3 (5.2)	0.07	11.9 (5.2)	13.7 (5.4)	0.0009
Q5: Relevance	24	9.9 (5.9)	10.3 (5.8)	9.6 (6.0)	0.23	9.0 (6.1)	10.9 (5.6)	0.001
Q6: Internal validity	24	10.5 (6.9)	11.1 (7.0)	9.9 (6.8)	0.08	10.0 (7.0)	11.0 (6.8)	0.16
Q7: Magnitude and significance	24	9.1 (5.4)	8.7 (5.3)	9.4 (5.4)	0.17	8.8 (5.6)	9.4 (5.1)	0.22
Q8: Sensitivity/specificity/predictive value/likelihood ratios/2X2 grid	12	3.6 (3.6)	3.7 (3.7)	3.5 (3.5)	0.4	2.6 (3.3)	4.7 (3.5)	<0.001
Q9: Number needed to treat	12	2.0 (3.2)	2.3 (3.4)	1.8 (3.0)	0.1	1.1 (2.3)	3.0 (3.7)	<0.001
Q10: Confidence intervals	4	1.4 (1.9)	1.6 (1.9)	1.2 (1.8)	0.06	0.6 (1.4)	2.2 (2.0)	<0.001
Q11: Diagnostic study methodology	4	0.2 (0.9)	0.2 (0.9)	0.2 (0.8)	0.51	0.2 (0.9)	0.2 (0.9)	0.93
Q12: Prognostic study methodology	4	1.7 (2.0)	1.6 (2.0)	1.8 (2.0)	0.32	1.6 (2.0)	1.9 (2.0)	0.11
Overall total	204	96.3 (22.8)	97.8 (23.9)	95 (21.9)	0.22	90.5 (21.0)	102 (23.1)	<0.001

DO = Osteopathic medical school; MD = allopathic medical school; SD = standard deviation.

5). There were a significant number of FTEBM tests with incomplete or missing responses, and therefore we performed a sensitivity analysis comparing complete and incomplete FTEBM tests. In general, female and DO participants were more likely to skip at least one FTEBM test question compared to the remainder of respondents. However, when comparing overall percentage test scores (out of 100%), when controlling for sex and medical school type (i.e., DO vs. MD), participants who skipped at least one FTEBM test question score only slightly lower (2.8%; 95% confidence interval: 2.1–3.4; $p < 0.001$) than those who completed the entire examination.

DISCUSSION

Limited data exist exploring the level of knowledge medical students have regarding EBM. With a pivot by ACGME and ABEM toward milestones and metrics that have measurable outcomes, this becomes an important content area. In our cohort, medical students achieved a score on the FTEBM of about one half of the maximum. This suggests that there is a measurable disconnect between what students should know before starting residency and what they actually do know. To narrow this gap, both undergraduate and graduate medical educators will need to enhance the opportunities for learners to become proficient in EBM skills. Despite our expectation that EBM knowledge would increase during medical school, our cohort demonstrates that third-year students outperform fourth-year students. This may indicate that EBM is not emphasized during clinical rotations, especially those that are elective. It may also reflect a traditional model of EBM education, which tends to

occur in undergraduate medical education during the first two years, without revisiting the topics during clinical years. As it relates to EM, this suggests that incorporation of EBM into undergraduate EM clinical experiences represents an important opportunity. Given that previous studies estimated that around 60% of medical schools have third-year students obtain experience in EM—and it is required in one-third of schools—it may be best to have EBM didactics in fourth-year clerkships to prepare medical students for graduate training in EM (6,7). Our informal feedback from students during our EBM training sessions contained within our fourth-year EM elective suggests that, with clinical vignettes and experience, the concepts are easier to understand.

Whether stratified by year or degree, the questions on the latter part of the test tended to have the lowest scores. It is unclear whether this represents a more systematic lack of understanding of statistics and methodology by medical students or whether they ran out of time after attempting the earlier short answer questions. While the test itself was not timed, it was a part of an orientation process; in deference to the other items on the agenda, some students may have felt more time pressured than others. In the end, their overall performance may have been impacted by the fact that the FTEBM was part of orientation and not part of the rotation grade. This may be why the lowest scores were seen in December. This part of the academic year has third- and fourth-year students at the midpoint academically, but the close proximity to winter academic vacations or the match process may mean that students were more focused on other issues.

Our data do not allow us to identify why allopathic students outperformed osteopathic students on the FTEBM.

The number of schools the cohort was drawn from was similar, leading away from an explanation that a single institution of either type skewed the data. The overall difference between these subgroups was not large (about 10 points). Much of that difference came from the statistical questions, numbered 8 through 10. In the end, the average score on the 204-point instrument, including all the sub-analysis groups, was close to the overall average of 96 (47%). This suggests that the FTEBM could be used with a similar threshold to determine for all medical students entering an EM residency to document milestone Level One competency. Future work to determine if the FTEBM could be used to track EM resident improvement during postgraduate training could be entertained. In fact, it might be able to help determine if the resident had achieved the requisite milestone Level Four skills needed for graduation. The anchor for Level Four includes, “demonstrates evidence-based clinical practice and information retrieval mastery” (3). Another area of study could be to see if changes in medical school curriculum in EBM would show improvement in the FTEBM. Regardless, if medical students enter EM residencies with only half of the EBM knowledge—as measured by the FTEBM—this cohort suggests that graduate medical educators must ensure a robust curriculum on the topic.

Limitations

This cohort only represents medical students who elected to rotate at a single hospital network in Pennsylvania, and the results may therefore not be generalizable. Incomplete tests and the nature of a retrospective study are also limitations. In addition, the motivation of the students to perform their best on an orientation exercise may have impacted their performance. Finally, the students in the cohort represent both a cross-section of medical schools and intended specialties. Medical students who enter EM may score differently on the FTEBM from medical students as a whole.

CONCLUSIONS

As measured by the FTEBM, medical students demonstrate understanding of about half of EBM. Concepts surrounding statistics in general have lower scores. EM residencies will need to formally instruct their residents in EBM concepts in order to meet ACGME/ABEM milestone requirements and graduate as prepared EM physicians.

Acknowledgments—An abstract of this report was presented in poster form at the American College of Emergency Physicians Research Forum in Chicago, Illinois, October 28, 2014, in Chicago, IL. We thank Anita Kurt, PhD, RN, for research operations management, Dawn Yenser, C-TAGME, for test administration, and the senior librarian assistance of Kristine Petre, MLS, CM, AHIP.

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ARTICLE SUMMARY

1. Why is this topic important?

Evidence-based medicine (EBM) has been included in the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Emergency Medicine (ABEM) milestones project as a required component during emergency medicine residency training. Milestone Level One states that graduating medical students must be able to “describe basic principles of EBM.”

2. What does this study attempt to show?

We sought to identify the EBM skills of third- and fourth-year medical students.

3. What are the key findings?

As measured by the FTEBM, senior medical students demonstrate understanding of about half of EBM.

4. How is patient care impacted?

Patient care is impacted by physicians adept at using EBM at the bedside. Emergency medicine residents can anticipate the need to instruct their residents in EBM concepts in order to meet ACGME/ABEM milestone requirements.