Topics in Training

Medical Student Musculoskeletal Education
An Institutional Survey

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Background: Since the 1910 Flexner Report, medical education continues to undergo curriculum and graduation guideline reform to meet the needs of physicians and patients. Our aims were to (1) assess the quality of musculoskeletal education at our institution’s School of Medicine by reporting the results of the Freedman and Bernstein examination among our medical students across all four years of training, and (2) stratify results according to medical school year, educational module, and intended career.

Methods: We surveyed the 460 2009-2010 School of Medicine students via e-mail. The survey contained a validated orthopaedic examination of musculoskeletal competency (passing grade, 70%), demographic questions (e.g., year in training, clinical area of interest, and time dedicated to musculoskeletal topics in medical school education), and a 10-point tool for determining confidence in assessing musculoskeletal disorders. There were 354 responses (77.0%); six were excluded for incompleteness, leaving 348 for analysis. Linear regression analysis was used to determine the association between test scores and days spent studying musculoskeletal material. The unpaired Student t test was used to compare performance among areas of interest and training years, with p < 0.05 being considered significant.

Results: The mean score was 51.1%; only sixty-seven (19.3%) of the students passed. Fourth-year students scored significantly higher (59.0%) compared with first-year students (37.3%), but >65% of students in both groups failed. Only 34.2% of the graduating students had completed a musculoskeletal elective. Students who participated in elective musculoskeletal education had a higher pass rate (67.5%) than those who did not (43.9%, p < 0.001). A minimum of fifteen days dedicated to elective study of musculoskeletal medicine significantly increased the chance of passing this examination. First-year through fourth-year students ranked their level of confidence in dealing with musculoskeletal issues as 3.18, 3.82, 3.57, and 4.77, respectively.

Conclusions: To our knowledge, this is the first study to test this examination with medical school class years and have quantifiable results that advocate for incorporation of a dedicated musculoskeletal block in medical student education.

Medical education reform began with the Flexner Report in 1910, which provided curriculum and graduation guidelines for medical students. More than 100 years later, we continue this process to meet the needs of physicians and patients. However, there are troubling discrepancies between the time dedicated to teaching specific topics in medical school and the scope of the related clinical problems encountered in medical practice. One area of medical school curriculum that

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is notably impaired by this imbalance is musculoskeletal education.

In the United States, musculoskeletal disorders represent the most common health complaints, accounting for more than 130 million physician visits and 10% to 28% of all primary care visits each year and costing approximately $850 billion a year. These costs account for a substantial portion of the country’s health-care expenditures.

Despite these facts, our own institution has had no required medical student musculoskeletal clerkship rotation or elective for several decades, and a landmark study in 2003 by DiCaprio et al. found that only 20% of allopathic medical schools in the United States had a dedicated musculoskeletal clerkship, making the quality of musculoskeletal training for medical school graduates inadequate. Clawson et al. surveyed 5487 second-year residents in the United States and found that most reported being ill-prepared in the area of musculoskeletal medicine, and another survey of pediatric residents identified orthopaedics as the main area in which they believed that their medical school education had been deficient.

This discrepancy appears to persist beyond the training years and into the realm of clinical practice. In a survey of family care physicians, 51% said that they had insufficient training to address musculoskeletal issues, which may be related to the fact that 56% of the respondents stated that medical school was their only source for formal musculoskeletal instruction. This issue is also prevalent outside the United States. Canadian family medicine practitioners stated that 27.4% of their practice involved musculoskeletal disorders; however, <3% of the typical Canadian medical school curriculum hours are devoted to musculoskeletal education. This lack of training can detrimentally affect physician performance and patient care.

Researchers have moved beyond subjective surveys to provide quantifiable measures of students’ musculoskeletal knowledge. An important effort came in 1998 when Freedman and Bernstein created a 25-point examination to test musculoskeletal competency. Their examination was validated by orthopaedic and internal medicine residency directors throughout the United States. This written examination had questions such as the following: “What nerve is compressed in carpal tunnel syndrome?” “Name two differences between rheumatoid arthritis and osteoarthritis.” “How is compartment syndrome treated?”

Several institutions have reported using this examination. When the eighty-five incoming medical and surgical residents at the University of Pennsylvania were tested, 82% failed this examination. Jones also reported that 82% of the graduating students at the University of the West Indies, Barbados, failed to pass the examination. Day et al. administered the same examination in 2007 at Harvard Medical School and found that only 2%, 7%, and 26% of second-year, third-year, and fourth-year students, respectively, passed the examination. Both the Harvard and University of Pennsylvania programs have undergone substantial curriculum reforms in the past decade.

This problem is not limited to allopathic medical schools. Stockard and Allen showed that 70% of osteopathic graduates failed to attain a passing score on this examination. These studies have shown that the Freedman and Bernstein examination has been widely accepted as a cognitive measure of students’ knowledge; however, it does not measure their clinical performance or their confidence addressing musculoskeletal issues.

Our primary aim in the present study was to assess the quality of the musculoskeletal education at our institution’s School of Medicine by reporting the results of the Freedman and Bernstein examination among our medical students across all four years of training. We hypothesized that students exposed to more hours of teaching in musculoskeletal education and students planning to pursue careers related to musculoskeletal health would be more confident addressing musculoskeletal issues and would perform better on the Freedman and Bernstein examination. Our secondary aim was to stratify the results according to medical school year and educational module.

### Materials and Methods

Institutional review board approval was obtained for this study. We surveyed the 2009-2010 medical student body of our School of Medicine via the school’s official e-mail listing at the end of the academic year. The e-mail survey contained
the examination developed by Freedman and Bernstein (designed to evaluate cognitive mastery of basic musculoskeletal medicine), questions regarding demographic information (such as year in training, clinical area of interest, and time [in days] dedicated to musculoskeletal topics during medical school education), and a tool for determining confidence in assessing musculoskeletal disorders on a 10-point scale ranging from “not at all confident” to “very confident.” The confidence scores were grouped as 0 to 3 = low, 4 to 7 = moderate, and 8 to 10 = high. Students who had previously seen the examination or answers were asked not to participate. Responses were required within one month from the date of the initial e-mail, and reminder e-mails were sent two times each week.

Completed surveys were returned via e-mail as an attached document. To maintain anonymity, reply e-mail addresses were used only to verify that surveys were not answered in duplicate; the attached files were saved without reference to the senders’ addresses. Surveys were excluded if they had incomplete responses or information.

Of the 460 surveys sent, 354 were returned (a 77.0% overall response rate). No student reported seeing the examination or grading rubric before the distribution of this survey. Six surveys were excluded because of incomplete data entry, leaving 348 (75.7% of 460) for data analysis. The response rates were comparable among first-year, second-year, third-year, and fourth-year classes: 68.6% (eighty-one of 118), 73.1% (eighty-seven of 119), 86.7% (ninety-one of 105), and 75.4% (eighty-nine of 118), respectively.

Statistical Analysis
All of the examinations were graded according to the Freedman and Bernstein examination by the first author. A passing score in this study was set at ≥70% as in previous studies.11-13 A linear regression analysis was performed to determine the association between test scores and days spent studying musculoskeletal material. The unpaired Student t test was used to compare performance among areas of interest and years in training. A p value of 0.05 was considered significant.

Our Curriculum
The curriculum at our School of Medicine was recently redirected after a five-year review, resulting in the “Genes to Society” curriculum.14 In this curriculum, students are exposed to musculoskeletal medicine during the preclinical years through anatomy and lecture-based instruction on rheumatologic disorders. Longitudinal learning takes place through clinic visits with actual patients and interdisciplinary instructors. Additionally, they learn musculoskeletal physical examination skills with standardized (acting) patients. During the third and fourth years, also known as the clinical years, students have the option to enroll for two weeks in a surgical subelective such as orthopaedic surgery, plastic surgery, neurosurgery, or vascular surgery, during their required basic surgery clerkship. Approximately four to eight of the twenty to twenty-five students on the basic surgery clerkship elect to take the orthopaedic subelective each quarter. Students on this rotation are given a handout by the senior author with questions to be completed one-on-one with an orthopaedic resident or attending surgeon (Table I). The residents and attending surgeons are aware of this handout and are prepared to dedicate time to answering the questions or discussing them with students on the service.

Source of Funding
No funding was received in support of this study.

Results
The mean grade (and standard deviation) across all classes was 51.1% ± 19.1%. A passing score of ≥70% was attained by only sixty-seven (19.3%) of 348 students (Fig. 1). Students who received musculoskeletal instruction as an elective outside of the required basic curriculum scored significantly higher than students who did not take additional musculoskeletal electives (67.5% compared with 43.9%, respectively; p < 0.001). Only 34.2% of the graduating students had completed a musculoskeletal elective. Fourth-year students scored significantly higher than first-year students (59.0% compared with 37.3%, respectively; p < 0.001). There was no difference between the second and third-year students (52.5% compared with 54.3%, respectively; p = 0.540) (Fig. 2). Students with a passing score of ≥70% were more likely to have had fifteen or more days of
musculoskeletal exposure beyond the regular requirements of the curriculum. The coefficient of determination was $r^2 = 0.44$ (Fig. 3).

Students who reported they were most likely to enter fields closely related to musculoskeletal medicine (i.e., orthopaedics and rheumatology) (Fig. 4) scored significantly higher

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**Fig. 2**
Mean grade according to class.

**Fig. 3**
Linear regression of grades versus additional days of study beyond the required medical school curriculum. The dashed lines indicate the 95% confidence interval.
than students entering unrelated fields (67.5% compared with 43.9%, respectively; p < 0.001). Of note, students planning to enter the field of obstetrics and gynecology also performed significantly better (mean, 72%) than students entering unrelated fields (p < 0.001).

First-year through fourth-year students ranked their confidence level in dealing with musculoskeletal issues as 3.18, 3.82, 3.57, and 4.77, respectively. Although no significant difference in the test scores was found between third and fourth-year students, fourth-year students were significantly more confident than third-year students in dealing with musculoskeletal problems (mean confidence scores, 4.77 and 3.57, respectively; p < 0.001) (Fig. 5). These scores remained on the lower end of the moderate confidence grouping.
Discussion

Although most of the medical students in our study failed the examination, the passing rates of 3.7%, 14.9%, 31.8%, and 24.7% for first-year, second-year, third-year, and fourth-year students, respectively, were better than those in previous studies in which this examination was used. There was a correlation coefficient of 0.67 (coefficient of determination, 0.44) between grade performance and student musculoskeletal study time. Thus, there was a moderate relationship between time spent studying musculoskeletal topics that was not part of the required medical school curriculum and performance on this examination. These results suggest that increased time dedicated to musculoskeletal education can improve musculoskeletal competency. To our knowledge, this is the first study to test this examination with medical school class years and have quantifiable results that advocate for a dedicated musculoskeletal block in medical school education. Having requirements such as musculoskeletal clinical rotations would likely have increased our students’ performance on this examination.

Of note, although no significant difference in performance among second, third, and fourth-year students was found, the reported confidence level of fourth-year medical students was significantly higher (p < 0.001). This finding suggests that although some confidence may be attained through experience on the clinical wards, the cognitive foundation may not necessarily follow.

The future and quality of orthopaedic surgeons and orthopaedic patient care depend on medical student education, recruitment, and curriculum redirection. Our study supports the findings at other institutions that medical students are not receiving adequate education in musculoskeletal medicine. On March 21, 2002, President George W. Bush announced that 2002 to 2011 would be the “United States Bone and Joint Decade.” The United States Bone and Joint Decade was also a multidisciplinary coalition of organizations and sponsors concerned with the deficit in knowledge and resources pertaining to musculoskeletal medicine. The most important aspect of the United States Bone and Joint Decade as it related to medical student musculoskeletal education was a subcommittee called Project 100. Project 100, chaired by Dr. Joseph Bernstein of the University of Pennsylvania, was created to improve medical school education by encouraging 100% of American medical schools to offer dedicated instruction in musculoskeletal medicine. The project has greatly improved the awareness of this educational deficiency, but schools’ commitment toward actual reform and incorporation of musculoskeletal education as a required element of the curriculum continues to be a struggle. As of 2011, 106 of 127 schools have some musculoskeletal requirement, but this fact means that 17% of United States medical schools continue to have no required musculoskeletal instruction.

With increased attention to this topic, the Association of American Medical Colleges created a Medical School Objectives Project in 2005 to review the current state of musculoskeletal education and to offer recommendations for the future. The report, published in September 2005, provided guidelines and recommendations for medical schools to enact curriculum reform. Because musculoskeletal disorders are treated by many different clinicians—rheumatologists, orthopaedists, family practitioners, emergency physicians, pediatricians, and others—the authors of the report advocated for interdisciplinary course instructors. This complex web of practitioners is unique to the topic area of musculoskeletal medicine and likely adds to the difficulty in teaching and evaluating skills. A successful interdisciplinary team can integrate learning experiences throughout the curriculum and identify the material as part of a coherent curriculum component. The report noted that explicitly identifying musculoskeletal content in the curriculum will prevent fragmentation and help reinforce the importance and relevance of this information in students’ future careers.

Our curriculum incorporated many, but not all, of the recommendations of the United States Bone and Joint Decade and the Association of American Medical Colleges. Most notably, the orthopaedic subspecialty during the basic surgery clerkship remains an option rather than a requirement. Our study has shown, on the basis of the validated examination by Freedman and Bernstein, that this curriculum can be effective in teaching key musculoskeletal concepts to students.

Our study is limited by its cross-sectional design and the inherent flaws associated with such a design. Response rates were high for a survey study; however, approximately one-quarter of the student body did not complete the survey. Future study should include a five-year follow-up to determine the impact of the new curriculum. Some studies using this examination have set 73.1% as a passing score, whereas others have used 70% score, whereas. We chose a 70% score to more closely correspond to that of other allopathic institutions in the United States that use this examination for medical student populations.

Although the United States Bone and Joint Decade concluded in 2011, fulfilling its mission continues to be a struggle and needs to be a priority for United States medical schools. Project 100 and the Association of American Medical Colleges offer guidelines to better address the educational needs of medical students. Our results support the use of these resources as a way of creating a fundamental change in medical education that will improve the training of physicians and the care of patients for decades to come.

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