Educating medical students in musculoskeletal surgery and medicine: How to get a course up and running at your institution: AOA Critical Issues

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Introduction
Approximately 15% to 30% of visits to primary care physicians in the United States and Canada, 20% of emergency room visits in the U.S., and 20% of nonsurgical pediatric visits to physicians in Europe are for the purpose of addressing musculoskeletal complaints and injuries. In 2004, the National Ambulatory Medical Care Survey indicated that musculoskeletal conditions comprised the number-one reason for visits to physicians’ offices, with approximately 92.1 million visits reported annually. Two years later, in 2006, the Centers for Disease Control and Prevention (CDC) reported that an estimated 7.9 million (15%) of the 53.3 million surgical and nonsurgical procedures performed during visits for ambulatory surgery in the U.S. were related to the musculoskeletal system, a percentage that is second only to that of procedures related to the digestive system (27%). With the current system of managed care and the prevalence of musculoskeletal disease, knowledge of musculoskeletal medicine must not only be mastered by specialists but should also be well understood by practitioners across a wide range of fields, including internal medicine, family practice, emergency medicine, pediatrics, and surgery.

Nevertheless, relatively little attention is devoted to musculoskeletal medicine in most medical school curricula. Of the 122 medical schools in the U.S. in 2003, fewer than 50% required preclinical courses in musculoskeletal medicine, fewer than 25% required a clinical course in that subject area, and nearly 50% had no required course, preclinical or clinical. In 2005, the Association of American Medical Colleges (AAMC) published a report highlighting this deficiency as part of its Medical School Objectives Project. In this report, entitled “Contemporary Issues in Medicine: Musculoskeletal Medicine Education,” the AAMC stated that “Medical schools may not be...
accomplishing this educational goal (i.e., preparing doctors to care for patients with musculoskeletal conditions) since the attention paid to the conditions in the usual medical school curriculum is not commensurate with the prevalence of these conditions". This conclusion is further supported by recent studies, which further suggest that the discrepancy between the magnitude of musculoskeletal problems and physician competency in musculoskeletal medicine is likely the result of educational deficiencies at the medical school level.

While numerous studies have articulated a need for more musculoskeletal curricula in medical schools, very few articles address the question of how to answer this need. By offering strategies employed by orthopaedic surgeons who have successfully expanded musculoskeletal medicine education at their home institutions, this American Orthopaedic Association (AOA) symposium report serves as a guide on how to incorporate musculoskeletal education into medical undergraduate curricula.

Establishing New Courses of Instruction
Medical school education has been in a state of constant revision since the time of Flexner and his eponymous report, but the organization of the curriculum at most medical schools generally follows three categories: preclinical education, clinical education, and augmentation of existing courses ("everything else"). We will present strategies for establishing new courses of instruction in these three categories.

Although the process of curriculum reform would be unique to every institution, the concepts successful at our home institutions can be broken down into the following eight steps: (1) identify existing musculoskeletal curriculum, (2) identify key supporting educators, (3) assess existing musculoskeletal curriculum, (4) initiate musculoskeletal reform, (5) lobby for course additions, (6) design musculoskeletal course content, (7) recruit and develop teaching faculty, and (8) evaluate student competency in musculoskeletal topics.

Identify Existing Musculoskeletal Curriculum
Establishing a case for reform requires first identifying how much of the existing curriculum is dedicated to musculoskeletal medicine. Beginning in 2004, one of us (C.S.D.) started the process of building a case for reform by first determining how much preclinical time had previously been dedicated to musculoskeletal medicine at Harvard Medical School. The total time dedicated to lectures (twenty-six hours), laboratory sessions (3.5 hours), dissections (nine hours), and clinical training (two hours) across both preclinical years was 40.5 hours, less than the national average of sixty-five hours. A similar lack of required preclinical and clinical hours also existed at the Washington University School of Medicine. These data regarding deficiencies are critical not only as evidence for establishing need but also as guides when designing additional course content.

Identify Key Supporting Educators
Due to the dearth of orthopaedic surgeons among the educational leaders in medical schools, our field often lacks a strong political voice when advocating for its interests at medical schools. In turn, it becomes necessary to seek out other senior faculty in other specialties who are willing to advocate for musculoskeletal curriculum reform. When the idea of dedicating more time to musculoskeletal medicine was originally proposed at Harvard Medical School, some senior educators raised concerns about the actual need for curriculum additions. As a result, we chose to use the Freedman and Bernstein examination to evaluate the effectiveness of the old curriculum, since the test was constructed to be a test of basic cognitive mastery. The examination—consisting of twenty-five open-response questions, each covering an orthopaedic topic assumed to be important for general medical knowledge—was validated by 124 orthopaedic program directors and 240 program directors of internal medicine departments in the United States who assigned a mean importance score of 7.4 of 10 to the questions and set the passing rate at 70%.

During this process, numerous senior educators at Harvard Medical School were approached to collaborate on an objective evaluation. Ultimately, three senior educators (the director of the Harvard Medical School Center for Evaluation, the associate dean of medical affairs, and the vice chairperson of the curriculum committee) agreed to help design a study that would assess the cognitive knowledge of and attitudes toward musculoskeletal medicine in Harvard Medical School students across all four years. This step was critical for recruiting allies, as the voice of the vice chairperson of the curriculum committee or the associate dean of education sounds much different to other institutional senior educators than does the voice of a single clinical orthopaedic surgeon when lobbying for curriculum reform.

A similar outreach to colleagues was employed at the University of Pennsylvania School of Medicine, where the surgery clerkship director had a well-earned reputation for forward thinking and a commitment to excellence; she became the first point of contact. When presented with the fact that musculoskeletal topics made up a component of the National Board of Medical Examiners subject examination (commonly known as the shelf examination)—a subject-specific, standardized, computer-based examination used to determine grades following the surgery clerkship—the clerkship director agreed to offer an elective in orthopaedic surgery as part of the surgery clerkship and invited orthopaedic faculty to lecture on musculoskeletal medicine as part of the formal didactic sessions in surgery.

Assess Existing Musculoskeletal Curriculum
Currently published research from other institutions may help initiate the process of curriculum reform, but building a strong case for change typically requires institution-specific evidence. Demonstrating the local inadequacy of musculoskeletal course offerings and student performance in the subject matter is a necessary step. A critical assessment of the Washington University School of Medicine elective orthopaedic surgery rotation prior to reform revealed that instruction during the third year of undergraduate study consisted of a four-week elective rotation in orthopaedic surgery without preclinical lectures or case studies. The students were not given learning objectives; also lacking were routinely assigned faculty, scheduled lectures,
instruction on physical examination techniques, and objective evaluations of knowledge. Texts and references for reading were neither distributed to the students nor cited as sources for additional information. The on-call experience was haphazard. Moreover, there was no incentive for faculty members to improve their teaching performance as teaching was neither recognized nor encouraged. Consequently, the scores of students from the elective orthopaedic surgery rotation routinely were in the lowest quartile as compared with the scores of students from the fifteen other optional surgical rotations offered. Meanwhile, at Harvard Medical School, our study results demonstrated a clear lack of basic knowledge of musculoskeletal medicine and low confidence in performing physical examinations related to musculoskeletal conditions⁶. Both assessments provided to the respective medical schools clear evidence that supported the need for a change in musculoskeletal curriculum.

Initiate Musculoskeletal Reform

After evidence of inadequacy has been established and buy-in has been obtained from key senior educators, the next step is to establish a strategy for implementing change. At Harvard Medical School, for example, the vice chairperson of the curriculum committee, who became a key supporter of our efforts to enact change, created the Harvard Medical School Musculoskeletal Task Force, which was comprised of two associate deans, two course directors, three clinical site directors, one surgical clerkship director, two rheumatologists, and four orthopaedic surgeons, all of whom shared a common interest in the musculoskeletal curriculum at Harvard. Using guidelines established by the 2005 AAMC Medical School Objectives Project Report⁷, one of us (C.S.D.) developed educational objectives for a four-year musculoskeletal curriculum, which was then reviewed and approved by the task force as the platform for lobbying for change to the preclinical curriculum.

Lobby for Course Additions

Bringing aboard additional senior educators and identifying where course work can be added are undoubtedly difficult tasks. The work by one of us (M.I.B.) at Washington University School of Medicine demonstrates one way in which this complicated process can be approached. The surgical clerkship director at Washington University School of Medicine was convinced of the need for either a stand-alone musculoskeletal rotation that would be mandatory during the three-month surgical clerkship or, at the least, a rotation offered to the students that would include other rotations of less widespread appeal (i.e., neurosurgery). At our institution, the surgical clerkship director controls the time that is apportioned among the individual rotations during the three-month block and had to be involved in these discussions at their inception, as our institution would not accommodate an additional stand-alone rotation during third-year. This meant that the only place in the curriculum for the proposed one-month rotation was during the three-month surgical clerkship. A one-on-one discussion with the surgical clerkship director helped us to obtain the required dedicated time for musculoskeletal topics.

We then had to impress on the associate dean of medical education the need for a stand-alone rotation on musculoskeletal surgery and medicine during the clinical year. We based these arguments on data previously published in Clinical Orthopaedics and Related Research⁸. A curriculum outline that would serve as a template for rotation objectives as well as methods of instruction was provided to the associate dean to allow her to conceptualize how the course would appear, what the students would be taught, and why this information was important for them. Personal discussions held with the associate dean of medical education over a period of several months, during formal appointment times in the dean’s office suite, allowed us to bring this important participant on board.

Finally, the curriculum committee of the medical school (chaired by the associate dean of medical education) had to be convinced of the need for a one-month rotation. To accomplish this, one of us (M.I.B.) emphasized two key points: (1) the burden of musculoskeletal disease on the societal level is both large and increasing, but (2) other specialties (e.g., cardiology, endocrinology, pulmonary medicine, gastroenterology, and general surgery) receive significantly more attention in the curriculum than musculoskeletal medicine relative to their epidemiology. Care provided to the local community served by both the hospital and the medical school was stressed to further validate our point. The presence of anatomists on the curriculum committee as well as the interest in musculoskeletal science expressed by third-year and fourth-year students was critical for us in achieving success at this juncture.

Design Musculoskeletal Course Content

The aforementioned AAMC report, published studies, and institution-specific assessments should serve as the overarching guide when designing course content⁹,10,11-13. Educational aims have to be tailored to the local environment. Some learning opportunities will fall into the “everything else” category. For example, a new third-year elective within the surgery clerkship was started at the University of Pennsylvania School of Medicine. While it was certainly nice to have a new course, the reach of the course was constrained by its brief duration (two weeks), the divided attention of the students (all of whom still had to attend surgery didactics and take a surgery examination), and the fact that only 20% of the class would be able to choose this elective. Nonetheless, a worthwhile course was built. Students were asked to perform physical examinations on orthopaedic patients who were brought to the resuscitation bay or who presented for an office visit in the orthopaedic trauma clinic and to write up patient notes for ten of those patients (five from the resuscitation bay and five from the orthopaedic trauma clinic); they were required to present an orthopaedic trauma case during fracture conference (including pertinent history, physical examination, radiographic findings, and preoperative orthopaedic trauma surgical plan); and they were required to demonstrate the ability to apply basic lower-extremity and upper-extremity splints and to display knowledge of basic musculoskeletal anatomy. The overall approach was to take the aims and methods of a full-length trauma rotation (four weeks, usually
chosen by students destined for orthopaedic surgery) and distill them for an “undifferentiated” student in a shorter course. Given that every school has ample upper-level electives in musculoskeletal medicine and orthopaedic surgery, this approach can be used to create meaningful courses for general use.

Another key feature of course design is to meet locally defined deficiencies. As part of a more thorough analysis of the data obtained from a musculoskeletal proficiency study among Harvard Medical School students, one of us (C.S.D.) determined that the students performed substantially worse on the sections of the Freedman and Bernstein examination that tested the specific anatomic regions of the lower extremity, upper extremity, and back as compared with the sections that dealt with conditions that were more systemic, such as cancer, rheumatoid arthritis, and metabolic bone disorders10. Students also believed that they were inadequate in examining most anatomic regions. These data, along with the objectives defined by the Harvard Medical School Musculoskeletal Task Force, heavily influenced the course topics chosen and the design of specific lectures and small-group tutorial sessions for the preclinical years of the new Harvard curriculum.

Recruit and Develop Teaching Faculty
With the addition of new courses dedicated to musculoskeletal medicine, it becomes critical to ensure that adequate faculty staffing is available to teach these new courses. To ensure that the techniques of performing a physical examination would be taught in the most effective manner possible, the course director for Patient-Doctor II, the clinical skills and physical examination course at Harvard Medical School, requested an eight-to-one student-to-orthopaedic-faculty ratio. As a result, twenty faculty members for each of four joint examinations were recruited to teach 170 students. Thus, if the faculty members did not overlap on the four different joint examinations, a total of eighty faculty members would be needed to teach this session. Each faculty member only sees the eight to ten students for whom they are responsible. Before one of us (C.S.D.) could recruit faculty members, he first needed the chairpersons of all four major orthopaedic departments of the Harvard Medical School hospitals to buy into his plan. Fortunately, they all were supportive of this endeavor at our medical school and strongly encouraged all of their respective faculty members to participate. Unfortunately, most of the orthopaedic faculty members that we recruited were primarily experienced in teaching fourth-year medical students interested in orthopaedics or orthopaedic residents and fellows. To support the transition of these faculty members into teaching first-year and second-year medical students, most of whom would not be choosing orthopaedics as their field of practice, the course director of the pulmonary pathophysiology course was recruited to provide a didactic session on educating this student population, provide guidance on lecture design, and give feedback to these faculty members.

Although no formal training of faculty took place prior to implementing the new curriculum at Washington University School of Medicine, the course director (M.I.B.) has personally followed up with each faculty member either in person or via a direct e-mail at least every six months since the curriculum was implemented. The purpose of these communications is to frankly assess the willingness of the current teaching faculty to continue as teachers. Those who do poorly are given the opportunity to graciously focus their teaching attention elsewhere, but if they want to improve, they are offered additional reading and training opportunities by the course director.

Evaluate Student Competency in Musculoskeletal Topics
Finally, mechanisms must be put in place to gauge the effectiveness of the implemented changes and evaluate student performance. Since the course was designed to be a part of the three-month surgical clerkship at Washington University School of Medicine, the method of student grading involves grades from each of the three one-month rotations combined with the grades from the shelf examination and from the small-group tutorials that the students are required to attend. In 2004, orthopaedic surgeons (J.B. and M.I.B.) teamed with rheumatologists and other musculoskeletal medicine stakeholders to work under the auspices of the National Board of Medical Examiners to design and field-test the shelf examination10, including the seventy-five questions covering musculoskeletal surgery and medicine. The questions cover commonly taught conditions and diagnoses and are intended to test broadly based knowledge rather than particulars of interest only to specialists. The examination is a closed-book test and is computer based. Local proctors monitor the examination itself.

Specific evaluation methods, matched to the course, should also be used. During the third-year elective orthopaedic surgery rotation within the surgery clerkship at the University of Pennsylvania School of Medicine, for instance, students are asked to complete an “orthopaedic knowledge map” at the outset of the rotations and again at its completion. The ability of students to apply basic lower-extremity and upper-extremity splints is assessed by the resident staff in the trauma bay and the emergency room and by faculty in the operating room. Although the evaluations contribute only a small amount to the overall grade of the student, the process of evaluation focuses the attention of students as well as that of teachers and allows the progress of both to be assessed.

Discussion
Medical undergraduate education is the foundation of every physician’s career. Although the technical aspects of practice are often taught exclusively in residency, what is taught in medical school serves as the foundation for all further study and future practice. A solid four-year curriculum is an indispensable element of lifelong medical learning. It would be desirable that all medical students be exposed to the full range of relevant topics with adequate depth and breadth. However, both time and resources are limited. During the development of a medical undergraduate curriculum, decisions must be made about what topics to include and how much to emphasize those topics.

According to the published literature, there is an appreciable gap between the prevalence of musculoskeletal disease in the patient population and prevalence of medical practitioners
with sufficient mastery of the knowledge, skills, and attitudes needed to manage these musculoskeletal conditions. Much of the blame has been placed correctly on the lack of musculoskeletal education present in medical school curricula. Moreover, research suggests that further musculoskeletal education improves patient care—not only as a result of better cognitive knowledge of musculoskeletal conditions among practitioners—but also by bringing more diverse and competitive applicants to the specialty of orthopaedic surgery itself.

To address this challenge, we undertook a comprehensive curriculum reform process at our institution. We believe that adding musculoskeletal education to medical school curricula is not only possible but also necessary to meet the evolving needs of contemporary orthopaedic surgery. Our approach involved several key components, including the development and administration of student evaluation tools.

However, we recognize that the constraints of an intensely political environment within the medical school may make an extensive preclinical curriculum and required clerkship in musculoskeletal medicine an unreachable goal for many medical schools. All of the well-meaning requests and data-driven petitions will fall on deaf ears if the petitioner does not take into account the needs of those whom he or she is petitioning in terms of local realities. As former House Speaker Thomas P. (“Tip”) O’Neill Jr. once quipped, “All politics is local.” Similarly, the surgeons who wish to establish a course in musculoskeletal surgery and medicine at their own institutions must pay attention to the local needs and the particulars of their institutions.

Finally, change takes patience. The preclinical curriculum reform process at Harvard Medical School started in 2003 with a conversation with a senior member in the dean’s office, and yet the course was not implemented until 2007. At Washington University School of Medicine, the medical undergraduate curriculum reform process started in 1998 with the first clinical orthopaedic rotation beginning in 2006. At the University of Pennsylvania School of Medicine, although there has been an orthopaedic clinical clerkship in place for decades, the elective course of the general surgery clerkship began only in 2009, two years after the required preclinical course was abolished.

During the symposium, three course types were discussed: preclinical, clinical, and augmentation of existing courses (“everything else”). A listing of the rationales for choosing each type is given in Table I. As we developed this manuscript, our hope was to provide an effective framework for approaching the task of how to add musculoskeletal education to already existing medical school curricula at the level of involvement deemed

### TABLE I Rationale for Preclinical, Clinical, and Augmented Courses

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<tr>
<th>Course Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Preclinical course</td>
<td>Early exposure of students to orthopaedic surgery</td>
<td>Finding faculty with skills and interest in basic science can be difficult</td>
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<td></td>
<td>Easier to add a few random days to 2 years</td>
<td>Preclinical courses are usually already full, and many existing courses are run by nonorthopaedic senior educators</td>
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<td></td>
<td>May be built by simply amalgamating what is already there and dispersed</td>
<td>What you want to teach and what the school wants taught may not be the same</td>
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<td></td>
<td>Conducive to lectures</td>
<td>Difficult for a clinical department to run</td>
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<tr>
<td>Clinical rotation</td>
<td>Realistic picture of orthopaedic specialty</td>
<td>May be too late to influence career choices</td>
</tr>
<tr>
<td></td>
<td>Easier to find faculty</td>
<td>Logistics of integrating into full 3rd-year rotations</td>
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<tr>
<td>“Miscellaneous” course</td>
<td>Easiest to arrange</td>
<td>Labor intensive</td>
</tr>
<tr>
<td>(e.g., sessions on anatomy or</td>
<td>Can teach what really excites us</td>
<td>Department may not get credit for work</td>
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<td>physical diagnosis)</td>
<td></td>
<td>4th-year apathy may be a factor if added to “back end” of curriculum</td>
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<td></td>
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<td>Students may not recognize orthopaedic surgery as a legitimate freestanding</td>
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<td></td>
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<td>department</td>
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<td></td>
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<td>Easiest for medical school to drop when curricula are in flux</td>
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appropriate, whether it be preclinical, clinical, or as a way to augment already existing courses. At the same time, we wanted to demonstrate concrete examples of how this framework was put into practice at our institutions while keeping in mind the difficult political obstacles and environments that have undoubtedly been faced by those who have attempted curriculum reform. This paper can serve as a guide and source of encouragement that the task of adding musculoskeletal topics to a medical school curriculum, while difficult, is possible and worthwhile.

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