Evidence-based and Population-based Medicine:
National Implementation Under the UME-21 Project

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Background and Objectives: The Undergraduate Medical Education for the 21st Century (UME-21) project developed and implemented innovations to medical school curricula at medical schools across the country. This report describes the development and implementation of innovative approaches to improving instruction in evidence-based medicine with a population-based perspective. Methods: Each school participating in the UME-21 project designed, implemented, and evaluated its own unique curriculum initiatives. We examined these initiatives using data abstracted from written reports submitted to the project Executive Committee. Additional data were obtained by personal communication with project directors and evaluators at the various schools, student and preceptor comments, internal program evaluation at each school, and external evaluation by the UME-21 project leadership. The Association of American Medical Colleges Graduation Questionnaire was also used. Results: Fourteen of 18 participating schools implemented a broad range of curricula to facilitate teaching and learning about evidence-based and population-based medicine. Common themes included the application of evidence to patient care, use of clinical practice guidelines and pathways, and the general incorporation of evidence-based techniques (literature searching, critical appraisal, etc) into the teaching of other content, such as clinical science and managed care. Teaching approaches included Web-based and other computer-based education, an emphasis on active and self-directed learning, use of small groups and workshops, and distribution of this content over multiple years. As an alternative to full-length evidence-based medicine courses, many schools incorporated an evidence-based approach into existing courses and clerkships. Data demonstrated an upward trend in student satisfaction with how topics were presented at UME-21 schools. Conclusions: These innovations successfully demonstrated that evidence-based and population-based medicine content can be introduced into medical school curricula. Introducing these constructs in ways that demonstrate their relevance to patient care facilitates student learning.

Numerous reports have detailed major themes and content areas that will be needed for physicians to practice competently in the 21st century, \(^2\) and some important topics are absent or underrepresented in existing medical school curricula. \(^2\) Within a health care environment that is increasingly sensitive to optimizing the quality and cost of care, a challenge to medical educators is to develop curricula that provide a sound scientific foundation for clinical practice and scholarly investigation. To support these goals, greater importance is being placed on learning to practice evidence-based and epidemiologically sound medicine, with an emphasis on a population-based perspective. \(^2\) The Undergraduate Medical Education for the 21st Century (UME-21) project identified the practice of evidence-based medicine (EBM) and population-based medicine (PBM) as one of nine key content areas to be integrated into medical school curriculum in the clinical years. \(^2\)

Methods

Each UME-21 partner school and associate partner school submitted written reports describing its curriculum projects to the UME-21 Executive Committee. We reviewed these reports to identify schools that addressed evidence-based medicine and population-based medicine topics and summarized the results. Common themes and educational approaches were identified and
used as a basis for compiling the results. Additional data were obtained by personal communication with project directors and evaluators. Specific evaluation methods were as follows:

**Evaluation**

The effectiveness of project implementation was assessed by each school and by the UME-21 program. Components of the evaluation included internal evaluation, project reports, and the analysis of broader measures, such as the Association of American Medical Colleges (AAMC) Graduation Questionnaire (GQ) data (see Shea et al and Veloski et al in this issue). Because EBM and PBM themes were often woven into the curriculum, specific evaluation of their effectiveness was fairly difficult. When more conspicuous projects and courses were conducted, evaluation was simplified. In settings where discreet educational units existed, such as an appraisal assignment or training session on literature searching, evaluation was conducted at the session and/or overall clerkship level. When these activities were specific and easily identifiable by students, they were evaluated as being relevant and valuable.

Course evaluation forms for students and preceptors were used to provide formative assessment about the implementation of local programs. Summative measures included student and preceptor self-assessments, student satisfaction questionnaires, examination and project grades, and preceptor evaluations of students.

At a broader project level, AAMC GQ data provided a measure for comparison between UME-21 schools and to all medical schools. Noting that local funding for UME-21 activities began in 1998, 1999 was used as a baseline year since most seniors had not yet been exposed to major UME-21 interventions. For analysis related to EBM/PBM, UME-21 schools were stratified into categories of high, moderate, low, or no EBM/PBM activity, based on the expected impact of their UME-21 project on their GQ results. Factors considered were a combination of the quantity of instructional time and the depth and scope of the school’s project. For example, a school with a high-intensity intervention that only impacted a handful of students, such as a single senior elective, was categorized as having low activity. A school with EBM curriculum interventions throughout the preclinical and clinical years was placed in the high category.

**Results**

EBM and PBM curricula were developed, implemented, and evaluated at all eight UME-21 partner schools and six of 10 UME-21 associate partner schools (see Pascoe et al in this issue). The projects included a broad range of learning objectives and educational methods. The majority of schools included both EBM and PBM learning objectives. All 14 schools targeted the clinical curriculum, and nine (64%) also included the preclinical curriculum. Themes that were common to the curricular objectives at many schools included application of EBM principles to practice, medical decision making, practice guidelines, literature searching/information access, population needs assessment, community-oriented primary care principles, research principles and study design, statistics, reading/interpreting medical information, and epidemiology.

**Approaches to Teaching**

Fundamental activities that were encouraged within the UME-21 project included the development of innovative approaches that facilitated teaching and learning about the content areas. Local sites pilot tested the strategies at their individual institutions to determine their potential exportation to other medical schools. Eleven schools introduced specific innovations into the third-year curriculum, and seven schools introduced specific EBM/PBM activities in the fourth year.

Emphasis was placed on time-tested approaches to introducing new material to adult learners and on demonstrating to learners the relevance of EBM/PBM in patient care. Because the majority of schools implemented their EBM/PBM curricula during the third and fourth years, it was considered important to facilitate learning beyond the classroom setting. Though lectures were still a common curricular component, active learning by students was strongly encouraged in the form of student projects, activities with clinical preceptors, and case-based or small-group learning activities.

Students were often asked to present their analysis of a subject or prepare a critically appraised topic (CAT) summary. Literature searching was taught by librarians who had special expertise in EBM in laboratory or workshop settings using computerized databases. Learning exercises were often based on patient cases that demonstrated the clinical relevance of the material. Web-based curricula were introduced to enable asynchronous learning. Other Web materials incorporated EBM or PBM principles into exercises on other topics.

**Preclinical Years**

In the preclinical years, integration of and transition to EBM-oriented terminology and approaches generally occurred within existing clinical epidemiology and biostatistics courses. However, several schools, perhaps most notably the University of Miami and the University of Pennsylvania, developed more comprehensive preclinical EBM curricula. At the latter institution, a three-part “Clinical Evaluative Science” course—rooted in an introductory clinical epidemiology course but extending over the first 18 months of medical school—provided a relatively detailed perspective on the forces that shape clinical decision making. The in-
terrelationship among evidence, economic forces, patient preferences, and societal values was a prominent feature of this course, which had the overall goal of preparing students for the diagnostic and management decisions they would shortly be making in the clinics and in hospitals.

Clinical Years

More generalized integration of EBM throughout the curriculum was reported in the clinical years, perhaps most notably at the University of Pittsburgh. In this and other schools, EBM and PBM became integral components of the core clinical clerkships. Ambulatory experiences were targeted, especially for introductory community health and PBM content. This was an important component of the UME-21 projects at Dartmouth Medical School and the University of California, San Francisco.

Specific Innovations

Though the following is not an exhaustive list of the innovations at every UME-21 school, these examples are illustrative of the types of approaches used.

Separate EBM elective courses were one method of introducing EBM into the curriculum, capitalizing on the fourth year as an appropriate teachable moment. Senior students came to the classroom equipped with adequate scientific knowledge and clinical exposure to appreciate an array of topics including basic science subjects and advanced and applied content in areas such as EBM. An example of such a successful senior elective was the program developed at East Virginia Medical School. The experience at this school consisted of introductory EBM didactic sessions during an initial 1-month course, followed by a year-long mentored experience in which the group of students developed a systematic review document on a single topic for use by the institution and physicians of the partner managed care organization.

Another concentrated elective in EBM experience was developed at the University of Pittsburgh. During a 1-month elective, a workshop and independent study format was used to encourage students to learn about EBM and medical decision making. Taught by an interdisciplinary team, including clinicians, biostatisticians, basic scientists, and librarians, students learned from each other and through progressively more difficult workshops and exercises. The elective culminated in student-to-student presentations of critically appraised topics.

As an alternative to classroom instruction, the University of Wisconsin developed a self-instructional Web-based program on the basics of EBM (see www.fammed.wisc.edu/pds/three/ebm/index.html). Self-directed EBM learning resources have also been developed at other schools, including electronic cases written at the University of North Carolina (see www.hsl.unc.edu/lm/ebm/index.htm). EBM resources were also made available to students using personal digital assistants at Dartmouth Medical School and the University of Pittsburgh.

Health care economics and managed care topics were also major content areas within UME-21. At Jefferson Medical College, a 1-week managed care mini-clerkship within an ambulatory subinternship combined topics in managed care and content in EBM during the workshops and assignments. Similarly, health care economics was a consistent theme of the Clinical Evaluative Science course, an integral component of the preclinical curriculum at the University of Pennsylvania.

A broad range of student projects was developed to support teaching and learning in EBM/PBM. For example, at the University of Nebraska, students performed an analysis of a patient’s care with regard to its cost and appropriateness, and how it might be modified, using a performance improvement model. At the University of Pittsburgh, students identified a patient-relevant clinical practice guideline and appraised it, as part of the assignments during the Community/Ambulatory Medicine Clerkship. To learn about health care delivery from a population perspective, students at the University of Minnesota reviewed an actual patient claims database as part of a project in which they formulated a proposal for a disease management program.

At the University of New Mexico, students appraised the health needs of a Native American population to gain a greater understanding of how population-based issues play essential roles in delivering health care to the community. To learn to apply evidence in the area of therapeutics, students at the University of Nebraska prepared a mock submission to the hospital Pharmacy and Therapeutics Committee that included a literature search and an analysis of the evidence in support of the formulary request. Students learned about community needs through community health assessment projects at Dartmouth Medical School and the University of Pittsburgh.

When asked about instructional time in evidence-based medicine, 79% of seniors at UME-21 schools felt that the time spent was adequate, compared with 78% nationally. At UME-21 schools with high and medium activity, the response had risen 14% by 2001. In comparison, the low-activity UME-21 schools and the national average had risen only 8%, and the UME-21 schools with no stated EBM activity had risen only 6%. This would support the conclusion that the more in-depth UME-21 projects did have an influence on these students’ experiences in EBM.

UME-21 schools administered a supplemental questionnaire to their senior students. Among the eight partner schools, there was a 27% increase in the number of students reporting that they had been exposed to ac-
cessing clinical evidence from the Cochrane Collaboration or other EBM databases. Thirty-seven percent of students at all UME-21 partner schools reported having this exposure in 1999. This rose to 52% in 2000 and was up to 64% in 2001, for an overall average increase of 27%. However, the stratified 2001 results among the schools are high-activity schools, 31% increase; moderate, 31% increase; and low, 27% increase.

The rate of positive responses to the AAMC GQ questions, such as those regarding time spent on critical appraisal, decision analysis, clinical epidemiology, and interpreting clinical data and research reports, was fairly high nationally even before UME-21. Very little increase was seen in these areas within the UME-21 schools or in the average of all US schools, from 1999 to 2001. The available outcome measures are not optimal for analysis of individual curriculum innovations data (see Shea et al and Veloski et al in this issue).

Discussion

An important feature of many EBM and PBM curriculum initiatives was the involvement of effective local leaders who championed this content area in general and oversaw specific innovations. For example, at the University of Pittsburgh, key UME-21 project leaders and faculty (eg, vice dean and assistant dean for medical education) were highly visible supporters of the EBM/PBM innovations at multiple levels, including at the Curriculum Committee, as course and clerkship directors, and in the classroom. This served to help overcome resistance to change, emphasize the importance of EBM/PBM to students, and keep these curricular themes at the forefront. Based on discussions with UME-21 project leaders and faculty, this type of commitment was associated with successful UME-21 innovations throughout the project.

An important component of developing and implementing innovative curriculum is how that change is perceived in the local environment. When attempting to introduce EBM into the curriculum, UME-21 educators were sensitive to biases that others might have about what is meant by EBM and how some of these principles might be viewed in the current health care climate. For example, clinicians, and particularly many senior clinicians, may have negative associations with the term EBM. Some physicians believe that EBM is an attempt to impose cookbook-like approaches to practice on all physicians. Clinicians might resist teaching students about clinical pathways and practice guidelines before they have learned to appropriately utilize these resources themselves. Very few practitioners would find it rewarding to be completely relieved of their autonomous ability to make patient care decisions, so it is understandable that an approach that could tie them to either practice guidelines or scientific literature might be distasteful. Others may misunderstand the meaning of the phrase “evidence-based medicine” and argue that they have always practiced EBM. Thus, one component of successful integration of this content was overcoming faculty resistance. This was one reason why it was helpful to introduce this content in many different ways, including by using more subtle approaches. For example, EBM techniques were often introduced into existing courses rather than taught as freestanding learning modules.

It is unclear whether these interventions, such as teaching critical appraisal, have any long-lasting impact on lifelong learning or patient care. Only a limited number of studies have been performed on the lasting impact of teaching about EBM. These studies are limited by size, methodology, and other factors and are mostly conducted in the graduate medical education setting. At this point, the strongest possible statement may be that there was no derogatory effect from teaching these skills, but as in most aspects of medical education, there is no strong body of evidence that the interventions are effective and have long lasting impact.

Another challenge exists when attempting to teach students how to solve clinical problems in areas in which there is inadequate scientific evidence about how best to proceed. Both students and physicians may have a degree of discomfort when making decisions in the face of a lack of evidence or clinical uncertainty. In the context of the UME-21 project, EBM/PBM is considered to be a knowledge set or toolkit, rather than a complete solution to all clinical questions. Thus, an important barrier to overcome when attempting to integrate learning about EBM into an existing curriculum is to foster understanding of precisely what is and is not meant by EBM.

Future Opportunities

Until the community of medical school educators has become facile with the body of knowledge within the EBM and PBM content areas, it will continue to be challenging to communicate them to medical students. One method that may support teaching about this content is the continued development of teaching resources that may be easily adapted for use by interested medical schools, residencies, and other groups. Textbooks and teaching materials about this content have not yet proliferated to the same degree as, for example, biochemistry, and there are comparatively fewer content area experts and champions.

Another approach to promote teaching and learning about EBM/PBM is to continue to weave this content in as fundamental principles incorporated into the teaching of other, more traditional, medical school subjects. Thus, workshops on literature searching and critical appraisal may be more readily received by students and faculty when sprinkled liberally throughout the preclinical and clinical curriculum than if concentrated in a
single block exposure. In a practical sense, this has greater face validity, since these skills are not intended to be applied as an academic exercise but rather used in the course of caring for patients.

Conclusions
UME-21 medical schools developed a diverse array of strategies for integrating topics in EBM/PBM into the medical school curriculum. Though some strategies require greater institutional commitment than others, all of these strategies are readily exportable to other medical and health professions schools. Although we do not have high-quality evaluation data, the most successful, and probably the most durable, interventions readily demonstrate the relevance of these subject areas to patient care. Success at each institution was, in part, somewhat dependent on leadership by individuals who championed the importance of these skills for physicians in the 21st century.

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