

Guiding Preclinical Medical Students in Finding, Synthesizing, and Communicating Translational Basic Research Literature: Roles for Basic Science Research Mentors

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Abstract

Problem

Understanding and communicating medical advances driven by basic research, and acquiring foundational skills in critically appraising and communicating translational basic research literature that affects patient care, are challenging for medical students to develop.

Approach

The authors developed a mandatory course from 2012 to 2018 at Texas A&M University College of Medicine to address this problem. Medical Student Grand Rounds (MSGR) trains first-year students to find, critically assess, and present primary research literature about self-selected medically relevant topics. With basic science faculty mentoring, students completed milestones culminating in oral presentations. Students learned to

search literature databases and then choose a clinical subject using these skills. They outlined the clinical subject area background and a mechanistic research topic into a clinical problem based on deeper evaluation of primary research literature. "Mechanistic" was defined in this context as providing experimental evidence that explained the "how" and "why" underlying clinical manifestations of a disease. Students received evaluations and feedback from mentors about discerning the quality of information and synthesizing information on their topics. Finally, students prepared and gave oral presentations, emphasizing the primary literature on their topics.

Outcomes

In the early stages of the course development, students had difficulty critically assessing and evaluating

research literature. Mentored training by research-oriented faculty, however, dramatically improved student perceptions of the MSGR experience. Mentoring helped students develop skills to synthesize ideas from basic research literature. According to grades and self-evaluations, students increased proficiency in finding and interpreting research articles, preparing and delivering presentations, and understanding links among basic and translational research and clinical applications.

Next Steps

The authors plan to survey fourth-year students who have completed MSGR about their perceptions of the course in the context of clinical experiences in medical school to guide future refinements.

Problem

Because of the rapid pace of medical advances translated from basic research, physicians require increasing proficiency

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in finding and assessing basic research literature conveying new approaches to prevent, diagnose, and manage illnesses. Physicians must learn to synthesize and interpret innovative, sometimes contradictory research information to make clinical decisions. Moreover, they must communicate new developments to patients, colleagues, and trainees.^{1,2} However, the foundational skills of critically appraising and communicating basic research on disease mechanisms affecting patient care—translational basic research—are challenging for many medical students to develop.

Accordingly, students need training to connect clinical practice with basic research.^{3,4} Unfortunately, many students perceive basic mechanistic research as clinically irrelevant.⁴ This perception often accompanies a curriculum that underemphasizes the importance of understanding, synthesizing, and communicating basic research in the

context of clinical thinking. Moreover, preclinical students learn broadly about medical science knowledge and are introduced to evidence-based medicine and clinical research, yet have little experience with learning that applies deep knowledge to the frontiers of disease mechanisms. In our experience, most medical students struggle to use basic research literature in clinical contexts, and self-directed exploration of research literature is usually a daunting task. Learning general concepts about disease mechanisms limited to well-established basic medical science is insufficient for students' future responsibilities as physicians. Although students do not necessarily need to learn to do basic research, they must learn to access and interpret basic research literature. Without this training, they will be ill-equipped as residents and physicians to link basic science research to clinical practice and, when relevant, to explain the ties to colleagues, patients, trainees, and laypersons.

Medical students often learn basic research methods and thinking by working in a basic research laboratory. Laboratory-based experiences, however, can temporally and spatially disconnect students' research experiences from clinical practice. Moreover, an intensive laboratory research experience often is not easily scheduled within required preclinical or clinical courses. As a companion problem, roles for basic science researchers as mentors for learning within the clinical domain are not well defined. During preclinical instruction, these researchers typically function solely as content experts.

Approach

We hypothesized that a learning experience centering on a student-selected translational basic research topic of clinical relevance would help preclinical students develop skills in finding relevant information in basic research literature, critically assessing these findings, and communicating scientific information in clinical contexts to patients and peers.⁵ From 2012 to 2018 at Texas A&M University College of Medicine, we developed Medical Student Grand Rounds (MSGR), a mandatory 13-week, 1 semester credit hour course for second-semester, first-year students. MSGR runs concurrently with, but thematically independently from, courses in microbiology and immunology, pathology, and cardiovascular and respiratory systems. During MSGR, each student took a mentor-assisted journey into a focused domain of current primary basic research literature on a student-identified disease mechanism.

Historical perspective

When we started MSGR in 2012, it trained students to conduct effective PubMed searches. Students chose general topics from an assigned list, conducted literature searches independently, and completed training about preparing scientific presentations. Students developed presentations independently, largely without formative feedback. They delivered oral presentations to small peer groups, facilitated by a faculty member who graded only their presentations. This design lacked project milestones and frequent mentoring by researchers. Students often struggled to find and understand basic literature, had little

experience with oral presentations, and found MSGR's purpose irrelevant.

Starting in 2013, MSGR was redesigned as a stepwise progression through milestones, culminating in oral presentations. This design divided the course into attainable steps and reduced student procrastination. Students chose translational basic research topics as they reviewed primary scientific literature. However, appraising, synthesizing, and presenting research literature continued to daunt many students according to facilitators' evaluations and student feedback.

Our collective experience with MSGR over time suggested that student mentoring by basic science researchers would engage students to develop long-lasting critical thinking and synthesis skills. In 2016, we recruited basic science faculty to teach students how to effectively read, synthesize, and interpret primary research articles. Students selected a clinical subject correlated with a mentor's expertise (see Supplemental Digital Appendix 1, at <http://links.lww.com/ACADMED/B207>) and selected focused mechanistic research topics after reviewing relevant current primary research articles. We defined "mechanistic" as providing experimental evidence explaining the how and why underlying clinical manifestations of a disease. Both faculty and librarians guided students in retrieving journal articles and beginning evaluating and appraising potentially relevant clinical information.

In academic year (AY) 2017–2018, students completed, with faculty mentoring, 8 milestones (Figure 1) culminating in an oral presentation. This MSGR design had 4 distinctive features. First, selecting a topic of interest and searching basic science literature with mentor feedback enabled self-directed learning. Second, by completing course milestones, students deepened their understanding of disease mechanisms by synthesizing basic research literature and considering how their findings might inform clinical practice and help advise patients. Third, the emphasis on mechanistic research engaged basic science faculty as mentors, which extended students' critical thinking about research and connections between basic science knowledge and its research foundations. Fourth, students honed

their formal presentation skills, which are useful in scholarly and clinical contexts. The long-term goal of MSGR was not to produce physician–scientists but to stimulate physicians to be functionally literate with finding, appraising, and interpreting clinically relevant basic research.

Early milestones trained students in searching primary scientific literature on their chosen topics. Later milestones guided students to critically analyze mechanistic primary research articles in a focused research area. Through each milestone, a researcher mentored each student individually and as part of a small group, which encouraged peer interactions and peer teaching. Mentors provided feedback on milestone achievement, discussed research topics and articles, and shared their experiences of the research endeavor. Students learned by adhering to a milestone plan and were motivated by choosing their clinical and research topics.

Summary of milestones

Week 1: Training in searching literature. Medical librarians provided a hands-on tutorial about finding research articles in literature databases and evaluating and citing sources.

Weeks 1–2: Identifying a general clinical subject area. Students ranked 3 preferred research-related clinical subjects linked to mentors' expertise (see Supplemental Digital Appendix 1, at <http://links.lww.com/ACADMED/B207>). From these ranked lists, course directors assigned students to mentors, with each mentor working with no more than 7 students to promote quality mentoring.

Weeks 2–5: Background and clinical significance outline. Students prepared their first outline, which presented background information for the selected clinical topic and identified the research area of focus. Mentors guided students in understanding concepts of mechanistic research and in critically evaluating and synthesizing topic-specific research articles.

Weeks 6–9: Mechanistic research and translation outline. Students outlined their research topics and annotated primary research articles that became the focus of their MSGR capstone presentations. Feedback from

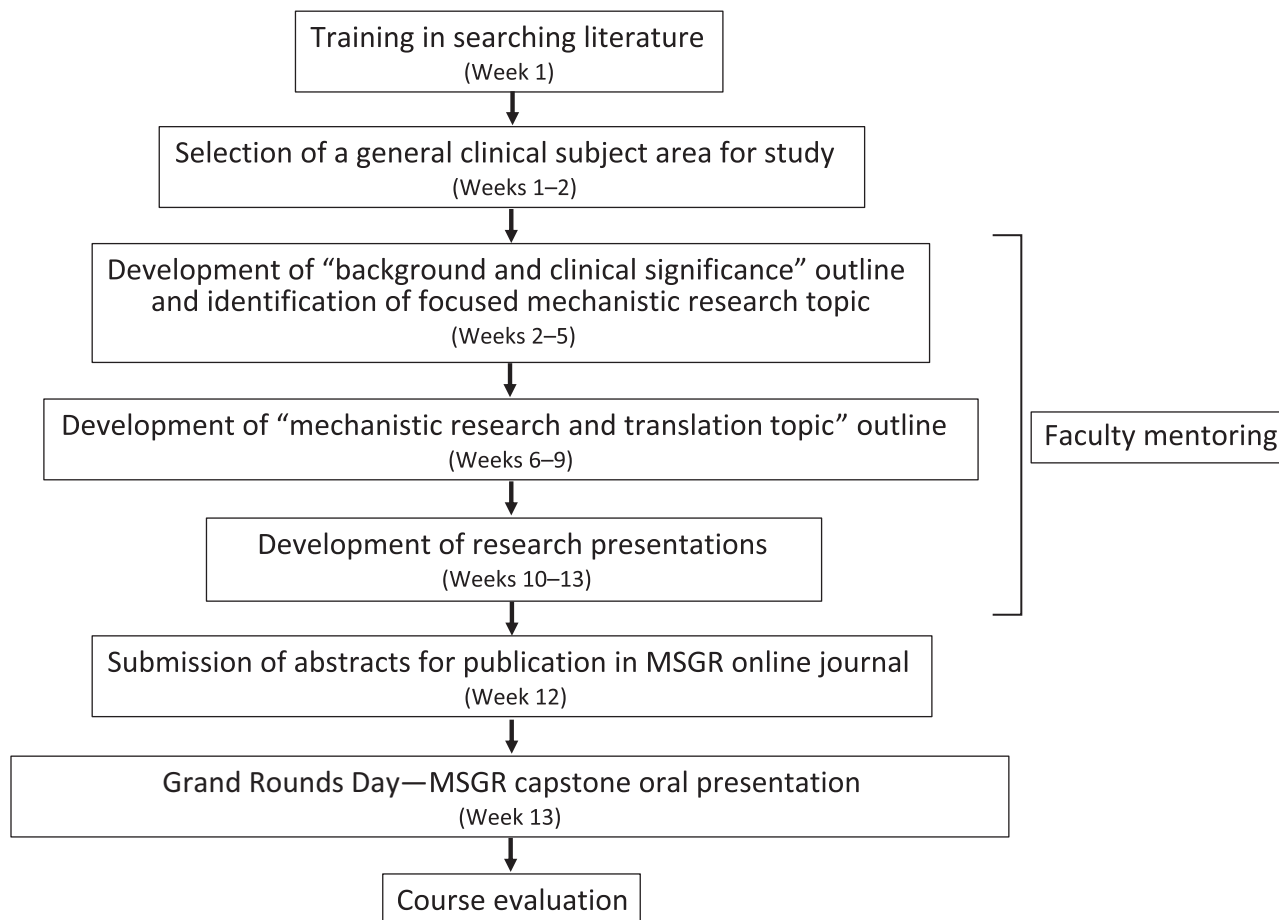


Figure 1 Process and timeline of the MSGR experience. In the 2017–2018 version of MSGR, 155 second-semester, first-year preclinical students with mentoring from basic science researchers completed 8 milestones during 3 months culminating in a 15-minute oral presentation. Abbreviation: MSGR, Medical Student Grand Rounds.

and interactions with mentors guided students to deeper understanding of their research topics.

Weeks 10–13: Drafts of research presentation. Students completed a module about how to prepare and deliver an effective scientific presentation. Students submitted preliminary versions of their presentation slides and notes. Formative feedback from mentors improved the content, organization, and appearance of presentations.

Week 12: Abstract for publication in the MSGR journal. After receiving instruction in writing a scientific abstract, students submitted 400-word presentation abstracts to the online journal *Proceedings of the Texas A&M Medical Student Grand Rounds* (<https://jmsgsr.tamhsc.edu/>).

Week 13: MSGR capstone oral presentation. Each student presented a research-styled, 15-minute seminar

synthesizing multiple primary research articles. Each presentation group included 5–10 students and a faculty member, who facilitated and graded. To promote more objective evaluations, the facilitator mentored no students in the group. Students completed a self-evaluation of their MSGR experience and peer reviewed their presentation group members.

Course evaluations

Students and mentors submitted Likert-type evaluations and free-text comments.

Outcomes

These outcomes refer to MSGR in AY2017–2018, with 155 students and 21 mentors.

Student evaluations

The students’ mandatory course evaluation presented 15 statements, using a 4-point Likert-type response scale (4 = strongly agree or outstanding; see Supplemental Digital Appendix 2, at <http://links.lww.com/ACADMED/>

B207) and solicited qualitative responses. Students generally supported MSGR. Means for 13 of the 15 items were ≥ 3.00 ; the exceptions were peer review and self-assessment activities (mean 2.78 and 2.88, respectively). The mean score for the course’s overall quality was 2.82. The mean score for overall effectiveness of students’ presentation faculty facilitators was 3.46. Mean scores were ≥ 3.33 in 7 specific categories for mentors and 3.39 for the overall effectiveness of their mentors. Historical comparisons of student-generated ratings of the course and mentors are in Figures 2 and 3. Students appreciated recurring interactions with mentors but perceived disparities across mentors in feedback and grading (see Supplemental Digital Appendix 3, at <http://links.lww.com/ACADMED/B207>).

Student reflections

In a self-evaluation survey, students responded to the open-ended question, “What did you learn in the course?”

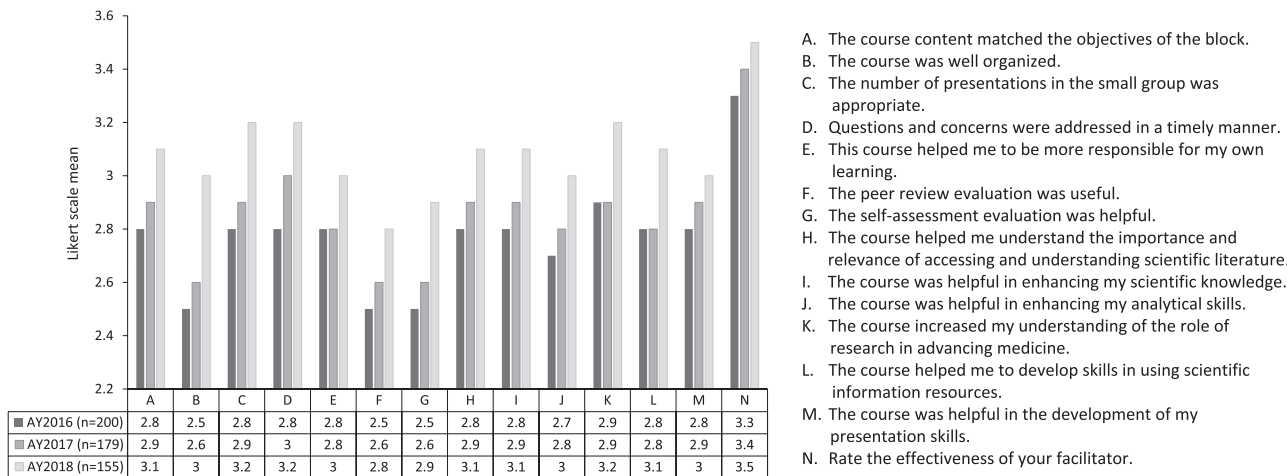


Figure 2 Quantitative results from student-generated evaluations of MSGR, 2016–2018. Students completed a mandatory Likert-type evaluation. Means of items A–M are derived from a 4-point scale where strongly disagree = 1, disagree = 2, agree = 3, and strongly agree = 4. Mean of item N is derived from a 4-point scale where poor = 1, fair = 2, good = 3, and outstanding = 4; n = number of second-semester, first-year students who completed the survey in 2016 (AY2016; response rate = 98.5%), 2017 (AY2017; response rate = 99.9%), and 2018 (AY2018; response rate = 97.5%). The Likert scale mean ordinate was truncated at 2.2 to better visualize changes occurring among the items from years 2016 to 2018. Abbreviations: MSGR, Medical Student Grand Rounds; AY, academic year.

Responses were coded thematically using QDA Miner Lite software (Provalis Research, Montreal, Quebec). Most students indicated that they had progressed toward the 3 course goals: finding relevant scientific information about a specific research topic (93/155 students [60%] responded positively), interpreting and critically assessing scientific information (85 students [55%]), and preparing and delivering a scientific presentation (90 students [58%]). For sample quotes, see Supplemental Digital Appendix 3 at <http://links.lww.com/ACADMED/B207>.

Mentor-generated evaluations

Mentors favorably evaluated MSGR, particularly regarding integration of basic and clinical science and organization (overall quality = 3.9/4) (see Supplemental Digital Appendix 4, at <http://links.lww.com/ACADMED/B207>).

Perspectives

The major innovation of the MSGR course is that through mentoring by professional basic science researchers, preclinical students achieve knowledge of a broad and rapidly evolving spectrum

of scientific biomedical literature. The 1-semester longitudinal MSGR milestone approach is feasible and doable for students despite the constraints of a full preclinical schedule. MSGR extends the foundational preclerkship knowledge that students have acquired to basic research domains of clinical problems and patient care. It also helps integrate basic and clinical science, an ongoing challenge for medical education.^{6–9} MSGR promotes self-directed learning because students choose topics through independent literature searching and analysis and learn how to critically appraise and synthesize

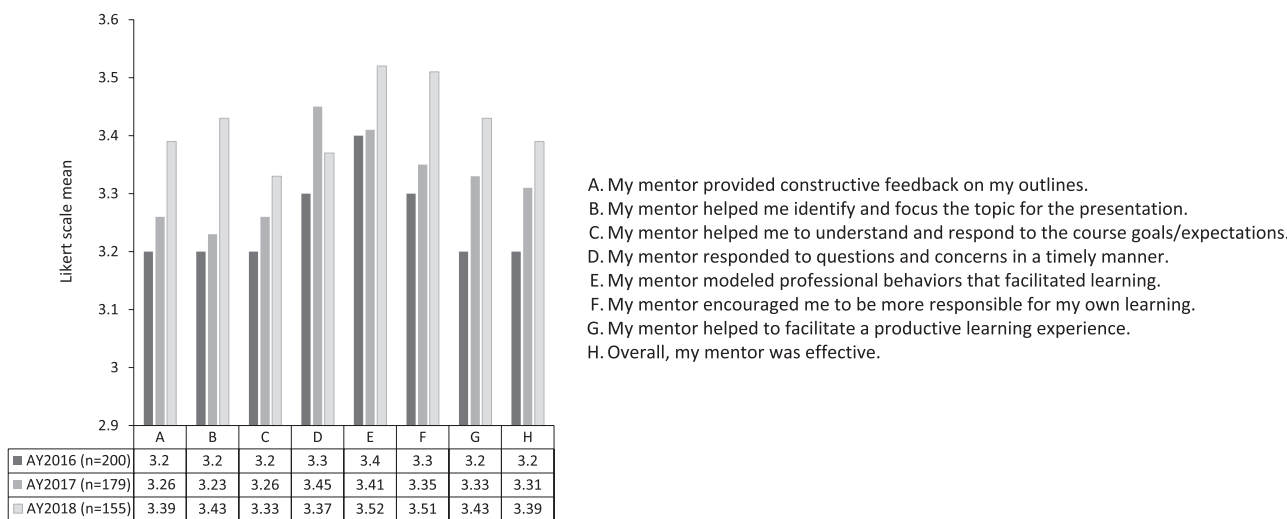


Figure 3 Quantitative results from student-generated evaluations of MSGR mentors, 2016–2018. Students completed a mandatory Likert-type evaluation. Values are means of items A–H derived from a 4-point scale where strongly disagree = 1, disagree = 2, agree = 3, and strongly agree = 4; n = number of students completing the evaluation in 2016 (AY2016; response rate = 96%), 2017 (AY2017; response rate = 93.9%), and 2018 (AY2018; response rate = 96.1%). The Likert scale mean ordinate was truncated at 2.9 to better visualize changes occurring among the items from years 2016 to 2018. Abbreviations: MSGR, Medical Student Grand Rounds; AY, academic year.

scientific information under guidance and feedback from basic researchers. Through critical thinking about basic research literature, students learn how to apply the scientific method to improve patient care.

Students' quantitative course evaluations and qualitative self-evaluations indicated that their mentors played important guiding roles. Allowing students to choose their topics, a feature of self-directed learning, motivated them to learn and promoted mentor engagement. Mentors, likewise, rated the overall course quality. In a survey distributed after MSGR in AY2021, which had a similar course design, 21 mentors (response rate 62%) surveyed affirmed that 7 students per mentor is the maximum number for quality mentoring and that MSGR mentoring is sustainable for mentors with an active research program (20 out of 21 mentors [~95%] indicated a positive response). Mentoring relationships encouraged students' interest in research, teaching, and academic medicine careers. Moreover, familiarizing students with basic research mindsets may promote future cooperation between physicians and basic researchers to advance health care.¹⁰

There are several limitations of basic science mentoring in MSGR to consider. Research topics were restricted to the expertise of mentors, thus excluding topics in behavioral and social sciences, which some students preferred. Also, some students perceived inconsistencies in grading across mentors.

Next Steps

To test our hypothesis more broadly, in future iterations of MSGR, we will extend quantitative and qualitative analyses of evaluations and add survey questions relating to students' previous and concurrent research experiences. We will add training about the peer review process to improve students' perception of its role in MSGR and mentor training to help improve grading concordance across mentors. We will also survey fourth-year students about perceptions of MSGR in clerkship contexts to determine its longer-term impact and guide additional improvements. Finally,

we plan to survey students from different specialties to determine the long-range clinical impact of skills taught in MSGR. Extending the MSGR approach to clinical years may have promise in a novel selective piloted at our institution wherein third-year students conduct an in-depth literature search on mechanisms of disease in patients they helped treat during their clinical rotations.

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Previous presentations: Portions of this course have been presented at the following conferences: The 6th International Conference of Association of Biochemistry Educators, May 7–11, 2017, Clearwater, Florida; the 7th International Conference of Association of Biochemistry Educators, May 3–7, 2019, Tucson, Arizona; joint virtual meeting between the Association of Biochemistry Educators and the Association of Professors of Human and Medical Genetics, May 3–7, 2021; the Association of Graduate and Medical Departments of Biochemistry annual meeting, January 15–20, 2020, Quito, Ecuador; and TEACH-S Virtual Symposium, Baylor College of Medicine, May 14, 2021.

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