Basic Science Right, Not Basic Science Lite: Medical Education at a Crossroad

Ruth-Marie E. Fincher, MD, MACP[1], Paul M. Wallach, MD, FACP[2], and W. Scott Richardson, MD[3]

[1]Education Discovery Institute, Medical College of Georgia School of Medicine, Augusta, GA, USA; [2]Touro University College of Medicine, Hackensack, NJ, USA; [3]Medical College of Georgia School of Medicine, Medical College of Georgia/University of Georgia Medical Partnership, Athens, GA, USA.

This perspective is a counterpoint to Dr. Brass' article, *Basic biomedical sciences and the future of medical education: implications for internal medicine*. The authors review development of the US medical education system as an introduction to a discussion of Dr. Brass' perspectives. The authors agree that sound scientific foundations and skill in critical thinking are important and that effective educational strategies to improve foundational science education should be implemented. Unfortunately, many students do not perceive the relevance of basic science education to clinical practice.

The authors cite areas of disagreement. They believe it is unlikely that the importance of basic sciences will be diminished by contemporary directions in medical education and planned modifications of USMLE. Graduates' diminished interest in internal medicine is unlikely from changes in basic science education.

Thoughtful changes in education provide the opportunity to improve understanding of fundamental sciences, the process of scientific inquiry, and translation of that knowledge to clinical practice.

KEY WORDS: medical education; educational models; teaching; clinical care; research.

J Gen Intern Med 24(11):1255–8
DOI: 10.1007/s11606-009-1109-3

Dr. Brass[1] raises some provocative issues in his commentary, *Basic biomedical sciences and the future of medical education: implications for internal medicine*, about the impact of evolutionary changes in medical education on students' interest in science and clinical reasoning ability. We believe he makes some valid points but also reaches conclusions disparate from the prevailing views of many in the medical education community. Despite our differences, we share a passion for developing educational models that prepare students to fulfill the evolving health-care needs of the 21st century. In this commentary, we respond to Dr. Brass' article, beginning with a brief recounting of the history of how we came to have the medical education system we have today, then addressing areas of common ground and areas of divergent views, and concluding with suggestions for "a way forward."

Received June 25, 2009
Revised August 14, 2009
Accepted August 24, 2009
Published online September 23, 2009

HOW WE CAME TO HAVE OUR CURRENT SYSTEM OF MEDICAL EDUCATION

In the nearly 100 years since the publication of the Flexner Report[2], much has changed, including the practice of medicine, the health-care system, the academic health science center, the expected competencies of physicians, the characteristics of medical students, the expectations of patients, our understanding of adult learning, and the volume of medical knowledge. The core elements of Flexner's recommendations, embraced by Brass[1], were that analytic reasoning is the basis for medical decision making and that research should be stimulated by questions raised in the context of patient care. These principles remain sound. However, in the spirit of continuous improvement, we can embrace the enduring elements of Flexner's recommendations, but we must also ensure that today's medical education reflects the contemporary reality in the 21st century.

While much attention is focused on attempts to reform medical education[3], some may fail to recognize the impact of significant changes in medical practice and academic health science centers over the last 100 years on medical education[4]. Today's environment for medical education has evolved since Flexner's time in ways that necessitate another era of change in the educational system.

For instance, in Flexner's day, what was considered cutting edge research could and did emerge from observations of patients during the course of clinical practice. As Cooke et al.[4] pointed out, teaching, clinical care, and research activities were intertwined and mutually beneficial because patients were the basis for research. This symbiotic relationship enabled physician-scientist-clinicians of the Flexnerian Era to move seamlessly from the ward to the classroom to the laboratory.

During the 20th century, research productivity became the core element for faculty promotion, overshadowing excellence in clinical care or teaching[5]. Creation of the National Institutes of Health began an era of funding for basic science research, development of basic science departments, and expansion of graduate programs[4,6]. Research became the priority of most basic science departments, although they were also charged with educating medical students. Most basic science faculty had little knowledge of clinical medicine, resulting in discipline-based basic science education with little clinical context.

By mid-century, cutting edge research had become increasingly complex and molecular, rather than patient, based. Successful researchers required new skill sets and more time for research and grant writing, resulting in less time for teaching.

Concurrently, important changes affected clinical faculty. With little or no remuneration for teaching, most medical school clinical faculty have had to earn their salary through clinical productivity. As a result, it has become increasingly difficult to become a top-flight researcher, clinician, and educator. Financial pressures and institutional expectations for advancement promoted a division between basic science and clinical faculty, and eroded faculty time for undergraduate medical education[7]. The sheer volume of biomedical knowledge has expanded dramatically, along with increased expectations of newly graduated physicians. These changes, in turn, have changed what we now consider the fundamental or basic science knowledge needed by our students. Fundamental science includes the broad background of biological and social science, and quantitative aptitudes needed to gather and interpret scientific evidence, and apply it to make evidence-based patient care decisions. If physicians are to understand well and use sensibly multiple types of knowledge that apply to clinical care, they need to learn not only knowledge from studies of the biology of human health and disease, but also knowledge from clinical care research, knowledge about working in health systems, knowledge of psychology and sociology, knowledge derived from clinical experience, knowledge of professional values and ethics, and knowledge about patients' experiences, values, and preferences. More than just mastering each body of knowledge, our students need to learn to use judgment in understanding, weighing, and integrating these many types of knowledge into sound decisions in the service of their patients. Since new knowledge will be made after they graduate, our students should be able to evaluate original research and literature that assess and summarize research results and expert opinions, such as systematic reviews[8] and practice guidelines[9–11]. The importance of appraising evidence critically and applying it judiciously is clear[12,13].

Since Flexner, our knowledge about how people learn has grown tremendously and is still changing rapidly. This trend also demands that we re-examine the learning strategies and tactics we use in medical education[14,15]. This challenge is widely acknowledged, and it has been labeled as one of the major internal challenges to medical education[16].

Points of Agreement. We agree with Dr. Brass about five important points. First, understanding the scientific foundations of medical practice and using this knowledge to inform decisions for patient care is an essential competency of physicians. Second, physicians should think critically as they access and examine evidence and guidelines in providing quality care to individuals. Third, students and physicians often assert the lack of direct relevance of basic science to the practice of clinical medicine. Fourth, as our understanding of the science of learning changes, educational strategies should be applied to enhance learning of the sciences fundamental to medicine. Finally, internists, both generalists and subspecialists, should continue to be engaged in the ongoing discussions of medical education reform.

POINTS OF DIVERGENT VIEW

While we have areas of agreement with Dr. Brass[1], there are points about which our views diverge. First, it appears very unlikely that emerging directions in American medical education will diminish the importance of the fundamental sciences. The changes being implemented have not devalued the basic sciences, nor have the changes in basic science education impeded the learning of clinical decision making. We suspect students' perceptions of the basic sciences as "irrelevant" are more likely related to the need to do a better job of choosing, updating, and presenting content in a way that demonstrates relevance than to less time devoted to basic science education. Second, the proposed changes in the United States Medical Licensing Examinations (USMLE) are designed to strengthen and broaden assessment of students' knowledge of and ability to apply fundamental sciences to clinical medicine, not to diminish the importance of the fundamental sciences. Third, the diminished interest in internal medicine is less likely due to changes in basic science education than to other factors, including income, workload, and perceived quality of life. We also doubt that changes in medical curricula have played a significant role in MD/PhD program matriculation, as students apply for these programs prior to starting medical school. Finally, Dr. Brass's general assertion that "clinical faculty" are inadequate role models and teachers because they are not conversant with the fundamental sciences is unfounded. We elaborate on each of these points of disagreement below.

Despite our divergent views, we see several positive adaptations developing in response to the evolution from Flexner's time to the contemporary reality. Many medical schools have taken steps to integrate more meaningfully the basic and clinical sciences to diminish unintended redundancy and to emphasize the importance of fundamental science in clinical decision making. Concurrently, many have introduced early patient care experiences, some longitudinal, and increased active, self-directed learning activities. This national movement toward curricular integration and the evolutionary changes in the USMLE should result in enhanced experiential reinforcement of basic knowledge.

Medical schools have been expanding what is considered fundamental science from the traditional disciplines of anatomy, physiology, biochemistry, microbiology, pharmacology, and pathology also to include behavioral science, communication science, epidemiology, statistics, critical appraisal of the literature, health-care economics, and the sciences of quality and safety. Failing adequately to educate in these areas has potentially dire consequences for our patients and the health-care system. Learning science fundamental to medicine is a lifelong pursuit; the sampling offered in medical school should provide foundations necessary for lifelong education, including the commitment and skills necessary to continue to learn over a career.

Assessments of students' achievement are evolving, and can become even more explicitly aligned with contemporary goals for medical education. Students' experience preparing for the responsibility of caring for patients is a potent long-term stimulus for learning[4,17]. However, interval assessments of their acquisition of the knowledge, skills, and attitudes necessary for medical practice are a strong and more immediate stimulus. If assessment can foster learning, increasing attention is and should be placed on how to assess not only

students' mastery of knowledge from the fundamental sciences, but also meaningful integration into the context of clinical decision making.

Many schools are rebuilding the way the fundamental sciences are taught. The traditional fact- and lecture-based model for basic science education, without significant clinical context, has resulted in short- but not long-term retention of knowledge[18]. For many students, basic science has been reduced to a rite of passage, characterized by binging and then purging after completing the basic science-centric component of the licensure examination (USMLE Step 1). Multiple studies have confirmed that students' retention of non-contextualized basic science factual information is poor[19–21]. In addition, the current system of separation of basic from clinical science in a "two-plus-two" model results in separation rather than seamless, longitudinal integration. This temporal separation may exacerbate students' misperceptions of basic science as irrelevant to patient care. Curricular models in which students learn scientific fundamentals in authentic health-care contexts may help students comprehend this knowledge and be more readily able to transfer and apply it to clinical decisions, which should reinforce positively its perceived relevance to patient care.

The USMLE licensing examinations are also evolving in ways that should enhance, not lessen, the importance of the fundamental sciences. We believe that Dr. Brass' concerns about a negative impact of changes in the USMLE licensing process on the importance of scientific foundations of medical education are unfounded. The result is likely to be the antithesis of his concern. Two USMLE decision points (or gateways), one at the end of medical school in preparation for supervised clinical practice and the other during residency training in preparation for unsupervised practice, will parallel the licensure process[22]. Gateways refer to state licensing board decision points; the first for a provisional training license and the second for an unrestricted license. The number and timing of the assessment elements to enable decisions at the two gateway decision points have not been specified[23]. Assessing basic science knowledge on each USMLE examination should enhance the importance of the sciences and increase students' appreciation and retention of underlying principles. At the same time, framing the examinations around competencies will strengthen the linkage between medical education and the competencies necessary for medical practice.

Finally, Dr. Brass[1] links a diminished emphasis on basic science education and decline in the number of faculty who move seamlessly from the bench to the bedside with the decline in students' interest in careers in the specialty of internal medicine. We believe the decline in students' interest in internal medicine is more related to the marketplace than to failure to instill scientific curiosity. Students who belong to "Generation X" and the "Millennium Generation" place more importance on lifestyle and discretionary time than the previous generation[24].

WAY FORWARD

The recently released *Scientific Foundations for Future Physicians* report provides a framework for "the way forward"[25]. The report supports the value of up-to-date basic science content that reflects the importance of the sciences in clinical practice. It also emphasizes that the medical education process should result in scientifically inquisitive and compassionate physicians who have the motivation, tools, and knowledge to find the information necessary to provide the best, most scientifically sound care for their patients. It proposes a competency-based approach to pre-medical and medical education, and presents a set of core competencies. Similar reports addressing social science and behavioral foundations are being prepared.

A key challenge in implementing necessary changes in medical education will be creating a truly integrated medical education continuum that begins in medical school and extends through residency and practice. The fundamental sciences can and should be integrated better with the clinical sciences in our educational programs, as both are essential to progress in each. We will emphasize two ideas for changing education: more contextualized teaching of scientific foundations and more research understanding and experience for students.

Contextualized teaching of foundational science and clinical medicine. It is unlikely that faculty will be predominantly clinician-scientists, who are extramurally funded researchers with an extensive presence in the laboratory and on the wards. Rather, teams of scientists and clinical faculty should work together to promote scientific, evidence-based education. We must recognize and value a core of outstanding clinician-educators, clinician-scientists, and basic scientists, and reward effective collaboration in education. Ongoing reforms in medical education should emerge from effective use of teams to help students understand the foundational science and its application to clinical decisions[26].

Clinician-educators may not be engaged in conducting bench or translational research, yet they are very much able to role model and teach the application of discoveries and the process of using best evidence to make clinical decisions. The bench-scientist-as-best-teacher conclusion is not supported by the emerging scholarship about excellence in clinical teachers[27–30]. We wonder if Dr. Brass recognizes how many clinician-educators might interpret his concerns about the comprehensive teaching ability of clinicians who are not trained as scientists as a dismissal of their enormous talents and tremendous efforts on behalf of their learners and patients. Since the majority of the current clinical faculty was formally trained a decade or more ago, any shortcomings in their ability to teach the scientific foundations of medicine could be an indictment of the historical educational system that he embraces. As we look to the future, optimal clinical education requires collaboration among clinician-scientists, clinician-educators, basic scientists, and students who are dedicated to the principles of self-directed, continued learning.

Educational experience for to promote enhanced understanding of research for students and clinicians. There is a need for clinician-scientists, and medical schools should spawn interest among students in clinician-scientist academic careers. Students should be encouraged to acquire research experience even if their school does not require a research project. Opportunities include participating in research activities during unscheduled times, extending medical school to

participate in a 1-year research experience, or doing a research fellowship. Such opportunities are likely to stimulate participation in science by clinicians and interest in careers as clinician-scientists. However, we support educational and research experiences designed to promote better understanding of research and ability to apply the published biomedical literature to clinical decisions. The anticipated results would be a more in depth understanding of research principles for all students and faculty, more research experience for some, and germinating interest in careers as clinician-scientists for some.

CONCLUSION

As a result of thoughtful changes, we have the opportunity to educate physicians who possess factual knowledge of fundamental science and understand the process of scientific inquiry and translation. They will have the ability to access and interpret information, the skills to determine when a practice guideline applies and when it does not, and will be able to determine what they know and what they need to learn. Physicians must understand the foundational sciences and apply them to the care of patients in order to know when a clinical guideline "fits" and when it does not. Facts, concepts, and processes should be presented where possible in an integrated fashion, analogous to the way in which physicians will ultimately access, analyze, and use information. Students should play an active role, stimulated by basic scientists, physician-scientists, and clinical faculty. We should use the licensing examinations to foster learning and clinical decision making. Internists and other physicians should remain actively engaged in the debate as we collaborate to develop the very best medical education system for the 21st century. Our patients and students deserve nothing less. Basic science lite? Hardly!

Conflict of Interest: *None disclosed.*

Corresponding Author: *Ruth-Marie E. Fincher, MD, MACP; Education Discovery Institute, Medical College of Georgia School of Medicine, CB-1843, Augusta, GA 30912, USA (e-mail: rfincher@mail.mcg.edu).*

REFERENCES

1. **Brass EP.** Basic biomedical sciences and the future of medical education: implications for internal medicine. J Gen Intern Med. 2009. doi:10.1007/s11606-009-0998-5
2. **Flexner A.** Medical Education in the United States and Canada: a report to the Carnegie Foundation for the Advancement of Teaching. New York; 1910.
3. **Christakis NA.** The similarity and frequency of proposals to reform US medical education: Constant concerns. JAMA. 1995;274(9):706–11.
4. **Cooke M, Irby DM, Sullivan W, Ludmerer KM.** American medical education 100 years after the Flexner report. N Engl J Med. 2006;355 (13):1339–44.
5. **Ludmerer KM.** Learning to Heal: The Development of American Medical Education. New York: Basic Books; 1985.
6. **Ludmerer KM.** Time to Heal: American Medical Education from the Turn of the Century to the Era of Managed Care. Oxford University Press; 1999.
7. **Barzansky B, Etzel SI.** Educational programs in US medical schools, 2003–2004. JAMA. 2004;292(9):1025–31.
8. **Haynes RB.** What kind of evidence is it that evidence-based medicine advocates want health care providers and consumers to pay attention to? BMC Health Serv Res. 2002;2(1):3.
9. **Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, Schunemann HJ.** GRADE: 1. An emerging consensus on rating quality of evidence and strength of recommendations. Brit Med J. 2008;336:924–6.
10. **Guyatt GH, Oxman AD, Kunz R, Vist GE, Falck-Ytter Y, Schunemann HJ.** GRADE: 2. What is "quality of evidence" and why is it important to clinicians? Brit Med J. 2008;336:995–8.
11. **Guyatt GH, Oxman AD, Kunz R, Falck-Ytter Y, Vist GE, Liberati A, Schunemann HJ.** GRADE: 3. Going from evidence to recommendations. Brit Med J. 2008;336:1049–51.
12. **Sackett DL, Rosenberg WMC, Gray JAM, Haynes RB, Richardson WS.** Evidence based medicine: what it is and what it isn't. [Editorial] Brit Med J. 1996;312:1–72. PMID: 8555924.
13. **Straus SE, Richardson WS, Glasziou P, Haynes RB, eds.** Evidence-Based Medicine: How to Practice and Teach EBM, 3/e, Edinburgh, UK: Churchill Livingstone/Elsevier; 2005.
14. **Bransford JD, Brown AL, Cocking RR, eds.** How People Learn: Brain, Mind, Experience, and School. Washington, DC: National Academy Press; 2000.
15. **Sawyer RK, ed.** The Cambridge Handbook of the Learning Sciences. Cambridge, UK: Cambridge University Press; 2006.
16. **Ludmerer KM.** The internal challenges to medical education. Trans Am Clin Climatol Assoc. 2003;114:241–50.
17. **Miller J, Bligh J, Stanley I, al Shehri A.** Motivation and continuation of professional development. Br J Gen Pract. 1998;48:1429–32.
18. **D'Eon MF.** Knowledge loss of medical students on first year basic science courses at the University of Saskatchewan. BMC Med Educ. 2006;6:5.
19. **Watt ME.** Retention of preclinical knowledge by clinical students. Med Educ. 1987;21:119–24.
20. **Sissons JC, Swartz RD, Wolf FM.** Learning, retention and recall of clinical information. Med Educ. 1992;26:454–61.
21. **Swanson DB, Case SM, Luecht RM, Dillon GF.** Retention of basic science information by fourth year medical students. Acad Med. 1996;71:S80–2.
22. Comprehensive review of USMLE available at: http://www.usmle.org/General_Information/CEUP-Summary-Report-June2008.PDF Accessed June 16, 2009.
23. **Scoles PV.** Comprehensive review of the USMLE. Adv Physiol Educ. 2008;32:109–10.
24. **Weinberger SE, Smith LG, Collier VU.** Redesigning training for internal medicine. Ann Intern Med. 2006;144(12):927–32. Epub 2006.
25. Report of the AAMC-HHMI Committee. Scientific Foundations for Future Physicians. Washington, DC: Association of American Medical Colleges, 2009.
26. **Greiner AC, Knebel E. (eds)** Health Professions Education: A Bridge to Quality. Institute of Medicine of the National Academies. Washington, DC; National Academies Press; 2003.
27. **Sutkin G, Wagner E, Harris I, Schiffer R.** What makes a good clinical teacher in medicine? A review of the literature. Acad Med. 2008;83:452–66.
28. **Kilminster S, Cottrell, Grant J, Jolly B.** AMEE Guide 27: Effective educational and clinical supervision. Med Teach. 2007;29:2–19.
29. **Ramani S, Leinster S.** AMEE Guide 34: teaching in the clinical environment. Med Teach. 2008;30:347–64.
30. **Reilly BM.** Inconvenient truths about effective clinical teaching. Lancet. 2007;370:705–11.