

# 100 Years after Flexner: Reconsidering Premedical Education

Michael Shusterman

In the early twentieth century the proliferation of for-profit medical schools and unstandardized curricula led to calls for drastic change. Medical schools operated under widely disparate models ranging from apprenticeship systems to university-based lectures. Physicians practiced with inadequate levels of training in both clinical and scientific medicine. Whereas previous efforts at reform by the American Medical Association (AMA) had proven ineffective during the 19th century, the advent of scientific medicine shifted the balance of professional opinion.<sup>1</sup> To reevaluate medical education in the United States, the AMA created in 1904 the Council on Medical Education (CME), tasked with standardizing admissions requirements to medical school and reforming medical school curricula and preclinical training.<sup>2</sup> In 1908 the CME and the Carnegie Foundation commissioned a report on medical education in the United States, led by education theorist Abraham Flexner, PhD.

Flexner undertook a rigorous survey of the 155 medical schools operating at the time and submitted his suggestions for reform in 1910 as the *Report on Medical Education in the United States and Canada*, more commonly referred to as the Flexner Report.<sup>3</sup> The Flexner Report's recommendations for medical education and admissions would serve as the foundation of the medical education system in the United States. Flexner strongly believed in the combination of scientific education with clinical practice, a consequence of following the university-based medical systems of Germany and France at the time. The resulting standardization of medical education was the 2+2 model of two years of science followed by two years of clinical practice. Today this curricular model is being challenged by a movement focused on shifting medical education towards a future when personalized genomic medicine may become available.<sup>4</sup> Similarly, science requirements are being condensed from 2 to 1.5 or fewer years in the hope of exposing medical students to clinical practice more rapidly.

However, whereas graduate level medical education has continued to evolve since the introduction of the seminal Flexner Report, the same has not been the case for premedical education requirements. Flexner advocated for a rigorous model of medical education based upon the laboratory scientific tradition. This led by the 1930s to the current set of standard requirements for admittance to medical schools—1 year of biology, 2 years of chemistry (general and organic), and 1 year of physics.<sup>5</sup> Since then a vigorous debate has continued on the importance and necessity of various subjects for medical school preparation.<sup>6</sup> Some have called for a rigorous reconsideration of the entire scope of medical and premedical education.<sup>7</sup> Emmanuel has argued that “many premedical requirements are irrelevant to future medical education and practice.”<sup>8</sup> He has proposed exchanging the traditional organic

chemistry, physics, and calculus requirements for courses on genetics, molecular biology, biochemistry, and statistics. Emmanuel argues that these new courses should be integrated with a strong background in the social and ethical dimensions of healthcare (policy, bioethics, social sciences).<sup>8</sup> In a recent assessment of science requirements for both medical school education and baccalaureate level preparation, Lambert and colleagues agreed with Emmanuel's assessments in exchanging the physical sciences for coursework devoted to biomedical and molecular principles.<sup>9</sup>

Others have looked towards Lewis Thomas' more radical suggestion of eliminating the majority of standard scientific preparatory requirements in favor of a broad liberal arts education.<sup>10,11</sup> Thomas argued that the loss of the liberal arts education had degraded the humanistic integrity and ethics of rising physicians who were willing to sacrifice professional and scientific values in an endless race to the top. Analyses have overridden fears that humanities majors are incapable of performing adequately in medical school. In a review Wershof et al. have shown that medical students who majored in the humanities and only took the minimal premedical requirements perform on par with students with more extensive preparation in the sciences.<sup>12</sup> However, this push for the integration of humanities into the curriculum has met with an opposing effort to spend more time on the sciences. A recent colloquium on evolution and medicine came to the conclusion that physicians require far greater exposure to evolutionary biology and that the subject should be incorporated throughout the medical education system.<sup>13</sup>

What then are we to make of these disparate opinions? One potential solution may lie in the proposals of a joint Association of American Medical Colleges (AAMC)-Howard Hughes Medical Institute (HHMI) report, *Scientific Foundations for Future Physician*.<sup>14</sup> The AAMC-HHMI study urges the adoption of the scientific competencies for medical and premedical education, with a focus on integrating core focus areas into interdisciplinary courses rather than rigid medical requirements. For instance, organic chemistry and biochemistry may be combined into a year long sequence that incorporates organic chemistry topics into the broader scale of biochemical principles. Similarly courses in the physical sciences may utilize systems such as neural networks to study electrical systems and consider Newtonian principles in the context of biomechanical systems. The report recognizes the difficulty in implementing such interdisciplinary courses across traditionally compartmentalized science departments in universities. Additional problems may ensue from resistance among faculty, particularly in the physical sciences, to incorporate greater

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Michael Shusterman is the co-Editor-in-Chief of *TuftsScope*.

emphasis on biological topics in coursework. However, since 2006, Harvard University has been successful in implementing a framework that has integrated biomedically relevant topics into typical premedical coursework.<sup>15</sup>

It would seem prudent for universities to reconsider the current design of premedical coursework in light of the changing attitudes among medical educators and students. Significant progress has already been made in the area of introductory biology reform through the inclusion of genetics, molecular biology, and physiology into preliminary biology courses. Further steps must result in the creation of an integrated organic chemistry and biochemistry sequence. Rather than eliminating organic chemistry this will reinvigorate the subject by forging a union between basic science and biochemical systems relevant to medical study. Finally, coursework in introductory physics should seek to incorporate biological principles, where possible, into curricula. Once implemented these initial reforms should serve as a catalyst for additional reconsiderations and changes to premedical requirements. It seems appropriate that 100 years after the Flexner Report serious efforts should be taken to once again reevaluate the paradigm of medical preparatory education.

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## RESEARCH HIGHLIGHT

### Larger Hospitals Associated with Lower Mortality for Three Common Conditions

Caroline Melhado

A recent study published in the *New England Journal of Medicine* found that patients suffering from acute myocardial infarction, heart failure, and pneumonia had lower rates of death after 30 days if they were admitted to a larger hospital. A review of standard Medicare analytic files demonstrated that patients admitted to a larger hospital had a reduction in mortality, however this reduction hit a threshold level, as reduction was insignificant as the hospital volume grew past the threshold.

The study included 734,972 patients of myocardial infarctions from 4,128 hospitals, 1,324,287 patients with heart failure at 4,679 hospitals, and 1,418,252 patients admitted with pneumonia at 4,673 hospitals. Hospitals not included were those that had fewer than ten patients annually. Researchers found that increasing the annual volume by 100 patients in a hospital was correlated to a 20% reduction in death after 30 days for patients admitted with acute myocardial infarction. Likewise heart failure showed an increase by 100 patients annually would lead to a 10% decrease in 30-day mortality, and a 5% reduction of mortality for patients with pneumonia. However, when the volume of a hospital reached 610 patients, the decrease in 30-day mortality was no longer significant for myocardial infarction. Thresholds for heart failure and pneumonia were 500 and 210, respectively.

Of the hospitals included in the study 25% were teaching hospitals, and 27% had cardiovascular revascularization services. While larger hospitals were more likely to have these characteristics, stratification of each of these components showed that they were not significant confounding variables. Limitations to this study are that only these three conditions were studied, and therefore the widespread application of larger hospitals for many more common medical problems might not follow this trend.

As policy makers grapple with ways to improve the healthcare system, researchers are studying ways to improve the outcomes of patients with common medical problems. While both negative and positive outcomes of these three conditions at large and small hospitals existed, the overall reduction in mortality at larger hospitals might shape future public health policy to favor larger medical institutions.

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Caroline Melhado is the Research Highlights Editor of *TuftsScope*.