

Emerging opportunities and career paths for the young physician-scientist

A recent 'Days of Molecular Medicine' Conference in La Jolla sponsored by the UCSD Institute for Molecular Medicine, the Salk Institute and *Nature Medicine* in-

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cluded a forum for discussion of the current status of physician-scientist career pathways—with a particular focus on the pipeline of new recruits. Forum participants included representatives from academia, private foundations, medical research societies and the pharmaceutical industry. Comments by participants from Asia and Europe also served to highlight the international significance of this issue.

Who are physician-scientists, and why do we need them? They are individuals with medical training who spend most or all of their time engaged in basic, disease-oriented or patient-oriented research. Much has been written over the past two decades regarding the importance of physician-scientists, and the problems faced by those entering this career track¹⁻³. Physician-scientists are vital members of the medical research enterprise, because the scientific questions they ask reflect the experiences they gain from taking care of sick people. This generalization can be illustrated by listing some of their notable achievements, such as the discovery of oncogenes, the low-density lipoprotein receptor, prions, HIV, pulmonary surfactant, and the defective genes in many inherited disorders; the eradication of smallpox and the near-eradication of polio; cures for childhood leukemia, Hodgkin disease, and testicular cancer; the development of open-heart surgery, of organ and bone-marrow transplantation, and of approaches to decrease mortality after heart attacks and strokes. The kinds of questions that physician-scientists tend to ask will become even more important as information about the human genome swells in this 'post-genomic' era. They are also in an ideal position to communicate and collaborate, both with PhD scientists and with health-care providers. Finally, physician-scientists can make the strongest case for the medical relevance of basic research to legislators, advocates and health agencies⁴.

Unfortunately, the number of physician-scientists has been declining for the last two decades. In 1983, there were 18,535 physician-scientists nation-wide. By 1998, this number had fallen to 14,479, a 22% decline⁵. This gradual but definite decrease in the face of an expanding need has been the subject of much concern and pessimism^{3,6}, including grave warnings of the possible loss in preeminence of American academic medicine⁷.

We are therefore pleased to report that the warnings of the past two decades and the advocacy efforts of a growing number of national organizations (Box 1) have resulted in many new initiatives by public and private funding organizations aimed at revitalizing the pathway (Box 2). We applaud all these efforts, but suggest that most need to be expanded further. For example, the recently established loan repayment program of the National Institutes of Health (NIH), which limits eligibility to individuals being trained in clinical research, needs to be expanded to include physicians training in basic and translational research as well⁸. Furthermore, the impressive efforts of non-profit foundations should be more widely publicized, and enhanced to focus on other critical weaknesses in the pipeline, such as the need to encourage more extended research opportu-

nities for medical students. Special attention also needs to be given to the unique hurdles faced by women, who are under-represented in the physician-scientist

pool (this matter is addressed by Nancy Andrews in this issue⁸).

In the past, there have been two major sources of physician-scientists: those who undertake combined MD and PhD training upon matriculation to medical school, and the so-called 'late bloomers', who engage in extended research training only after they have completed their medical school, residency and clinical subspecialty training (Fig. 1). The latter pathway (which has previously been the dominant source of physician-scientists) is the one in jeopardy⁵. The reasons are many: the heavy debt burden of most MD graduates; the extended post-MD research training interval of 8–10 years; the comparative fiscal security of a career in clinical practice; and the uncertainties for success even after pursuing rigorous research training.

The future health of academic medical centers and of the medical research enterprise requires that the numbers of physician-scientists be restored at least to past levels. To accomplish this, every possible approach toward rescuing the late-bloomer pathway should be pursued. Some of these have been initiated (Box 2). However, restoring this pathway to its former size will be difficult. Thus, other solutions to the pipeline problem are needed.

The most obvious one is to expand the highly successful NIH-funded Medical Scientist Training Programs (MSTP), the combined MD-PhD pathway that attracts undergraduates committed to pursuing a medical research career. But such an expansion is not as straightforward as it may sound. First, it is not clear that the National Institute of General Medical Sciences (NIGMS), which currently funds all these programs, is willing to accept the fiscal responsibility for such a major expansion. Second, some people doubt that the qualified applicant pool is currently deep enough to warrant major expansion. Finally, as the MSTP pathway has previously contributed less than a quarter of the total physician-scientist pool, even doubling its size cannot replace all the disappearing late bloomers.

With regard to the first issue, we suggest that although NIGMS should enhance its current level of support, additional 'disease-oriented' NIH institutes should also contribute financially to the expansion of the program. The categorical insti-

Box 1 National organizations expressing concern about the physician-scientist career pathway

- American Medical Association
- American Society for Clinical Investigation
- Association of American Medical Colleges
- Federation of American Societies for Experimental Biology
- Howard Hughes Medical Institute
- Institute of Medicine
- NRC Committee on National Needs for Biomedical and Behavioral Research
- NIH Director's Panel on Clinical Research

Box 2 Emerging opportunities for revitalization of physician-scientist careers

- Loan repayment programs from NIH for extramural trainees engaged in clinical research
- Loan repayment programs for NIH intramural trainees
- Career development programs of NIH
- Howard Hughes Medical Institute appointments to investigators doing patient-oriented research
- Support of physician-scientist training and career development by not-for-profit agencies
- Development of degree-granting postdoctoral programs for MDs at academic institutions
- Establishment of the Association for Patient-Oriented Research

tutes do not need to set up complex new mechanisms to award independent MSTP grants. Rather, they could fund supplements that would be applied for after successful award or competitive renewal of an NIGMS MSTP grant. For example, an institution with a strong record of accomplishment in immunology and infectious diseases and a recently awarded NIGMS-funded MSTP grant might apply to National Institute for Allergy and Infectious Diseases (NIAID) for a supplement to expand the existing program. Once awarded, such a supplement should not have disease-related strings attached to it.

Of course, any such efforts to expand the funding base of the MSTP programs must be accompanied by aggressive measures to ensure an adequate pool of highly qualified applicants and to encourage some MSTP students toward patient-oriented research (which is rarely done today). Current efforts at exposing high school and college students from underprivileged backgrounds to high quality university-level medical research may help to enhance the potential applicant base. In this regard, it was heartening to hear at the La Jolla Forum that several MSTP program directors are getting actively involved in such programs at their respective institutions.

As indicated earlier, the problems confronting the late-bloomer pathway are formidable. We therefore suggest additional efforts aimed at catching late bloomers early—before debt burdens, family responsibilities and other exigencies make it too late to attract them. All medical schools encounter talented and motivated medical students who are attracted to science after the first or second year of medical school and then decide they would like to enter the MSTP track. Although such individuals can be attractive candidates, the institutional MSTP program director often chooses instead to save the limited available slots for the next entering freshman class. We suggest that the NIGMS should expand MSTP existing programs modestly, assigning additional slots specifically for such late entry MSTP candidates, with stringent selection criteria based upon performance in the early years of medical school and promise for future research success.

Another way to catch these late bloomers early is to attract them to research training during the second half of medical school, but before they have gone

on to residency or fellowship training. Such individuals would not necessarily go on to a PhD degree, but would still require a structured, extended research-training experience without the distractions posed by simultaneous clinical training. Yet another approach currently being tried is the 'Generalist Physician-Scientist Pathway', which commits post-MD medical residents to an extended research experience but assumes that subsequent clinical sub-specialty training is not essential for a serious research career. Rather, the time saved by not doing sub-specialty training could be used to enhance the research-training component, or to start an independent academic career earlier.

Other pathways exist. One that has never been adequately explored involves a freshly minted PhD who wants to enter medical school with the goal of pursuing more clinically oriented research. Last, but not least, we point out that the need for physician-scientists is not unique to the US and that an international cooperative approach toward the issue is warranted. To date, there have been few organized approaches to this issue. Rather, international MDs take individual routes to come to the US for research training, and are often recruited to stay on as physician-scientists rather than returning to their countries of origin, which typically do not have any plans to re-assimilate them. Instead, we imagine international networks of affiliated institutions that help to identify and train physician-scientists on a worldwide basis. Such programs would enhance the quality of academic medical centers in the developing world, while increasing the worldwide pool of physician-scientists.

The bottom line is that no single training pathway can provide all the physician-scientists needed in the future. All of them must be used to restore the pipeline. Fig. 1 presents a schematic view of the former and current situation with regard to the pipeline for generating physician-scientists, and our suggestions for the future (the figure is not meant to present quantitative data, but rather to represent trends over time).

Finally, as emphasized at the forum by Donald Seldin (a well-known doyen of physician-scientist mentorship), all these efforts will be useless unless the cultures of medical schools return to their former state—where admissions committees give special attention to candidates with an interest in academic careers and research; where the spirit of inquiry is emphasized and her-

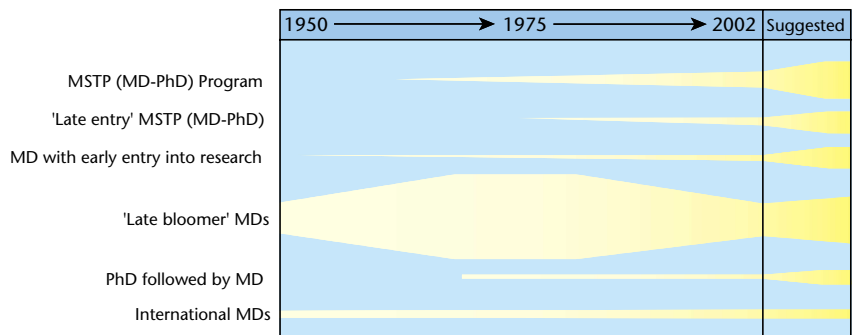


Fig. 1 Trends in pipelines for training physician-scientists. This schematic presents a rough estimate of the approximate proportion of individuals entering different training pathways at different time periods in the near and distant past, as well as our suggestions for the future. The figure is not meant to be quantitative, but rather to emphasize trends. The dominance of the late bloomers in the 1960s and 1970s has been followed by a recent decline, which has not been replaced by the modestly expanding MSTP (MD-PhD) program. Suggestions to restore the late bloomer pathway, at least in part, and to expand the MSTP program are indicated. Several other pathways that have previously made small contributions to the total pool are also shown, with suggestions for how some could be expanded.

alded; and where successful physician-scientists are visible, prominent role models for future generations. These desired cultural shifts cannot occur as long as medical schools and academic health centers feel imperiled by a seemingly obligatory focus on the financial bottom line, or if institutional leaders feel that sustaining the physician-scientist career path is a luxury. The cultural renaissance we envision requires the active participation of deans, chairs and the many existing physician-scientists who were fortunate enough to have entered this most rewarding career path when it was easier to do so. In the final analysis, these individuals now bear the heaviest responsibility to ensure that the emerging opportunities for young physician-scientist careers are seized.

1. Wyngaarden, J.B. The clinical investigator as an endangered species. *N. Engl. J. Med.* **23**, 1254–1259 (1979).
2. Goldstein, J.L. & Brown, M.S. The clinical investigator: Bewitched, bothered, and bewildered—but still beloved. *J. Clin. Invest.* **12**, 2803–2812 (1997).
3. Rosenberg, L.E. The physician-scientists: An essential—and fragile—link in the

4. Rosenberg, L.E. & Ley, T.J. The endangered physician-scientist: Opportunities for revitalization emerge. Invited paper to the Lucille P. Markey Charitable Trust programs evaluation committee of the NRC. (In the press.)
5. Ley, T.J. & Rosenberg, L.E. Removing career obstacles for young physician-scientists—loan-repayment programs. *N. Engl. J. Med.* **346**, 368–372 (2002).
6. Zemlo, T.R., Garrison, H.H., Partridge, N.C. & Ley, T.J. The physician-scientist: Career issues and challenges at the year 2000. *FASEB J.* **14**, 221–230 (2000).
7. Varki, A. Executive summary of the Nerflex Commission Report. *J. Clin. Invest.* **104** (Suppl.), S1–S3 (1999).
8. Andrews, N.C. The other physician-scientist problem: Where have all the young girls gone? *Nature Med.* **8**, 439–441 (2002).

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The other physician-scientist problem: Where have all the young girls gone?

There has been much discussion about the declining number of physician-scientists, and their potential impact on biomedical research and discovery. However, less attention has been paid to the fact that women are underrepresented in this area. Remarkably, as a woman physician-scientist, and director of the Harvard-MIT MD-PhD Program, I had never given it much thought. However, after talking with students and colleagues, I am convinced that women find physician-scientist careers much less attractive than do men. The initial 'pipeline' only carries a trickle, and it leaks. As Charles Vest, the President of MIT, wrote in his preface to the landmark 1999 report on women faculty¹, "I have always believed that contemporary gender discrimination within universities is part reality and part perception. True, but I now understand that reality is by far the greater part of the balance." The bottom line is that there are valid reasons for women opting out.

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women, and this fraction has not changed over the past 12 years. Of the 310 Harvard MD-PhD graduates since 1974, only 53 (17%) have been women, owing to both fewer female applicants and more attrition among female students. Proportions in other MD-PhD programs are not markedly different². In other words, women are less likely to enter combined MD-PhD degree programs than they are to enter either MD or PhD degree programs.

Although MD-PhD programs are the most visible pathway for training physician-scientists, they are not the only route, as discussed by Varki and Rosenberg in this issue³. Documented numbers of women entering physician-scientist careers as 'late bloomers', that is, physicians who become focused on research after medical school, are not easy to obtain. However, there is no indication that more women are entering by this route—if anything, the proportion may be smaller.

The problem

Among investigators of the Howard Hughes Medical Institute (HHMI), a leader in biomedical research in the United States, less than 2% are women with MD degrees. This is in marked contrast to the situation for men—24% of the investigators are men with MD degrees. It is not that HHMI excludes women—about 18% of HHMI investigators are women with PhD degrees. The situation is similar for the American Society for Clinical Investigation, an honor society for physician-scientists—only 12% of active members and less than 4% of senior/emeritus members are women. Of its 94 past presidents, only 1 was a woman.

Part of the explanation can be found in patterns of application to graduate educational programs. Taking Harvard Medical School as an example, it is encouraging to see that approximately 50% of the applicants to the MD program and 50% of the applicants to the PhD programs are women. This has been the case for some time, and matriculants generally reflect these proportions. In contrast, however, only 30–35% of the applicants to the Harvard-MIT MD-PhD program are

The reasons

Women in their early 20s consistently cite 4 reasons why they are less likely to choose this career path. Firstly, they are concerned that it will be impossible to combine a successful career with childbearing and family life. There is no question that this was once true, as carefully detailed by Elga Wasserman in her interviews with women members of the National Academy of Sciences⁴. However, as she also points out, it is decidedly not true now and has not been true for several decades. Most women in science, including women physician-scientists, have husbands and children. But most physician-scientists do not finish their formal education until they are 30 years or older, and they must subsequently negotiate residency and fellowship before they have independent control over their hours. This makes it very difficult to find flexible periods for pregnancy and infant care. Most people still expect women to assume the major responsibilities of caring for children and running the household. These are heavy duties, and the unpredictability of academic careers makes them seem even more daunting.