The Physician-Scientist: Career Issues and Challenges at the Year 2000

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BACKGROUND

IN THE MIDST of a promising era of expansion in biomedical research, there is growing concern about a serious decline in a crucial category of research personnel: physician-scientists. If this trend continues, many believe that key types of medical research will suffer (1). While apprehension about the survival of physician-scientists had been expressed previously (2–4), there are a number of indications that this problem is becoming more severe. Anecdotal evidence of the difficulties in recruiting and retaining medical school faculty has been growing. Increasingly, prominent leaders in the research community are calling attention to this issue (5, 6). External forces, leading to changes in the finances of academic health centers, are raising new obstacles to research and training (7). Nominations of physician-scientists age 45 or younger to honorary societies such as the American Society for Clinical Investigation have declined by almost 30% over the past decade, suggesting that the pool of talented young investigators is shrinking.

The implications of this situation for the progress of medical research made the question relevant to the mission of the Federation of American Societies for Experimental Biology (FASEB): *To enhance the ability of biomedical and life scientists to improve, through their research, the health, well-being, and productivity of all people.* At its December 1998 meeting, the FASEB Board voted to initiate an investigation of physician-scientists and career opportunities for biomedical research.

Responsibility for this study was given to the Career Opportunities Subcommittee of the Science Policy Committee, under the leadership of Nicola Partridge. The subcommittee collected and analyzed data on training and research activities from the Association of American Medical Colleges (AAMC), the American Medical Association (AMA), and the National Institutes of Health (NIH). In addition, the subcommittee organized a conference[2] to address the following questions:

- Are physician-scientists critical to the success of the biomedical research enterprise?
- What evidence exists that there is a decline in physician-scientists?
- If there is a decline, how might it be reversed or alleviated?

Delegates from the FASEB societies held a closed session at the conclusion of the conference in order to review the data and the panelists' testimony and to formulate recommendations. Through ongoing communication with the delegates, the Career Opportunities Subcommittee has endeavored to present, along with the data and conclusions from the conference, the consensus-based recommendations of the FASEB society delegates.

WHO ARE PHYSICIAN-SCIENTISTS?

For the purposes of this report, we define physician-scientists as those individuals holding an M.D. or M.D./Ph.D. degree who perform biomedical research of any type as their primary professional activity. We include physician-scientists who are conducting basic research (fundamental investigations

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[2] Physician-Scientists and Career Opportunities for Biomedical Research, June 15–16, 1999.

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that do not focus directly on patients or their diseases), disease-oriented research (investigations that involve the causes or treatments of disease, but do not involve direct contact with patients), or patient-oriented research (clinically oriented studies that involve physical contact with patients). The primary focus here is on the issues that affect the physician-scientist career path, regardless of research area, and how these issues are changing in light of recent developments in the biomedical research environment and the practice of medicine.

PERCEPTIONS: THE IMPORTANCE OF PHYSICIAN-SCIENTISTS

Physician-scientists are trained to ask clinically relevant questions in a health research environment that lead to the development of research projects linking basic and clinical sciences. Physician-scientists are also a vital force in transforming clinical observations into testable research hypotheses and translating research findings into medical advances. The scientific and medical contributions of physician-scientists have a substantial effect on the lives of the nation's citizens. Examples of the unique contributions they make to the field of biomedicine include the development of new or improved surgical techniques; an increased understanding of the causes and effects of adverse drug reactions; detailed descriptions of hereditary diseases and insight into their genetic components; and the identification and treatment of new or emerging infectious diseases. Physician-scientists also are a critical resource for assuring excellence in medical education, since they teach students that the basis of medicine is science and that scientific rigor should apply to patient care as well as research.

As we enter the post-genomic era, physician-scientists will have the specialized perspectives required to lead evolving fields such as genetic medicine, pharmacogenetics, and bioinformatics. As this research is translated into patient treatment protocols, it is physician-scientists who will have the necessary training and skills to ensure that these protocols are designed and evaluated in ethical and rigorous clinical trials.

THE DATA

There are no comprehensive sources describing the factors influencing the education and career outcomes for physician-scientists. Since data were collected from varied sources that often used different parameters, they could not be combined into a single, seamless estimate of the status of the physician-scientist career path. Nevertheless, important perspectives may still be obtained from a careful review and synthesis of the existing data. The overall pattern is clear and consistent: whereas biomedical research has been expanding over the last two decades, the physician-scientist workforce has not kept pace. This becomes evident by examining indicators along the training and career pathways of this group.

EXPANDING RESEARCH OPPORTUNITY

In recent years, NIH funding for investigator-initiated biomedical research has steadily increased. This investment has grown by 85%—from $4.2 billion in 1983 (constant 1998 dollars) to $7.8 billion in 1998—and has led to the expansion of research opportunities for many scientists. As a result of a strong bipartisan effort to double the NIH budget by the year 2003, this supportive funding environment is projected to continue well into the next decade.

DESCRIPTION OF THE PROBLEM: THE CAREER PATHWAY

Over the past 15 years, while research activity in the biomedical sciences has increased, several indicators show that the level of participation of physician-scientists in the enterprise has not kept pace with the overall growth. Data collected by the AMA on the 'major professional activity'[3] of physicians show a decrease in the number of U.S. physicians reporting research as their primary activity (**Fig. 1**). The number of physicians reporting research as their primary career activity fell by 6% over the last 17 years, from 15,377 in 1980 to 14,434 in 1997. During the same period, there has been almost a doubling of those reporting patient care as their principal career activity for the same period: 376,512 in 1980 to 620,472 in 1997. The number of M.D. faculty members in basic science departments of medical schools has also declined from 2381 M.D.'s in 1982 to 2195 in 1996 (**Fig. 2*A***). Of these individuals, the number who were active in research, as measured by principal investigator status (PI) on an NIH grant, declined from 481 in 1982 to 348 in 1997 (**Fig. 3*A***). In these departments, the decrease in the number of M.D. faculty members with NIH awards was even greater than the total reduction in the number of M.D. faculty members: 28% as compared to 8%.

Even though there has been a large increase in the number of M.D.'s in clinical departments of the medical schools (Fig. 2*B*), there is a much slower

[3] Major professional activity is defined by the AMA as the activity in which a physician engages for the greatest fraction of the average number of hours worked per typical week.

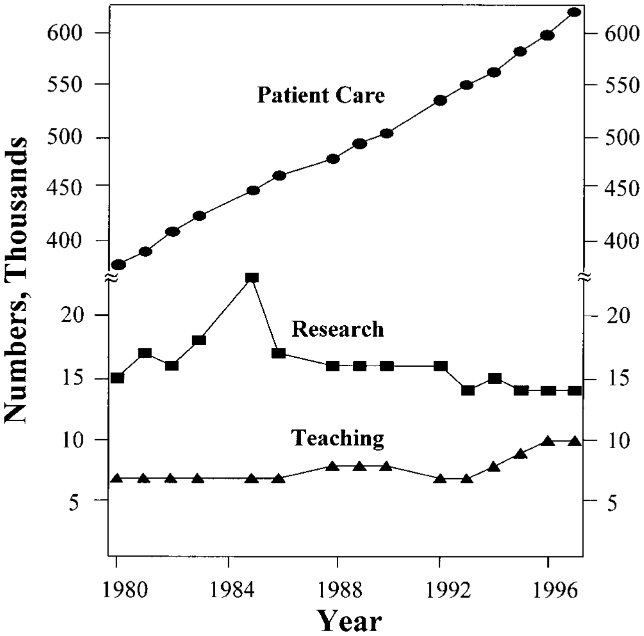

Figure 1. U.S. physicians by major professional activity. Numbers of physicians are shown by major professional activity. Patient care includes office-based practice and hospital-based practice. In addition to full-time staff, the data also reflect the primary activity of residents and clinical fellows. Data provided by the Department of Physician Data Services, Division of Survey and Data Resources, American Medical Association.

growth in the number of physician-scientists in these institutions compared to researchers with Ph.D. degrees. For example, the number of M.D. faculty in clinical departments who were PIs on NIH grants has risen 26% from 2470 in 1982 to 3103 in 1997 (Fig. 3*B*). During this same period, the number of Ph.D. faculty in clinical departments who were PIs on NIH grants increased 105%, from 1121 to 2296 (Fig. 3*B*). As a result, the fraction of NIH funded researchers in clinical departments who are physician-scientists has declined. This is further illustrated by the fact that the percentage of the total M.D. faculty in clinical departments with NIH grants remained stable from 1982 to 1997 at ~6%, whereas the percentage of the

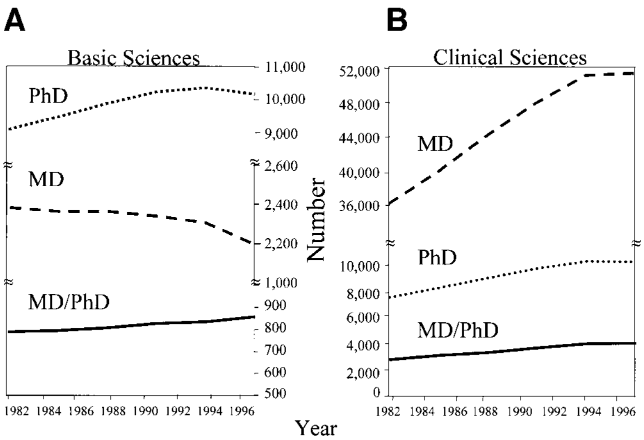

Figure 2. Number of faculty in medical school departments. The total number of faculty in both basic and clinical medical school departments. Data are shown by professional degree. Tabulated by Quantum Research Corporation for FASEB using data from the AAMC Faculty Roster System (FRS). Data from the FRS are from a March 31, 1999 extract. These data were obtained using 'rollback' programs, which calculate the number of active faculty for previous years based on data from the current file. These numbers will be higher than numbers reported from a snapshot of the data in previous years due to subsequent reporting.

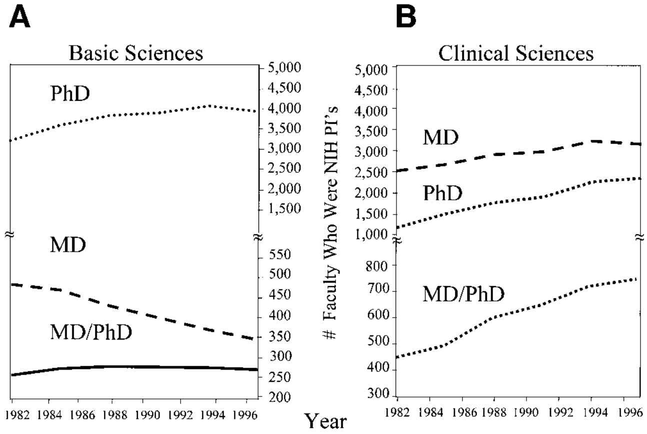

Figure 3. Number of NIH Principal Investigators in medical school departments. The number of faculty in both basic and clinical medical school departments who were NIH principal investigators. A principal investigator is defined as holding a research project grant (RPG). Activity codes for RPGs include: R01, R03, R15, R21, R22, R23, R29, R35, R37, R55, P01, P41 (only for NIGMS FY >= 1980), P42, U01. Exclusions are NLM, NCNR in FY 1986, NCRR for FYs prior to 1990, FIC grants prior to FYs 1993, and U01 activities for FYs 1980–81. Data are shown by professional degree. Data points indicate the year that the individual was a faculty member (subtract one for the year of principal investigation). Data tabulated by Quantum Research Corporation for FASEB.

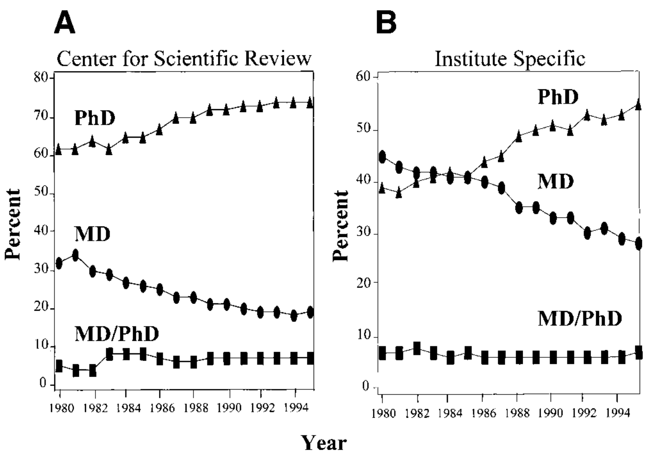

Figure 4. Composition of chartered NIH review panels. Percentage of active members by professional degree on initial review groups for the NIH Center for Scientific Review (CSR) and institute specific as of October 1st of each year. Percentages in figure do not add to 100%, because the 'Other' category is not reported in figure. Data provided by NIH, IMAC Legacy CMIS.

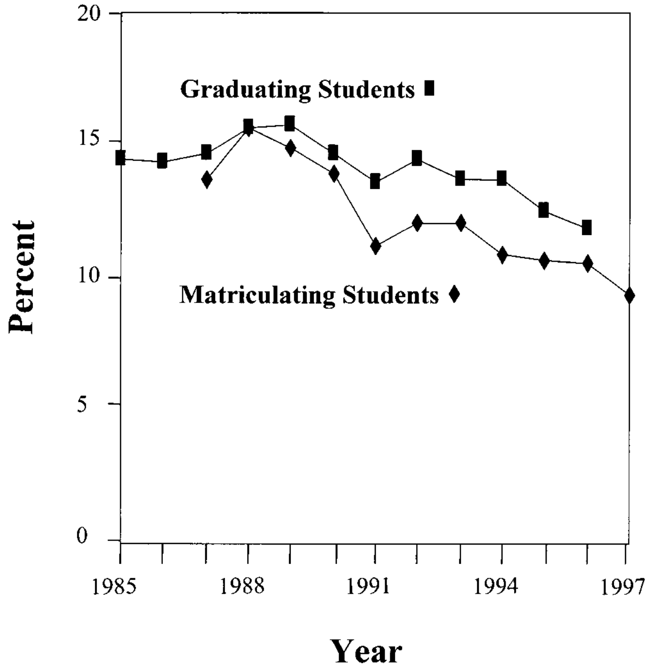

Figure 5. Percentage of medical students with strong research career intentions. Percentage of matriculating and graduating medical students who expressed a strong interest in pursuing a research career (several years set aside for full-time research or 25% or more time of entire career devoted to research). For matriculating students, year denotes the year of matriculation (1987–1997) and for graduating students, year denotes the year of graduation (1985–1996). Significant and exclusive categories are combined to form the 'strong research career intentions' category. Data provided by the AAMC Matriculating Student Questionnaire 1987–1997 and the AAMC Medical School Graduation Questionnaire 1985–1996.

Ph.D. faculty in similar departments with NIH awards rose from 15% to 23%.

Another measure of the degree of participation of physician-scientists in the NIH research community, and a reflection of their influence in the field of biomedicine, is the number of M.D. appointments to chartered NIH review panels. At both the Center for Scientific Review (CSR) and the various institutes, there has been a decrease in the percentage of M.D.'s on chartered review panels. In 1980, M.D.'s made up 32% of CSR chartered review panels and Ph.D.'s made up 62%; in 1995 these percentages were 19% and 74%, respectively[4] (**Fig. 4*A***). This decline was even larger for institute-specific chartered review panels (Fig. 4*B*). The 1980 percentage for M.D.'s was 45%, decreasing to 28% in 1995. For Ph.D.'s, the percentage increased from 39% to 55% over the same period. M.D./Ph.D. percentages for both types of chartered review panels remained unchanged at around 6%.

[4] A small fraction of members had other degrees.

DESCRIPTION OF THE PROBLEM: MEDICAL SCHOOL TRAINING

Surveys of matriculating medical students' expected level of involvement in research during their career indicate that there has been a decline in the percentage of students either planning a career in research or planning to devote a substantial portion of their career to research (**Fig. 5**). This downward trend is still evident when students graduate from medical school (Fig. 5).

One explanation for students electing not to pursue a career in research is the tremendous debt that they incur during medical school. This financial burden has increased substantially since the middle of the 1980s. In 1985, only 3% of medical school graduates had debt greater than $75,000. But in 1998, approximately half of all the graduates owed more than $75,000. Since the number of medical school graduates has remained relatively constant over this time period—15,000 to 16,000 per year—an increasing fraction of students are graduating from medical school deeply indebted. This is made more notable by the relatively low inflation of this period. In fact, the median level of debt for medical school graduates, after adjusting for inflation, has doubled since 1985 (**Fig. 6**).

Several recent studies have demonstrated that the time spent in preparation for a research career has lengthened. Although this problem exists for both M.D. and Ph.D. scientists, its effect on physician-scientists (with their alternative career opportunities) is likely to be more career limiting. A committee established by the National Research Council (chaired by Shirley Tilghman and Torsten Wiesel)

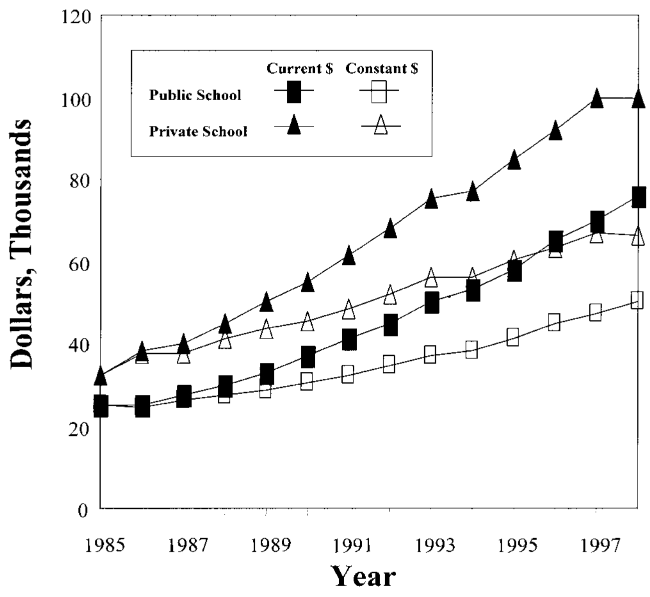

Figure 6. Median level of debt of medical school graduates. Data are for both public and private schools in current and 1985 dollars. Data provided by the AAMC Medical School Graduation Questionnaire.

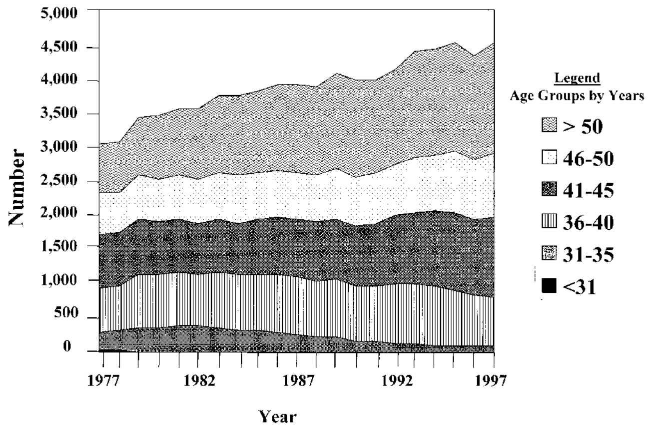

Figure 7. Age of NIH Principal Investigators with an M.D. degree. The figure shows the number of M.D.'s who were NIH principal investigators with Research Project Grants (RPG) by age groups: <31 years, 31–35 years, 36–40 years, 41–45 years, 46–50 years, and >50 years. Data are collected for all institutions that receive federal funding. Activity codes for the RPG include R01, R03, R15, R21, R22, R23, R29, R35, R37, R55, P01, P41 (only for NIGMS FY >= 1980), P42, U01. Exclusions are NLM, NCNR in FY 1986, NCRR for FYs prior to 1990, FIC grants prior to FYs 1993, and U01 activities for FYs 1980–81. The first day of the fiscal year is the reference point for calculating age. Ages under 22 years are determined to be incorrect. Data tabulated by Quantum Research Corporation for FASEB.

found that the number of young Ph.D. scientists (under age 36) applying for research grants was declining (8). This finding can be explained by the increasing length of time needed to prepare young scientists for the transition from student status to that of independent investigator (9).

There has also been a steady shift in the age profile of physician-scientists with NIH support. In 1977, 56% of all NIH PIs with an M.D. degree were less

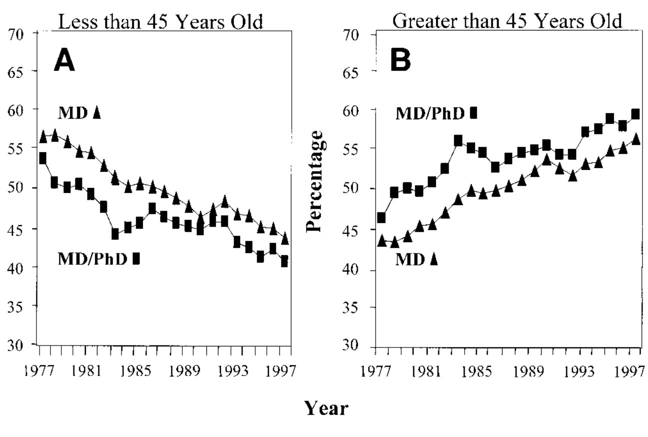

Figure 8. Age profiles of NIH Principal Investigators with M.D. or M.D./Ph.D. degrees. Figure shows the percentage of M.D.'s and M.D./Ph.D.'s in two panels. (*A*) shows M.D. and M.D./Ph.D. NIH principal investigators (PI) with Research Project Grants (RPG) less than 45 years of age; (*B*) shows M.D. and M.D./Ph.D. NIH PIs with RPGs greater than 45 years of age. Data are collected for all institutions that receive federal funding. See legend to Fig. 7 for a description of activity codes for RPGs.

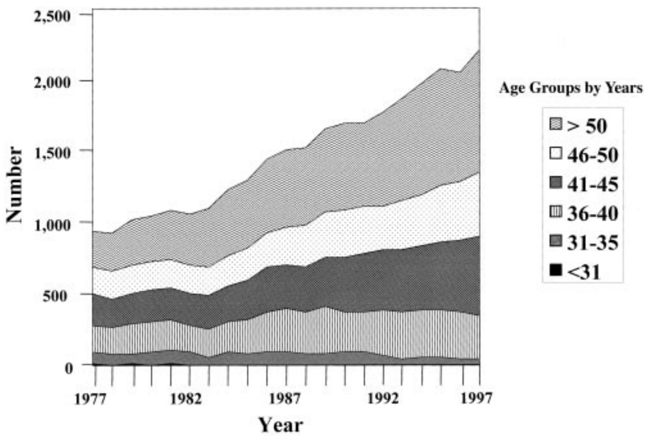

Figure 9. Age of NIH Principal Investigators with an M.D./Ph.D. degree. The number of M.D./Ph.D.'s who were NIH principal investigators with Research Project Grants (RPG) by age groups: <31 years, 31–35 years, 36–40 years, 41–45 years, 46–50 years, and >50 years. Data are collected for all institutions that receive federal funding. See legend to Fig. 7 for a description of activity codes for RPGs.

than 45 years old, but this percentage fell to 44% in 1997 (**Fig. 7** and **Fig. 8*A***). Conversely, 44% of all NIH PIs with an M.D. degree were over 45 years old, and this percentage rose to 56% in 1997 (Fig. 7 and Fig. 8*B*). A similar trend is evident for NIH PIs with an M.D./Ph.D. degree. In 1977, 54% of this population was less than 45 years old, and this percentage decreased to 41% in 1997 (**Fig. 9** and Fig. 8*A*). As seen with M.D. NIH PIs over 45 years of age, 46% of the M.D./Ph.D. NIH PIs were over 45 years old in 1977, and this percentage increased to 59% in 1997 (Fig. 8*B* and Fig. 9).

These demographic data of NIH PIs with M.D. and M.D./Ph.D. degrees capture only one-third of the M.D.'s who report research as their primary professional activity to the AMA. While this fraction represents a minority of all physician-scientists, we hypothesize that its age profile reflects the general population of physician-scientists.[5] Furthermore, since NIH contributes ~80% of the federal funds budgeted for health research,[6] this subset of physician-scientists is vital to the national biomedical research enterprise and represents a critical segment of the physician-scientist workforce.

DESCRIPTION OF THE PROBLEM: TRANSITION FROM TRAINING TO SCIENTIFIC INDEPENDENCE

For a physician interested in pursuing a research career, postdoctoral research training is necessary.

[5] The authors are not aware of any databases that track the age demographics of non-NIH funded physician-scientists.
[6] http://www4.od.nih.gov/ofm/PRIMER97/page6.stm.

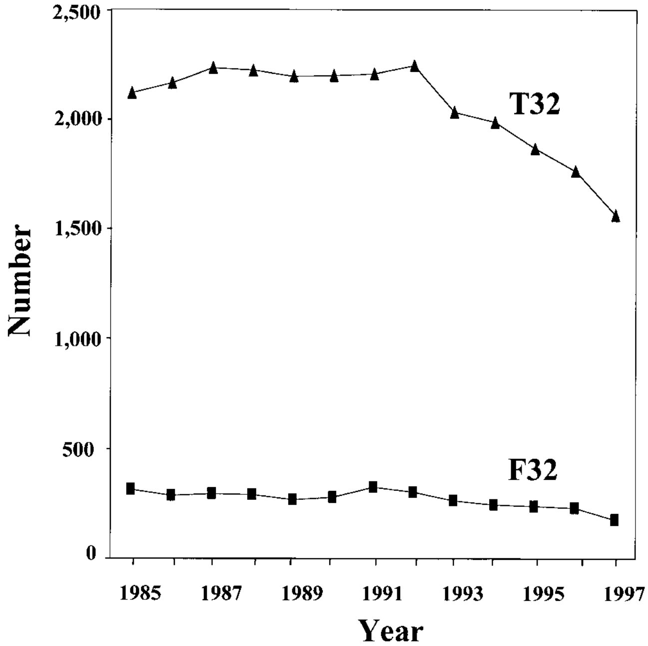

Figure 10. Number of NIH T32 and F32 fellowships to M.D.'s. The number of T32 and F32 awards made to M.D.'s by fiscal year. F32 fellowships are awarded directly by NIH to qualified postdoctoral fellows who have identified a sponsoring institution where they will be trained and perform their research. T32 fellowships are awarded competitively by NIH to institutions, which then have the discretion to confer them on qualified postdoctoral fellows to support their research training in a specific area. Data provided by the NIH Office of Extramural Research.

NIH sponsors two types of postdoctoral awards: training grants and fellowships.[7] The T32 training grants are awarded to institutions, which then confer awards to qualified candidates in their training programs. The F32 fellowships are postdoctoral awards made directly to individuals who have applied to NIH for support. The number of M.D.'s supported by each of these two programs has declined since 1985: the number of T32 awards to M.D.'s decreased 26% from 2120 in 1985 to 1562 in 1997 (**Fig. 10**), and the number of individual M.D. postdoctoral fellows (always smaller than the number of institutional trainees) declined 43% from 314 in 1985 to 180 in 1997.

For aspiring physician-scientists, NIH provides mentored training opportunities that offer higher stipends than traditional fellowships. One such program, the Mentored Clinical Scientist Development Award (K08), has seen an increasing number of applications and an average success rate of 50% (**Fig. 11**). Since the inception of the program in the early 1970s, the number of K08 awards per year has increased steadily to slightly more than 300 in 1998. This program has succeeded in preparing many young physician-scientists for a career in research (10), but it has not compensated for the absolute decrease in M.D.'s supported by T32 and F32 fellowships between 1990 and 1997.

The ability of the K series of awards to promote independent research careers may be impeded by their relatively low salary compared to clinical practice. For the Mentored Patient-Oriented Research Career Development Award (K23), some NIH institutes and centers often have a salary cap of $75,000. Given the substantial debt that many M.D.'s incur during medical school, 3–5 years of K23 support could limit their ability to fulfill their financial obligations and thus deter them from a research-focused career.

One critical objective for all research training programs is the preparation of young scientists for the transition from trainees to independent researchers. A hallmark of this progression is the submission of an NIH Research Project Grant (RPG) application. By reviewing the number of first-time applicants for RPGs by professional degree types, one can estimate the overall success in achieving this goal. For M.D.'s, there appears to be no net growth in the number of first-time applicants since 1978 to 1998 (average of 825 applicants per year) (**Fig. 12**). The number of first-time Ph.D. applicants has fluctuated over this same period (average of 2400 applicants per year); however, it is currently in an upward cycle (Fig. 12). In contrast, the number of first-time M.D./Ph.D. applicants has risen steadily over the

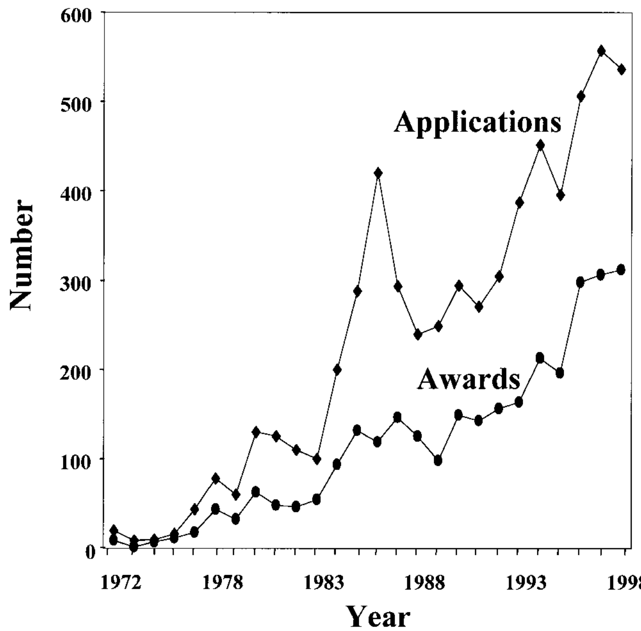

Figure 11. Number of K08 applications and awards. The number of applicants for K08 awards and the number of K08 awards by fiscal year. Data provided by the NIH Office of Extramural Research.

[7] Postdoctoral fellows are also supported as research associates on NIH research grants. There are no comprehensive data, however, on the characteristics of individuals supported in this way.

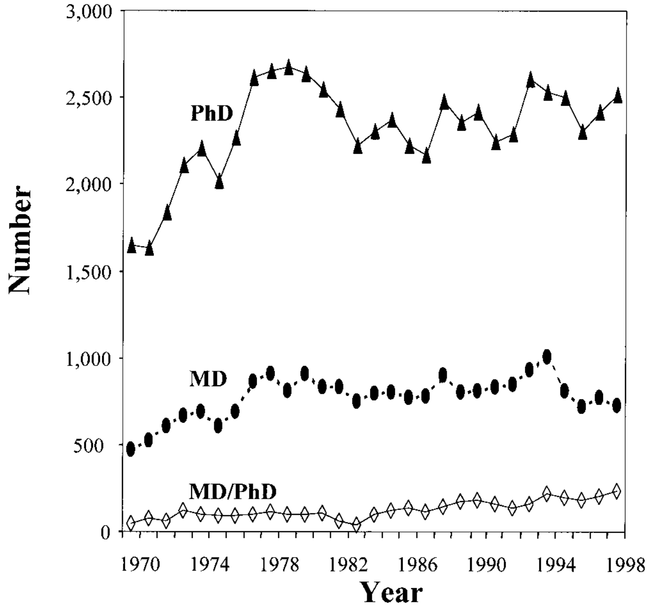

Figure 12. Number of first-time applicants for NIH research project grants. Data are presented by professional degree and represent the number of people who have never applied for a research project grant (RPG). The data do not include people who have submitted proposals in more than one grant cycle (i.e., first-time applicants who were not funded and are applying again). Activity codes for an RPG include R01, R22, R23, R29, R35, R37, P01, P41, U01, and U19. Data provided by the NIH Office of Extramural Research.

past 15 years, and in fact has more than doubled since 1984 (Fig. 12).

When physician-scientists do apply for independent awards, the possibilities for receiving funding are promising. Both M.D.'s and M.D./Ph.D.'s have similar success rates to Ph.D.'s for NIH RPGs. The average success rate for unfunded applicants from 1986 to 1995 was 21% for M.D.'s, 22% for M.D./Ph.D.'s, and 22% for Ph.D.'s (**Fig. 13*A***). Over those 10 years, the average success rate for previously funded applicants by degree

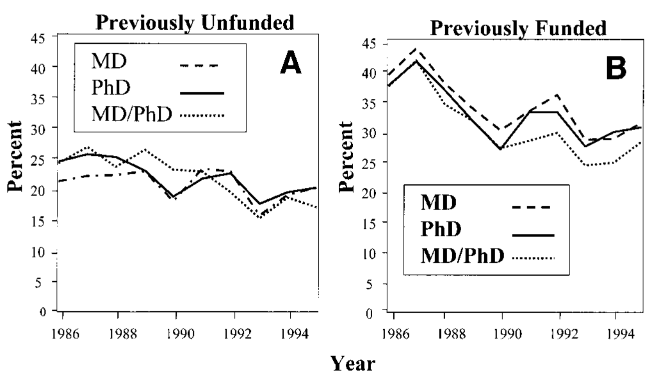

Figure 13. Success rates for NIH research project grants. Success rate data are presented by professional degree for individuals who have never had a research project grant (RPG) (*A*) and also for individuals who have received at least one previous RPG (*B*). Percentages were not adjusted for the number of unsuccessful application attempts. Data provided by the NIH Office of Extramural Research.

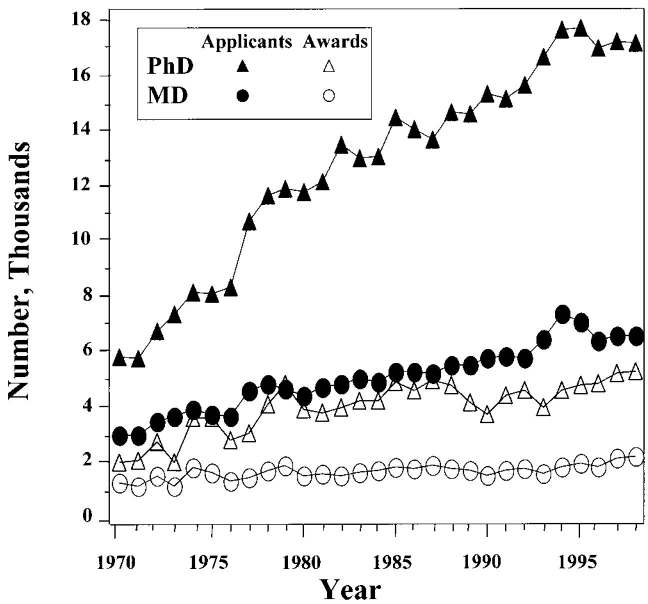

Figure 14. Number of RPG applicants and awards. The total number of applications for NIH research project grants (RPGs) and awards of RPGs by professional degree. Data provided by the NIH Office of Extramural Research.

was 34% for M.D.'s, 31% for M.D./Ph.D.'s, and 33% for Ph.D.'s (Fig. 13*B*).

The parity of M.D. and Ph.D. success rates, however, stands in contrast to a major differential in application rates. Since the 1970s, the number of Ph.D.'s applying for NIH grants has grown faster than the number of M.D. applicants (**Fig. 14**). In 1970, ~6000 Ph.D. scientists and 3000 M.D. scientists applied for RPGs. By 1998, the number of Ph.D. applicants had almost tripled and the growth in M.D. applicants had approximately doubled. As a result of this differential rate of growth in applications, the fraction of the RPGs going to Ph.D.'s rose while the fraction of grants awarded to M.D.'s declined. Today, just over 70% of the RPGs are awarded to Ph.D. scientists, with the remaining 30% awarded to M.D. or M.D./Ph.D. scientists.

THE IMPACT OF THE MEDICAL SCIENTIST TRAINING PROGRAM

One program often promoted as a solution for reversing the declining number of young physician-scientists is the Medical Scientist Training Program (MSTP), which the National Institute of General Medicine began in 1964. In MSTPs, students receive both clinical and research training and earn a combined M.D./Ph.D. The program is structured to prepare students to serve as a bridge between basic research and clinical medicine. The NIH recently completed a study that compared the accomplishments of MSTP graduates to graduates of other combined degree or Ph.D. programs (11). The authors found that MSTP graduates performed well across a series of outcome measures, including future academic appointments, grants, and publications. The review concludes that MSTP graduates have been very successful in establishing productive research careers. The effect of this specialized training program on increasing the productivity of physician-scientists is significant: M.D./Ph.D.'s make up ~2.5% of the medical school graduates each year, yet they hold about a third of the NIH grants going to physician-scientists.

Of the 38 NIH-funded MSTPs in 1999, one of the best documented is at Washington University School of Medicine in St. Louis, Missouri. Established in 1968, it currently has 153 participating students. According to Stuart Kornfeld, the school's former MSTP director, there has been a total of 276 graduates. Approximately 5% of the graduates have gone directly into postdoctoral research fellowships; the other 95% have entered residency-training programs.

Graduates of the Washington University School of Medicine's MSTP illustrate the program's potential: most of its graduates hold academic positions (74%), with the rest being somewhat equally divided among positions at NIH, industry, and private practice. Of the MSTP graduates from Washington University holding academic positions, 85% are involved principally in basic or disease-oriented research, 8% conduct patient-oriented research, 3% perform a mixture of both basic and clinical research, and 3% are not engaged in research. At the same time, the majority of Washington University MSTP graduates still devote some time to clinical activities (Stuart Kornfeld, M.D., personal communication).

Although the Washington University program and other MSTPs have clearly promoted the training and career development of physician-scientists, these programs cannot be the only means by which to increase the number of physician-scientists. Since the majority of MSTP graduates perform primarily basic research or disease-oriented research, other programs are needed to assist those individuals who are more interested in doing patient-oriented research. Moreover, MSTPs almost exclusively capture students who decide to become researchers before they *begin* medical school. Additional measures will be necessary to identify and train students who become inspired to pursue research careers at later times in their medical education.

FUTURE OF THE PHYSICIAN–SCIENTIST: CONCLUSIONS

The number of medical students interested in pursuing a career in research continues to diminish. Large medical school debt and declining mentorship contribute significantly to their decisions. If students decide to seek formal research training, however, the K08 award series has become an effective, albeit limited, alternative to the traditional T32 and F32 fellowships. Also, the encouraging funding situation and comparable success rates for M.D.'s and Ph.D.'s would seem to suggest that the means exist for young physician-scientists to develop productive careers.

Special training and the good possibility of funding, however, do not appear to have increased the traffic along the career pathway. There has been a decrease in the number of M.D.'s in basic science departments of medical schools holding NIH research grants, and less growth of NIH-funded M.D.'s in the clinical sciences, as compared to Ph.D.'s and M.D./Ph.D.'s. These facts, together with a decreasing proportion of NIH award holders under 45 years old, indicate that there are a declining number of successful young physician-scientists.

Anecdotal evidence suggests that the financial constraints brought on by managed care and other external financial pressures on academic health centers are forcing many physician-scientists to abandon research. Data suggest that there is a correlation between the market penetration of managed care and a decline in NIH awards to academic health centers (12). Specifically, for those physician-scientists who are also involved in patient care, increasing clinical demands can sometimes lead to less time for research and grant writing. As a result, these physician-scientists are at risk of becoming less competitive. Another deterrent is that physician-scientists usually earn less money than they could in private practice. Consequently, if current trends continue, the scientific contributions of physician-scientists and their mentoring of future medical researchers will be threatened.

RECOMMENDATIONS

1) **Establishing the Importance of the Career:** ***Premedical and medical school curricula should emphasize the importance of biomedical research as a foundation for the scientific principles that govern the practice of medicine.***

The underlying principle guiding the practice of medicine is the scientific method. The practice of medicine should be evidentiary, based on scientific facts, and guided by ongoing research. The training physicians receive must prepare them for the post-genomic era, so that they will be able to use this information effectively in caring for their patients. The importance of research and scientific training for all physicians (not only physician-scientists) should be a bedrock principle in the curricula of medical schools. FASEB society members teaching undergraduate students should emphasize these principles, and undergraduate faculty advisors should be aware of opportunities for physician-scientists. Medical school admissions committees should value exposure to research. In medical school, scientific methods and research should be appropriately emphasized, and mechanisms should be in place for students to receive research training as part of their medical school experience, if they so desire. Physician-scientists must serve as role models for medical students by participating actively in the classroom, the laboratory, and the clinic.

2) **Choosing the Career:** ***A national program for medical school debt forgiveness should be established for physicians who receive rigorous research training and pursue research careers.***

The large debt facing most medical school graduates is a disincentive for the prospective physician-scientist. For this reason, FASEB favors a national program that would reduce the indebtedness of medical school graduates who train to become physician-scientists and pursue research careers. Such a program would most likely capture late bloomers, whose interest in science develops directly out of experiences in medical school or through postgraduate clinical training. For these individuals, the large medical school debt burden represents a very real impediment to choosing this career since stipends paid during research training are substantially less than can be earned in clinical practice. Models for a debt reduction program have been proposed, and some have been used on a limited scale within selected target areas. FASEB recommends that an experimental program, sponsoring at least 100 M.D.'s per year, be initiated within 2 years. This program would include analytic features that would allow for an evaluation of its effectiveness. The Federation will immediately begin to work with appropriate agencies to design and implement such a program.

3) **Stabilizing the Early Career:** ***The NIH and other appropriate foundations should substantially expand the support for the training and mentoring of physician-scientists.***

The support for M.D./Ph.D. programs and early career mentored programs should be expanded substantially within the next several years. Currently, there are at least 400 M.D./Ph.D. graduates annually in the United States (13). FASEB recommends that the size of these programs be doubled over 5 years, so that a substantial increase in the pool of entry-level physician-scientists will be realized in ~10 years. However, the expansion of M.D./Ph.D. programs alone will not adequately meet the need for physician-scientists. There must be additional support for postgraduate research training, for physician-scientists who are undergoing mentored training, and for physician-scientists who have just become independent researchers. Disincentives to careers in research (e.g., low salary caps and salary restrictions for the PIs of mentored K series awards) should be removed.

4) **Stabilizing the Established Career:** ***Favorable institutional cultures must be developed in academia to support physician-scientists throughout their careers.***

Because of the increasing financial constraints placed on academic medical centers by managed care and other external forces, physician-scientists are being asked to assume more clinical responsibilities. This problem is now causing many physician-scientists to choose between research or clinical practice, a choice that prevents them from maximizing contributions to research and medicine. Leaders of academic medical centers should acknowledge the uniqueness of this career and develop specific measures at their institutions to protect this role. Reasonable clinical workloads must be maintained for physician-scientists. Teaching and reviewing responsibilities of physician-scientists must be valued in the same manner as clinical responsibilities. The NIH, in cooperation with academic medical centers, can help support physician-scientists by facilitating beneficial collaborations among M.D. and Ph.D. scientists (e.g., by allowing true coinvestigator status for M.D.'s and Ph.D.'s on grants) and using the special skills of physician-scientists on peer review panels. As medical school departments become more diverse, establishing a research culture that supports interactions among faculty of different disciplines and training will be critical for maintaining the competitiveness of their scientists and thus, their institutions.

5) **Tracking the Career:** ***Additional information must be collected to define the problem further and to monitor the outcomes of corrective efforts.***

Although FASEB and other organizations have identified problems in the supply of physician-scientists, there are inadequate data to develop precise national goals. Moreover, there is insufficient information to determine why young physician-scientists are turning away from this career. This lack of information impairs the ability of planning organizations to make timely recommendations for corrective measures. FASEB suggests that organizations like NIH, the National Academy of Sciences, AAMC, and others should continuously monitor the physician-scientist issue as solutions are proposed. These data will help to identify trends early, evaluate corrective measures, and ensure that this crucial scientific and health care resource is not irreversibly depleted. FJ

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