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Clinician-Investigator Training and the Need to Pilot New Approaches to Recruiting and Retaining This Workforce.

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Abstract

Clinician–investigators, also called physician–scientists, offer critical knowledge and perspectives that benefit research on basic science mechanisms, improved diagnostic and therapeutic approaches, population and outcomes medicine, health policy, and health services, yet few clinically trained health professionals pursue a research career. Sustaining this workforce requires attention to the unique challenges faced by investigators who must achieve clinical and research competence during training and their careers. These challenges include the duration of required clinical training, limited or discontinuous research opportunities, high levels of educational debt, balancing the dual obligations and rewards of clinical care and research, competition for research funding, and the need for leadership development after training. Women and individuals from underrepresented racial and ethnic groups comprise a small percentage of this workforce.

The authors summarize the recent literature on training for clinician–investigators, emphasizing approaches with encouraging outcomes that warrant broader implementation. Using this overview as background, they convened three workshops at the National Institutes of Health in 2016 to identify and refine key priorities for potential new pilot programs to recruit and retain the clinician–investigator workforce. From these workshops emerged three priorities for future pilot programs: (1) support for research in residency, (2) new research on-ramps for health professionals at multiple career stages, and (3) national networks to diversify and sustain clinician–investigator faculty. Implementation of any pilot program will require coordinated commitment from academic health centers, medical licensing/certification boards, professional societies, and clinician–investigators themselves, in addition to support from the National Institutes of Health.

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Despite unprecedented opportunities for conducting research in basic science, mechanisms of disease, diagnostic and therapeutic approaches, population and outcomes medicine, health policy, and health services, few clinically trained health professionals elect to pursue a research career.[1,2] In 2014, the National Institutes of Health (NIH) Advisory Committee to the Director Physician–Scientist Workforce (PSW) Working Group made a number of recommendations to strengthen this workforce, including suggesting changes to grant funding and training approaches.[3] Several PSW recommendations focused on the training of clinician–investigators, also called physician–scientists, including calls to support dual-degree training, to enhance diversity in the workforce, and of particular interest to our work here, to test new approaches to recruiting and retaining this workforce. The PSW recommendations join others calling for transformative approaches to education and training in science, medicine, and research.[4]

In this article, we describe recent efforts at the NIH to identify potential new pilot programs to enhance the clinician–investigator workforce. We first provide an overview of the current literature on the state of this workforce, including the challenges for clinician–investigators who must achieve both clinical and research competence, and current strategies for training these investigators. Using this information, we identified strategies with encouraging outcomes that may be implemented more broadly, and we conceptualized several potential pilot programs that might be considered for NIH support.

We then describe several workshops held in 2016 at the NIH to help refine these ideas and to identify new ones. Each workshop included extramural stakeholders, experts, and representatives and leaders from different NIH institutes. Stakeholder input refined our understanding of how the NIH might add value to new pilot programs with the goals of training and sustaining the clinician–investigator workforce. In the final part of this article, we describe key priorities for these pilot programs and emphasize that NIH support will need to be coupled with strong participation from academic institutions, medical boards, and professional societies for these approaches to be successfully implemented.

What the Literature Tells Us About the Clinician–Investigator Workforce

Current status of the clinician–investigator workforce

The clinician–investigator workforce includes individuals with MD, DO, MD–PhD, DDS–DMD, or DVM–VMD

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degrees, as well as nurses with research doctorate degrees, who devote the majority of their time to conducting biomedical research. The term physician–scientist was used in the original NIH PSW Working Group report,[3] but we use the term clinician–investigator here because it is more encompassing. Clinician–investigators are uniquely qualified to combine perspectives from direct patient contact and clinical experiences with scientific inquiry to promote advances in human health and the treatment of disease. Indeed, NIH research project grants led by MDs are twice as likely to involve human subjects and more likely to involve clinical research than those led by scientists with other degrees.[2] In 2014, the PSW Working Group estimated that there were about 14,000 clinician–investigators in the United States, of whom approximately 8,000 had research project grants from the NIH.[3] Among these NIH-funded clinician–investigators, about 60% held a health professional degree and 40% held both a health professional and a research doctorate degree. However, evidence suggests that the NIH-funded clinician–investigator workforce is aging and failing to attract and sustain sufficient numbers of new investigators.[5] Each year, a potential pool of clinician–investigators graduates from U.S. medical schools, including almost 20,000 individuals with an MD and several hundred with MD–PhDs, but only a subset of these graduates subsequently apply for an NIH grant (see Figure 1).[6] In the next section, we explore the challenges that these graduates face.

Challenges affecting the clinician–investigator workforce

Concerns about the vanishing pool of clinician–investigators have been raised for some time,[7–9] and potential solutions have been proposed.[10–14] Challenges facing this group include a need for enhanced diversity, the duration of clinical training, limited or discontinuous opportunities for research, high levels of educational debt, and stiff competition for research funding.

The need to enhance diversity. Women and individuals from underrepresented racial and ethnic groups represent a particularly small percentage of the clinician–investigator workforce.[15] Research suggests that women are less likely to pursue a clinician–investigator career or an academic appointment than their male counterparts.[11,16,17] Pipeline models that begin with research universities or dual-degree training historically have favored white men.[18] Low representation of individuals from underrepresented groups may reflect, in addition to the obstacles faced by all clinician–investigators, lower matriculation rates to medical school, reduced representation in training programs, differences in access to sponsors, underrepresentation in academic leadership positions, and other factors such as unconscious bias. Institutional projects designed to enhance faculty diversity at academic health centers have been the focus of the American Council on Education's career flexibility programs[19]; the National Science Foundation's ADVANCE programs, some of which are based at medical schools[20]; and the Doris Duke Charitable Foundation.[21]

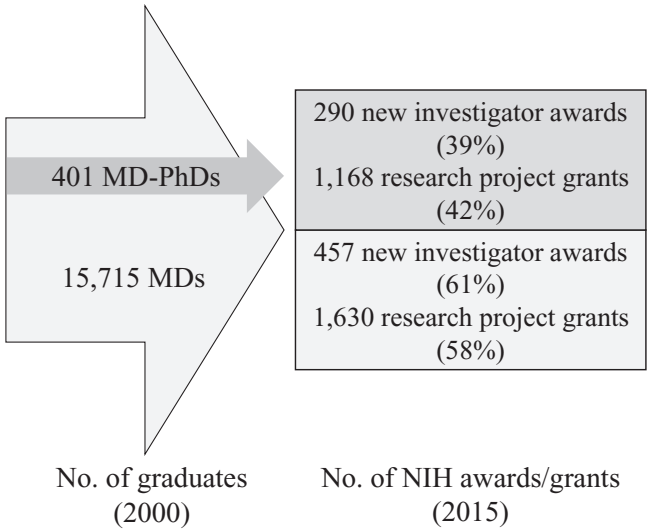

Figure 1 Comparison of the pools of MD and MD–PhD graduates with the number of National Institutes of Health (NIH) grants awarded. Of all NIH-funded MD or MD–PhD researchers, more than half hold an MD degree, and around 40% hold both MD and research doctorate degrees (see the percentages in the right panel of the figure). These percentages apply for both new investigator awards and research project grants. Based on the average age at which an investigator receives her or his first NIH grant (about 44 years of age[77]), about 15 years elapse between MD graduation and receipt of one's first NIH grant. When the numbers of MD and MD–PhD graduates in 2000 are compared with the numbers of NIH grants awarded to MDs and MD–PhDs in 2015, it is clear that few clinically trained health professionals elect to pursue a research career. Data on MD and MD–PhD graduates are from an analysis by the NIH Office of Extramural Research.[78]

The role of educational debt. High levels of educational debt can influence the career choices of health professionals. For example, the average medical school debt is now close to $200,000.[22] This level of debt may discourage clinicians from pursuing a research career since clinical practice will yield a higher income than research, which may be essential for debt repayment. The NIH Loan Repayment Program (LRP) established by Congress in 2001 provides one mechanism to reduce educational debt. It authorizes eight programs, with five that target the recruitment and retention of health professionals in specific research areas.[23] The LRP currently repays up to $35,000 annually of qualified educational debt in return for conducting research at least half-time. Recently approved legislation may allow for an increase in the maximum annual LRP support to $50,000 and broaden the eligible research areas.[24]

The effects of biomedical research funding. The landscape for biomedical research has changed rapidly in the last decade, adding to the challenges facing clinician–investigators at academic health centers. The doubling of the NIH budget from $13.7B in 1998 to $27.1B in 2003 was immediately followed by slow annual growth and significantly reduced budgets in the subsequent decade. As a result, institutions and researchers experience extraordinary financial pressure as an expanded workforce competes for flat funding and researchers' salaries increasingly are dependent on NIH grants.[25]

Despite the challenges described above, academic health centers, the NIH, foundations, and professional organizations have developed strategies to encourage clinician–investigator careers, and increasingly, these groups have studied the outcomes of these strategies. In the following sections, we summarize the literature on existing approaches to expanding the ranks of clinician–investigators, and where available, we describe the outcomes of these efforts.

Existing approaches to expanding the clinician–investigator workforce

Exposure to research before or during a health professional degree may stimulate or strengthen a student's interest in a research career. This exposure could include conducting research during undergraduate training, holding a research job during gap years after college, or conducting research as part of the formal curriculum or year out of a health professional degree. The NIH supports undergraduate summer research and postbaccalaureate research-intensive experiences (i.e., the Intramural Research Training Award on the NIH campus and the extramural Post-Baccalaureate Research Education Program that includes aspiring MD–PhDs).

In addition, students pursuing a health professional degree may participate in a summer or yearlong research training program in an academic laboratory that is sponsored by federal agencies, foundations, or scientific societies. For example, each year the Howard Hughes Medical Institute Medical Research Fellows Program supports about 75 medical, dental, and veterinary students for a year of research. Another 200 medical, dental, or veterinary students receive research training through NIH-funded institutional Clinical and Translational Science Award (CTSA)-sponsored TL1 programs. Alternatively, some medical schools offer a five-year program that includes a year of research or even an accelerated three-year MD program that might allow for a fourth year devoted to research.[26] While not geared specifically for research, these accelerated programs have no reported adverse effects on students' board scores or other professional achievements,[27] and they might be expanded to promote research experience. To date, evidence of the educational or career impact of a year of research is sparse, but available reports suggest that early exposure to research increases students' interest.[28,29]

Dual-degree health professional and research doctorate training. About a hundred U.S. medical schools offer MD–PhD programs,[30] and a number offer dual-degree DVM–PhD programs[31] and dentist/PhD programs.[32] Of these, 47 MD–PhD programs were funded by the NIH Medical Scientist Training Program (MSTP) in 2016; only 1 includes VMD–PhD training. An earlier report on outcomes of 24 MD–PhD programs and almost 6,000 graduates found high levels (67%) of alumni employment in academia[33] and that many graduates were appointed to full-time faculty positions.[34] MSTP alumni have succeeded in attaining grants from the NIH and from disease-focused, private foundations.[35,36] They also were more likely than other T32 graduates to propose R01 applications involving human subjects or to indicate that their work was clinical research using a Research, Condition, and Disease Categorization or a clinical trial checkbox.[37]

It is not clear what aspects of dual-degree training contribute to these promising outcomes or how best to broaden the impact of these programs. Contributing factors likely include the admission of students interested in research, an integrated research/clinical curriculum, and relatively low debt levels among students due to scholarships covering tuition. Concerns have been raised about the lengthy MSTP training period. While MSTP programs continue to evolve to address this concern, many still offer clinical foundations first, followed by a research doctorate and then clinical clerkships, resulting in an eight-year training period on average and research discontinuity. Concerns also have been raised about student attrition from the program or the subsequent research career and a lack of student diversity.[16,38]

Research master's or doctorate degree after a health professional degree. PhD training following medical, veterinary, dentist, or nursing training prepares clinician–investigators for research careers. At least one institution provides PhD training for physicians during fellowship. The Specialty Training and Advanced Research program admits fellows in a variety of specialties and offers a basic science PhD, a health services/outcomes PhD, a clinical research MS, or postdoctoral training for MD–PhDs.[39] The program relies on NIH postdoctoral T32 grants and institutional support and includes opportunities for trainees to transition to faculty positions at the institution. Outcomes from 123 graduates suggest that 80% were conducting academic or industry research, and 50% had received a career development award after completing the program.[39] Similarly, in veterinary medicine, NIH postdoctoral T32 programs through the Office of Research Infrastructure Programs support institutional programs that lead to a PhD after the completion of a DVM degree. Nurse–scientists can pursue a research doctorate with support from an NIH T32 grant from the National Institute for Nursing Research.

Research in residency. A number of postgraduate medical training programs in several specialties provide a research pathway that reduces the amount of core clinical training time during residency/fellowship and integrates research training.[40] Trainees still meet the clinical requirements for specialty board certification. Oversight and standards for these programs are the responsibility of the individual specialty boards, and the American Board of Medical Specialties is studying how board certification may best be combined with research training.[41,42] Such research pathways have been approved by the American Boards of Anesthesiology, Internal Medicine, Pathology, Pediatrics, Physical Medicine and Rehabilitation, and Radiology.

The benefits of such research pathways have been reported. The American Board of Internal Medicine studied outcomes from more than 800 participants who completed residency between 1995 and 2007. The clinical competency of these graduates was comparable to those in standard residency programs,[43] and their career outcomes in research were strong, with 72% holding subsequent positions in academic medicine, more than 85% reporting research activity, and participants reporting an average of 60% professional effort in research.[44] A 10-year retrospective study of the American Board of Radiology Holman Research Pathway found that most participants remained in academic medicine and demonstrated high research productivity.[45] Similar research

pathways are available in psychiatry[46,47] and radiation oncology.[48] Individualized approaches to mentored research in residency that are supported by the NIH and institutions warrant further consideration.[49]

Protected time to build a research program. Building a research career requires skills, time, funding, and effort. Required skills include experimental design, research technique, critical analysis and interpretation of data, and the effective communication of ideas and results, as well as guidance on the development of a research program. Many clinician–investigators gain research skills and experience with the support of NIH Mentored Career Development Awards, both institutional (i.e., K12 or KL2) and individual (i.e., K08 or K23). In general, mentored K programs support three to five years of 75% protected time for mentored research, supplies, travel, and career development to assist fellows or junior faculty members in the transition to an independent research career. Effective mentorship is a key component of these awards and is strongly associated with career satisfaction.[50]

Available data indicate that the mentored K programs successfully prepare scholars for research careers. K08 and K23 awardees and KL2 scholars have increased odds of receiving subsequent NIH funding, with about 40% earning an R01 or equivalent research grant.[51–54] Concerns have been raised about declining numbers of applications from health professionals and potential differences in the numbers of subsequent applications and research grant success among women and men.[55–57] Recent NIH policy changes to increase the minimum salary support provided and to allow salary compensation on other research grants during the later years of the K award may boost the appeal of these programs.

Mentoring and networking to promote clinician–investigator retention and success. Career development is an important component of the retention and success of clinician–investigators, and the availability of effective mentors (who provide advice) and career sponsors (who use their authority to advocate on behalf of the investigator) is critical.[50,58–62]

Existing clinician–investigator career development programs designed by professional societies and foundations provide examples of approaches that might be expanded to better support this workforce. For example, the American Society of Hematology established a national Clinical Research Training Institute that identifies 20 hematology-related fellows or junior faculty annually.[63] These scholars pursue a yearlong program that includes being matched with both a local and a national mentor, workshops to hone proposals, and strong oversight, with support from both NIH and society funds. Outcomes from 140 participants demonstrate that scholars go on to have strong publication records and subsequent research funding, and scholars have reported a strong research identity and psychosocial agency as clinician–investigators.[64,65] In another example, the Harold Amos Medical Faculty Development Program of the Robert Wood Johnson Foundation provides scholars from underrepresented groups with protected time and career development support.[66]

Many NIH CTSA and Institutional Development Award programs offer centralized resources for clinician–investigators that incorporate team-based research mentoring, access to essential core facilities, and education in professional skills.[58,67,68] This coordinated approach is effective; for example, faculty who entered a physician–scientist development program in 2000–2002 were more likely to earn an individual career award, and at a younger age, than a comparison cohort, and the institution outpaced the national rate of growth in K awards.[69]

Assessing the impact of programs to support clinician–investigators. Evaluating the impact of current and pilot programs to support clinician–investigators will help institutions and organizations tailor their efforts to strengthen and grow this workforce. Metrics including NIH or other research grants, patents, clinical trials, investigational new drugs, contracts, and job titles have been used as long-term outcomes and should continue to be collected for program participants and matched nonparticipants.[70,71] Qualitative benefits of any program, including impact on education, mentorship, collaboration, job opportunities, and work–life balance, are also important measures.[67,72] However, these long-term outcomes may take many years to appear and evaluate. Research presentations and publications, as well as the proportion of professional effort (rather than salary) spent in research, represent informative short- and intermediate-term measures to pursue. Effective approaches to collect these data are needed.[73–75] Representation ratios that indicate the relative participation of qualified individuals from diverse groups at different stages of the clinician–investigator career path also are useful.[18,76] Departments and medical schools share an interest in describing the outcomes of clinician–investigators' research since an important return on their investment lies in the public's perception of the institution's reputation, including its contributions to scientific discovery and health.[77]

Recommendations for Pilot Programs to Increase and Diversify the Clinician–Investigator Workforce

Using this overview of the literature as background, the NIH convened several workshops to refine approaches to recruiting, training, retaining, and enhancing the diversity of the clinician–investigator workforce. The first workshop was held in February 2016, and it brought together about 35 extramural participants, including experienced clinician–investigators from academic health centers, representatives of professional societies, experts from medical certification/licensing boards, and newly trained clinician–investigators. Half of these participants were women, a fourth were from underrepresented groups, and a third held dual degrees, while others held medical, veterinary, dentist, or nursing degrees. A second meeting was held in July 2016, and it involved 12 representatives from medical boards and licensing groups who provided input on professional education and certification. A third workshop was held in December 2016, and it engaged 12 clinician–investigators who were recommended by the leaders of different NIH institutes, again with broad diversity, to review potential new pilot programs.

At all three workshops, there was strong interest in the rapid expansion of promising existing programs and in the timely development and assessment of new pilot approaches. Participants also

noted that any proposed programs must be both feasible and scalable to have the desired, broad impact. Accurately estimating future workforce needs can be difficult, but most participants agreed that efforts are needed to at least maintain the existing size of the clinician–investigator workforce.

Additionally, participants recommended that the NIH evaluate pilot programs across institutions to learn which activities and interventions have the greatest impact, on whom, and under what circumstances. Because of the duration of clinician–investigator training, these assessments are likely to require at least 10 years of data and, wherever possible, should include information on both program participants and any relevant control groups. Program outcomes should be evaluated not only for traditional long-term goals that may take a decade or longer to appear but also for key short- and intermediate-term goals that can inform decisions to revise, expand, or end a particular funding opportunity. Enhanced tracking by both institutions and the NIH will facilitate these efforts.

As a result of these workshops, three priorities were identified for future pilot programs—support for research in residency, flexible research on-ramps for health professionals at multiple career stages, and national networks to diversify and sustain clinician–investigator faculty (see Chart 1).

Research in residency

Existing research in residency programs offer examples of structured approaches with predictable periods of protected time for research and clinical training, leading to residents with clinical board eligibility and research competence. These programs also include intensive mentoring and professional development. Expanding these opportunities to additional specialties and, importantly, to explicitly encourage MD graduates as well as dual-degree earners may increase the pool of clinician–investigators. A pilot might include an institutional research in residency program that selects participants from among the pool of residents and matches preceptors and trainees in effective clinical and research environments. It also should offer support for continued research during fellowship, assuming milestones are met. In addition, interactions with professional organizations and national mentors are likely to enhance participants' retention and career success as clinician–investigators; thus, these interactions might be encouraged during the fellowship period of an award. Given residency program accreditation goals, programs must identify research competencies, with milestones that are appropriate for both those who begin with an MD and varied levels of research experience as well as those with dual degrees and substantial prior research experience. Potential challenges for an institution developing a new research in residency program may include identifying and developing effective mentors for clinician–investigators and ensuring that participants' clinical duties are covered during their protected research time.

Research on-ramps

We recommend replacing the traditional pipeline metaphor with that of multiple on-ramps to the clinician–investigator career freeway (see Figure 2). The pipeline metaphor supports the assumption that clinician–investigators choose and begin training for a career very early, then may leak out before achieving an active research career. Such a metaphor may not sufficiently encompass the lengthy training period that is typical for clinician–investigators. Instead, we promote the concept of multiple on-ramps to a clinician–investigator career. These on-ramps might include access to research opportunities before and during medical school, opportunities for MS or PhD training following MD training, research residencies as described above, or other entry points. Pilot programs that expand opportunities for research and/or for MS or PhD training at multiple stages after medical school may have the greatest impact on encouraging clinician–investigator careers (see Chart 1).

Faculty networks

The retention of clinician–investigator faculty can be facilitated by national career mentorship and sponsorship programs in professional networks. Existing

Chart 1

Characteristics and Metrics of Success for Three Priorities for Future Pilot Programs to Recruit, Retain, and Sustain the Clinician–Investigator Workforce

Research in residency	Research on-ramps for health professionals	Faculty networks
• Research and clinical activities leading to research and clinical competence and board eligibility • Medical board approval for research in residency models in different specialties • Postgraduate year salary support • Accommodations for a range of prior research experience • Mentor development • Continued research support during fellowship	• Research opportunities at multiple career stages • Maximized support for candidates from underrepresented groups • Research doctorate following health professional training • Research skills taught in master's programs • Coordination of opportunities across institutions	• National links between clinician–investigators from underrepresented groups who are few in number at any individual institution • Connections by specialty, gender, or underrepresented group • Nominations by institutions • National networking and career sponsorship • Enhanced research efforts • Leadership needs addressed
Broad metrics of success[a]		
Short- and intermediate-term: Research publications and presentations; proportion of effort in research; participation by diverse groups Long-term: Research grants (National Institutes of Health or other); jobs that involve research; patents, clinical trials, investigational new drugs, contracts; impact on scientific discovery and health		

[a]Pilot programs should compare participants and matched nonparticipants for these metrics of success.

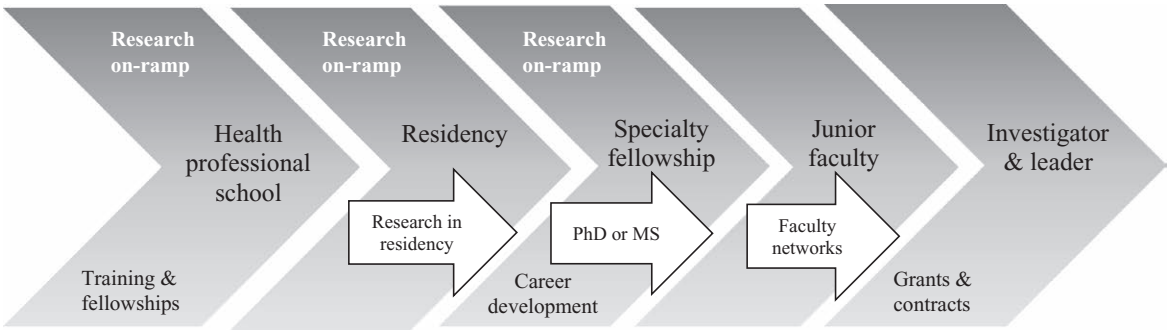

Figure 2 Depiction of the research on-ramp model for a clinician–investigator career. Existing National Institutes of Health support is indicated at the bottom of the figure. New, proposed on-ramps are indicated at the top of the figure. These on-ramps include additional research opportunities for health professionals at multiple career stages. Priorities for potential new pilot programs to recruit and retain the clinician–investigator workforce, indicated by the arrows in the middle of the figure, include support for research in residency, programs to complete a research degree during fellowship (or other stages), and national faculty networks to diversify and sustain this workforce.

approaches engage clinician–investigator faculty who are nominated by their institutions to participate in a national career development program. National programs offer additional mentors and opportunities to complement the mentors and research resources at the participants' home institutions. The development of new national programs may be particularly important to building faculty networks of clinician–investigators from underrepresented groups, who are few in number at any individual institution but can come together in greater numbers at the national level. A pilot might involve NIH research support as well as participation by national organizations or professional societies that are interested in sustaining specific clinician–investigator workforce pools.

Conclusions

Overcoming the challenges to training clinician–investigators requires bold action now, including adopting or expanding effective programs to support this workforce and piloting and evaluating new programs that address gaps in training and support. These programs will require NIH support coupled with strong participation from academic institutions, medical boards, and professional societies. Only then will the promise of the unique capabilities of clinician–investigators to conduct research on basic science mechanisms, diagnostic and therapeutic approaches, population and outcomes medicine, health policy, and health services be fully realized.

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