Special Report

The Chain of Scientific Discovery
The Critical Role of the Physician-Scientist

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Welcome, and thank you for joining us for the 2001 Scientific Sessions. It is a pleasure and a privilege for me to stand before you today, an honor for which I am indeed grateful.

For many years, pioneers of scientific achievement and distinguished colleagues have gathered in this forum to share knowledge, discoveries, and insights. As a result, the Scientific Sessions have grown to be the largest gatherings of cardiovascular scientists and healthcare professionals in the world. Joining together here, we are of one mind in our mission; though perhaps differing in some areas, we share a strong mutual respect. This professionalism, dedication, and tireless work ethic ultimately bring about extraordinary outcomes. As healers, scientists, and practitioners of medicine, we are challenged with fighting disease, curing illness, and bettering the human condition.

However, as you are all too painfully aware, since September 11th, we have been in the midst of a crisis that plagues our world. It is an environment that makes it difficult to fully focus our attentions on fighting heart disease and stroke, jobs that are certainly daunting enough.

It is my fervent desire that our shared value of human life will one day be shared throughout the world. I am frequently reminded of John Lennon’s famous song “Imagine,” where he says, “Imagine all the people, sharing all the world.” His lyrics remind us of our purpose this week, which is the free and open sharing of research and discoveries, asking of questions, and seeking of answers, all with the goal of making our world a better place.

In our profession, we are sometimes called to be teachers and sometimes to be students. In some cases, we may have the answers that others seek; at other times, we seek answers from those who may be wiser or more experienced than we. Each of us has faced pivotal moments in our lives and in our careers when we have sought answers, guidance, and inspiration from the same sources again and again, and have been provided with direction, clarity, and a renewed sense of purpose. These people assumed the mantle of “mentor” for us, and without them, we may not have been able to achieve our loftiest goals and ideals.

I would invite you all to take just a moment to recall those special individuals who were there for you along the way. Perhaps by recalling their faces, their names, and their contributions, you can repay them with a moment of thanks.

I would list several inspirational mentors, starting perhaps with the unlikely and inappropriately named “Mrs Arsenic,” who, far from poisoning, actually nurtured my intellectual curiosity at a time any young boy needs it most – the third grade. On my way to school one day, I came across a dead bird. I carefully wrapped it in a napkin and put it in my lunch box, hoping that I might be able to dissect it for my science class. To my surprise, Mrs Arsenic enthusiastically supported me, despite the horror and disbelief of my classmates. Mrs Arsenic was right there with me, feeding my thirst for scientific knowledge, nourishing my intellectual curiosity. Who can say what path my life may have taken if I had been discouraged, rather than encouraged, at that impressionable age?

Of course, any talk of my mentors would not be complete without mentioning my grandfather, Nathaniel Wales Faxon, MD, who was the Director of Massachusetts General Hospital from 1935 to 1955, and who was a colleague of Dr Paul Dudley White. My grandfather provided enormous guidance to me throughout my early career. His quest for knowledge was astounding. Twenty-five years ago, at age 90, he asked me to provide him with a textbook on genetics because he didn’t know enough about the subject and felt that genetics was going to be an important field in the future. Through the years, countless other teachers and tutors, sages and scholars have been there for me, including a man whom I have the good fortune to share the stage with today, Dr Tom Ryan.

I have had the opportunity to look at the issues of heart disease and stroke from different perspectives: from a personal point of view, through interaction with patients, students and faculty, and from a more global point of view through meeting with prominent and esteemed colleagues from a number of organizations such as the American College of Cardiology (ACC), the National Institutes of Health (NIH), the Centers for Disease Control (CDC), the World Heart Foundation, and the InterAmerican Heart Association.

In discussions with close associates, I am often encouraged by the tremendous progress we have made in our battle. It was in 1971 that John Lennon first asked us to “imagine” the future. Who could have ever imagined that we would see a world where people are living with totally artificial hearts with self-contained batteries, where we’ve had a 4-fold decrease in acute myocardial infarction mortality because of early reperfusion therapy, where...
we are on the threshold of controlling or even eliminating restenosis with drug-eluting stents, and where arrhythmias can be cured with catheter ablation? All around us, there are positive signs; age-adjusted cardiovascular disease (CVD) death rates are declining, new surgical techniques are being introduced, and new medications are being developed. However, there is still much to be done. Not everyone has realized the decline in heart disease and stroke. Studies presented at these meetings show a smaller decline for African Americans than whites. We need look no further than the recent studies from the ACC that projected a frightening increase in the rate of death from heart disease as the “baby boomers’” age (Figure 1), or the recent World Health Organization projections that by the year 2020, heart disease will become the No. 1 health problem in the world.3

Many of us are already painfully aware that heart disease is the No. 1 killer in the United States, and stroke is the No. 3 killer. We see it every day in the faces of our patients, their families, and their loved ones.

By focusing on the “Chain of Survival”—early access, early CPR, early defibrillation, and early advanced care—the American Heart Association (AHA) has enabled us to save lives and to move closer to accomplishing our Impact Goal of reducing coronary heart disease, stroke, and risk 25% by 2010. This chain has helped to define the issues facing us and has given structure and clarity to our efforts.

I suggest to you that there is a similar chain for all of us gathered here today, a chain that I would perhaps call “The Chain of Scientific Discovery.” Its 4 links would include discovery, translational research, clinical trials, and implementation (Figure 2).

Some of these links are exceptionally strong. In discovery, for instance, we stand on the threshold of unprecedented advancements, such as the mapping of the human genome and the resulting emergence of functional genomics and pharmacogenomics. We are aided by the allocation of significant resources to the NIH and a continuation of efforts to double NIH funding over 5 years.

Another strong link of the chain is implementation. The practitioners of our science are as passionate and compassionate, as informed and innovative, as they have been at any other point in time in our history. I would stress that there is a greater need to integrate programs and science into daily practice. The AHA’s “Get With the Guidelines” and ACC’s “Guidelines Applied in Practice (GAP)” program are excellent tools to accomplish this. I would also stress that we need to continue focusing on the serious racial and ethnic disparities that face our country as well.

However, I cannot in good conscience stand before you today without calling attention to what I and many of my colleagues perceive as a weak link in our chain. I spoke earlier of the profound effect that my mentors had on my development as a physician-scientist. I invited you all to recall your own personal mentors and how your lives would have been less fulfilling without them. I ask you, to whom do the students of today turn? From whom do they seek wisdom, guidance, and insight? Who teaches them patience, perseverance, and practice?

We are in danger of squandering some of the greatest advances in science, of losing lives because we cannot move new technologies, medications, and knowledge through the chain to where it belongs: at the bedside. I am not the first to hold this impending crisis up to the light of critical examination, although I do hope to be fortunate enough to be one of the last. Dr Julian Biebuyck of the Hershey Medical Center calls himself a social environmentalist because he is fighting the extinction of a rare creature, the physician-scientist.4 The American Society of Clinical Investigation Council declares, “there is a critical need to promote the training of the physician-scientist at a time when their role in US medical schools is being threatened. . . .”5

The Association of Professors of Cardiology states, “this growing crisis seriously threatens the quality and availability of cutting edge care for heart disease. . . .”6

The Association of American Medical Colleges estimates that by 2002, “nearly 100 major teaching hospitals will be close to broke. . . .”6

The Federation of American Societies for Experimental Biology feels “. . . a growing concern about a serious decline in a crucial category of research personnel: physician scientists. . . .”7

The National Heart, Lung and Blood Institute states, “. . . the clinical investigator, uniquely positioned to translate basic research advances to clinically meaningful programs, may be an endangered species.”8,9

Figure 1. Projections of heart disease, 2000 to 2050.

Figure 2. The chain of scientific discovery.
The American Association for the Advancement of Science opines, ‘‘. . . there is a defect in the structure of the country’s medical research edifice, which must be repaired. . . .’’\textsuperscript{10} In fact, it was over 20 years ago that former the NIH director, James Wyngaarden, articulated this belief in a paper entitled ‘‘The clinical investigator as an endangered species.’’\textsuperscript{11}

I could go on citing the concerns of other esteemed organizations and individuals. Perhaps, however, we can take a few minutes to look at some of the empirical evidence and to suggest some probable causes.

- The number of physicians reporting research as their primary career activity fell by 6\% over the last 17 years. During that same period, there has been a doubling of physicians reporting patient care as their primary career activity (Figure 3).\textsuperscript{7}
- The number of first-time MD applicants for NIH research project grants has plummeted in the past few years, with a 31\% drop from 1994 to 1997.\textsuperscript{7,10}
- The number of graduating medical students who expected to have a significant career involvement in research has fallen from 15.9\% in 1989 to 10.7\% in 2000, according to the American Association of Medical Colleges (personal communication, Andrew Quon, American Association of Medical Colleges, Division of Medical Education, November 6, 2001).
- Over 80\% of medical school graduates are in debt, and the average debt load for that group is just shy of $100 000 (personal communication, Andrew Quon, American Association of Medical Colleges, Division of Medical Education, November 6, 2001).
- Finally, although MD/PhDs are heavily in demand as medical school faculty members, many are assigned patient care duties rather than research. This fact is due to the competitive healthcare market, managed care, and declining Medicare/Medicaid reimbursement.\textsuperscript{13}

There seem to be 6 barriers to overcome:

- Financial pressures at academic medical centers
- Increased debt coming out of medical school
- Longer training periods for researchers
- Lure of greater salaries in private practice or pharmaceutical or device industries
- The cost and regulatory hurtles of clinical trials versus basic science research
- Perhaps most importantly, the lack of mentors to battle back against all of the above!

As a faculty member myself, and as a member of that endangered species called the physician-scientist, I have seen this issue firsthand, as I’m sure many of you have. The fact is that today, the overwhelming majority of clinical faculty time is directed to patient care and not to translational research, teaching, or mentoring, and this trend is likely to worsen.

It is important to point out that it is not just the medical school debt, the difficulty of obtaining grants, or the lure of greater salaries that dissuades students from the life of the physician-scientist. Frankly, often the lifestyle itself does not appear attractive. Recently, a 5-year study was conducted at a leading medical institution surveying the past cardiology fellows. The question was asked, ‘‘Why did you choose a career other than academics?’’ The answer was usually ‘‘a high level of dissatisfaction with the institution’s junior faculty lifestyle.’’ I’m sure that any of you here who are in a position to experience this would echo my sentiments. It seems to me the issue is not just attracting the talent, but keeping it. It’s critical that the fellows look up to young faculty as role models. If we cannot attract or retain the best talent, there’s a void that needs to be addressed. Our chances of steering students down the path of the physician-scientist and toward helping us advance from benchside to bedside are being diminished.

The loss of the physician-scientist is primarily responsible for this weak link, the clinical research link, which is understaffed, underfunded, and under-appreciated. It is understaffed because of the financial pressures placed on the medical student and the medical institutions; underfunded because the cost of clinical trials is so daunting and the research dollars flow more toward basic science than clinical research; and under-appreciated because of the critical lack of mentors. Not teachers, but mentors; I draw a distinct difference between the two. We are not talking about merely imparting knowledge, but showing a personal interest that focuses on career building and a strong sense of an individual’s needs, strengths, and potential.

What can we do about this problem? As a doctor, of course, it is not enough to diagnose the illness; we must work toward a cure. I don’t offer up these suggestions as evidence of any particular original thinking on my part, but rather as a restating of what many of us who fear for the future are advocating.\textsuperscript{4–15}

We must:

**Stabilize the System**

I speak here of the Academic Health Centers and the medical schools and teaching hospitals. There is no easy answer here, but there is also no shortage of parties who are seeking the same result. Whether through legislation such as the American Hospital Preservation Act, or through advocacy, intervention, or even a different financial paradigm, the financial pressures that force the physician-scientist to abandon the laboratory or the classroom because they cannot afford to be anywhere but in the business of generating revenues must be alleviated. Perhaps it can be accomplished through an increase in endowed chairs, through a system where academic salaries are separate from other forms of compensation, or through increased insurance payments for services. Whatever the solution, we need to focus on how we can support teachers and mentors to be free from the

![U.S. Physicians by Major Professional Activity](http://circ.ahajournals.org/)

**Figure 3.** Major career activities of US physicians, 1980 to 1996.
financial restraints that threaten to prevent them from tackling their most valuable role. With no one in the laboratory to move our research forward and no one in the classroom to move our students forward, we will stagnate.

Increase NIH Funding for Investigator-Initiated Clinical Trials
As I stated earlier, we are delighted that Congress continues on the path to double the NIH budget, and programs like the NIH’s new awards for clinical investigators are positive steps. Despite the disparity between the cost of funding basic research and the cost of funding clinical trials, we need reexamine the allocation of our resources within the links of our chain and perhaps reach the consensus that there may be a more equitable distribution possible.

Increase NIH Funding for CVD and Stroke
We also must reexamine our allocation of resources here and see if the nation’s No. 1 and No. 3 killers are receiving a significant share of our research budget.

Develop More Innovative Programs for Early Career Development
Using the successful NIH Career Development Programs such as the “K08” award and the AHA’s new “Fellow to Faculty” programs as models, we must challenge ourselves to develop new clinical research career development initiatives. We need multidisciplinary research training programs with increased incentives. We need incentives for greater collaboration and must provide the means to facilitate it, whether through technical or interpersonal means.

Ease the Financial Burdens on Our Students
With the average debt of a graduating medical school student approaching $100,000, the ability to choose a career path based on “interest area” rather than “interest owed” has decreased. I am delighted that the House and Senate are working toward funding for the loan repayment program authorized under the Clinical Research Enhancement Act. We must also look at other innovative programs of financial support, such as grants, stipends, or debt forgiveness, to encourage students to pursue research, and we must look to some private partnerships that will bridge the salary gap between industry clinical trials and academic clinical research.

Support and Foster Mentors
We need to ensure that our faculty has the abilities to mentor, the inclination to mentor, and the incentives to mentor. Great researchers, great scientists, and great doctors are not born, they are made. They are molded through years of learning, yes, but also through “instances of interest,” personal interest, delivered at key moments of questioning, from a source that is trusted and respected.

I would like to close by recalling some words spoken of a man who was, perhaps, a mentor in some way to each and every one of us in this room. Though perhaps it is true that only a few of us ever had the extreme good fortune of personally meeting him, his presence in our lives today is unmistakable and permeates all that we labor to accomplish. For it was said of this man, as the closing words of his eulogy, “... it is not the accumulation of years alone that has built his image. He is remembered for his industry, his unconquerable optimism, his gift of serving as an example. In the incubation of his laboratory in the Bulfinch Building ... were hatched the birds, you, in fact, who have flown out to inhabit the roosts of cardiology throughout the earth.”

That man, of course, was Paul Dudley White, considered one of the “founding fathers” of the American Heart Association. We are the birds that were hatched, and so my story has come full circle. I suppose, from “Mrs Arsenic and the Dead Bird” to “Dr White and the Roosts of Cardiology.” This is the stuff of a man’s immortality, for as Henry Adams wrote, “A teacher affects eternity; he can never tell where his influence stops.” We who follow in his footsteps are called to a life of greatness, called to affect eternity. Let us do so, as doctors, as teachers, as mentors, and above all, as men and women who can make this world a better place.

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References
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