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The Next Generation of Physician-Scientists: Adapting to Academic Cardiology in the 21st Century

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ABSTRACT

More than 3 decades ago, Wyngaarden and Gill first warned of the challenges facing physician-scientists in their seminal papers "The Clinical Investigator as an Endangered Species" and "The End of the Physician-Scientist." In the years since these papers were published, there has been expansion of stage I-II preclinical research focusing on discovery and exploratory studies. Expansion has often come at the expense of physician-scientists whose traditional role has been to bridge the gap between early preclinical research (stage I-II) and clinical trials (stage IV). Consequently, a paradigm shift has occurred, and increasing pressure has been placed on physician-scientists to choose between clinical practice and fundamental research. This shift is particularly concerning in the field of cardiovascular medicine, where the ubiquitous nature and clinical significance of cardiovascular disease make the role of the translational scientist essential. The challenges facing academic cardiologists have then further been amplified by the necessity not only to maintain clinical competence but also to maintain competence in highly technical fields with rapidly advancing technology. Potential solutions to these problems include increasing support from postgraduate training programs, increased participation

RÉSUMÉ

Il y a plus de trois décennies, Wyngaarden et Gill ont été les premiers, dans deux articles fondateurs, « The Clinical Investigator as an Endangered Species » (Le chercheur clinicien, une espèce en voie d'extinction) et « The End of the Physician-Scientist » (La fin du médecin-scientifique), à alerter l'opinion au sujet des défis que doivent relever les médecins-scientifiques. Depuis la publication de ces articles, on a assisté à un essor de la recherche préclinique de phase I-II mettant l'accent sur les études orientées vers la découverte et l'exploration. Cet essor s'est souvent fait au détriment des médecins-scientifiques, dont le rôle était, traditionnellement, de faire le lien entre la recherche préclinique initiale (phase I-II) et les essais cliniques (phase IV). Il s'est donc opéré un changement de paradigme, et le médecin-scientifique subit à présent des pressions de plus en plus fortes pour choisir entre la pratique clinique et la recherche fondamentale. Ce changement est particulièrement préoccupant dans le domaine de la médecine cardiovasculaire où, du fait de l'omniprésence et de l'importance clinique des maladies cardiovasculaires, le scientifique expert en recherche translationnelle joue un rôle essentiel. Les défis que doivent relever les cardiologues du milieu universitaire ont ensuite été encore amplifiés

It has been almost 40 years since Wyngaarden, the 12th director of the National Institute of Health (NIH), published "The Clinical Investigator as an Endangered Species," in which he reported an increasing disparity in both NIH applications and funding between physician-scientists (MD-PhDs/MDs) and PhDs.[1] The concerns noted by Wyngaarden led Gill to question whether we were witnessing "The End of the Physician-Scientist?" in his *American Scholar* 1984 paper.[2] Although, over the last 3 decades, we have yet to witness the extinction of the physician-scientist, the analysis of the scientific landscape in the 1970s and 80s by Wyngaarden and Gill identified several important trends that continue to threaten the academic cardiologist workforce to this day.

The translational axis of research is composed of discovery and exploratory studies (stage I and stage II), confirmatory preclinical translational studies (stage III: intermediate and large animal studies with high methodological rigor), and, ultimately, stage IV research composed of clinical trials (Fig. 1).[3] Traditionally, the unique role of the physician-scientist has been to bridge the gap between stage I-II and stage IV research, integrating findings from early research and facilitating the translational march from bench to bedside. This role is particularly important in the field of cardiovascular medicine because of the ubiquitous nature and clinical significance of cardiovascular disease in our society.

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of trainees in physician-scientist development programs, and recognition of the pivotal role physician-scientists play in translational research by funding agencies. Although the physician-scientist remains an endangered species, multifaceted solutions with a focus on collaboration among institutions, training programs, and funding agencies have the potential to maximize efficiency in biomedical research and successfully translate scientific discoveries from bench to bedside.

par la nécessité de maintenir leurs compétences non seulement en matière clinique, mais aussi dans des domaines extrêmement techniques où la technologie évolue rapidement. Les solutions envisageables pour remédier à ces problèmes sont notamment d'accroître le soutien des programmes de formation postuniversitaire, de faire participer davantage les stagiaires aux programmes de perfectionnement des médecins-scientifiques, et de faire reconnaître par les organismes subventionnaires le rôle pivot du médecin-scientifique dans la recherche translationnelle. Si le médecin-scientifique demeure une espèce en voie d'extinction, des solutions multidimensionnelles mettant l'accent sur la collaboration entre les établissements, les programmes de formation et les organismes subventionnaires ont le potentiel de maximiser l'efficience de la recherche biomédicale et de permettre la mise en application des découvertes scientifiques, du laboratoire au chevet du patient.

With technological progress in the field of molecular and cellular biology in the 1980s and genetics in the 2000s, fundamental laboratory-based research has become more rapid and increasingly productive. The same cannot be said for patient-oriented or large animal translational research, which remains time consuming and labor intensive. Consequently, many scientifically motivated physician-scientists have abandoned patient-oriented translational research for laboratory-based fundamental research, leading to an expansion of stage I-II preclinical research at the expense of confirmatory and translational stage III research.[1,3] Ultimately, this trend has resulted in increasing pressure on physician-scientists to choose between clinical practice/research or fundamental research, with little opportunity to translate findings into clinical practice. Within the field of cardiology, these challenges are amplified by the substantial clinical volume and the requirement of cardiologists not only to maintain clinical competence but to also maintain competence in highly technical fields with rapidly advancing technology such as echocardiography, electrophysiology, and cardiovascular interventions.

Data supporting these trends are concerning. In the United States, the number of NIH grant applications has more than doubled over the last 2 decades, which has led to a 50% increase in PhD-funded scientists. Conversely, the number of NIH-funded physician-scientists has remained stable over the same period, and now only 30% of all current NIH grants have been awarded to physician-scientists. More specific to cardiovascular research, American Heart Association fellow-to-faculty grant success rate was only 22% in 2016, a 13% decline over 3 years. A report on the status of early-career academic cardiology found that there was no increase in NIH grant funding among early-career members of the American College of Cardiology (ACC) despite an overall increase in funding from the National Heart, Lung and Blood Institute (NHLBI) over the same timeframe. In the same period, external grant funding among early-career ACC members also declined.

In Canada, comparative funding rate data for the physician-scientist remain less granular. However, in the 10 years from 2005 to 2015, the overall funding success rate for operating grants awarded by CIHR fell from 30% to 15%, with an increasing focus on fundamental/discovery-based science. Moreover, Canada lags in training physician-scientists, with a nation-wide average of 55 PhD graduates annually between the MD-PhD and clinician investigator programs, representing only 1.9% of medical graduates. Indeed, the Royal College of Physicians and Surgeons of Canada has highlighted a need to evaluate models of training and to increase early career support through mentoring and funding to develop and retain clinician scientists in Canada.

In parallel with a shift to fundamental discovery-based science, there has been a substantial increase in the therapeutic interventions (both interventional and medical) available to the clinician. The incredible progress that has been made in catheter ablation techniques and the development of percutaneous structural heart disease interventions exemplify both the expansion of therapeutic interventions available to the clinician and the increasing complexity in clinical decision making. The consequence of this progress has made excelling as both a clinician and a scientist progressively more challenging, ultimately increasing the divide between the bench and the bedside. Accordingly, with less emphasis placed on translational stage III research, physician-scientists are increasingly being faced with a choice: Clinically inclined researchers tend to focus on clinical excellence and clinically oriented research in favor of fundamental exploratory projects, in essence becoming *PHYSICIAN-scientists*. Alternatively, physician-scientists with more fundamental inclinations frequently withdraw from the clinical arena and translational research, instead focusing their attention on pursuit of stage I and II preclinical biomedical research, becoming de facto *physician-SCIENTISTS.*

Thus, the concerns raised by Wyngaarden in his seminal paper ring as true today as they did nearly 4 decades ago. Those who have continued to pursue careers in translational science with the goal of true bench-to-bedside application of research continue to face an uncertain funding and career landscape in an academic system designed to *primarily* reward novelty over methodological rigor and translation. Accordingly, an environment with a paucity of stage III translational and confirmatory research is created, which has resulted in well-documented issues of irreproducibility in preclinical research and high rates of attrition in the early phases of clinical development.[4] With an aging population and an increasing burden of chronic cardiovascular disease,