Emerging clinical scientist paradigm: a call for spectrum recognition in team science

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Team science[1]—what a concept! To many, the idea that a group of scientists can work together on a common problem and seek collective answers leading to success seems almost intuitive. Yet the practicality and value of the concept is only now beginning to be fully recognized. Part of this may stem from classical training moors where basic scientists talk among themselves but seldom to clinical trialists who talk among themselves but not much to population scientists. And the nascent field of implementation science is in its relative infancy as a formal discipline. This creates a conundrum because relatively few translational scientists have cross-training between disciplines and, in many cases, have little idea of the methodologies or interpretation of data generated by these different research groups. For all of these reasons and more, a broader approach to training and interaction between physician scientists with diverse clinical and research backgrounds to give due consideration for the spectrum of translational science is desperately needed.

The translational research continuum has expanded well past the traditional "bench-to-bedside" paradigm that has been used for decades.[2] Currently, the paradigm is designed to engage research and development of a therapeutic entity from basic ("bench") research (T0) that aims to define normal or pathologic physiological mechanisms that may become therapeutic targets. Preclinical animal models (T1) are designed to demonstrate in vivo therapeutic activity and various stages of clinical ("bedside") trials (T2) seeking to verify adequate safety and efficacy properties of the therapeutic agent that may lead to FDA approval.[3] The relatively new component of translational research called implementation science (T3) studies methods and potential obstacles to the successful utility of the targeted therapy in the population of interest.[4] The final stage (T4) is population ("curbside") research where the impact of the therapy on health measures of populations of interest are characterized.[5] This discipline has expanded significantly in recent years using integrated population and molecular technologies involving big data analyses to address public health issues and policies. This comprehensive research approach is the updated paradigm for bench-to-bedside-to-curbside necessary for the widest distribution of effective therapeutic approaches for all who need and can benefit from it.

This well-developed theoretical approach has developed from the early days of biomedical research that began in the US postwar 1950s and in earnest in the 1960s when the National Institutes of Health (NIH) began formal efforts through formation of the Medical Scientist Training Program (MSTP) in 1964.[6] Over the last 56 years, over 10,000 US-trained MD-PhDs have benefited from the MSTP. Yet not all US medical schools have MSTP funded grants and not all MD-PhD graduates go on to pursue research-focused careers, either leaving during subsequent residency or fellowship training or later as often frustrated junior faculty who are not successful in receiving extramural funding. Early in the MSTP years, the typical departmental paradigm for young translational research faculty was to provide institutional funded (sometimes from senior investigator direct and indirect grant funds) "protected time" for the faculty member to develop his (and sometimes her) research program, publish and apply for extramural funding—the coveted "R01". To their credit, these young people typically settled for much lower salaries than their community practice colleagues but because of student financial support typically did not finish training with the debt load so common among today's medical school graduates. As time progressed and economic pressures reduced the number of senior investigator grants (along with their indirect funds), fewer and fewer institutions could afford to provide funding for any meaningful protected time for young faculty who were not already highly likely to succeed in grant applications when they were first recruited. This has led to a relative shortage of clinical faculty who can and should be part of the translational research team further along in the translational research spectrum (ie, T2–T4) particularly in those institutions that do not have a large extramural funded research base among basic and clinical science departments.

This US biomedical research conundrum is not unlike that seen in other parts of the world but with an alarming difference. Whereas the financial issues for American medical graduates remain seriously underfunded, the emigration of foreign-trained medical scientists continues to increase. In many institutions, their training

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has been largely subsidized by their own national medical education system releasing them from the often crushing debt load that plagues many American medical graduates.[7] While many international graduates remain in the USA to pursue successful careers here, others take the wealth of knowledge, education, and experience gained during their stay in the USA back to their home countries to continue important research funded by their governments with different criteria for receiving research-related grants. The all too often net effect has been an increased risk for intellectual and technological stagnation (sometimes years later) and subsequent movement of innovative effects to other parts of the word. This is a dilemma that must be addressed and solved if we are to maintain our global leadership position in translational research.

The critical importance of translational research has expanded well beyond drug-device development to include the growth of new knowledge in each area of translational science. The importance of developing team science to solve our most challenging clinical science questions has been manifest in important ways particularly by the NIH who developed the National Center for Advancing of Translational Science (NCATS).[8] The stated intent of NCATS is to bring "more treatments to more patients more quickly". The seminal funding mechanisms from NCATS is the establishment of multiple research centers funded through the Clinical Translational Science Award (CTSA) program. This exciting program which is currently funding over 50 CTSAs around the country is focused on teaching integration of translational research technologies to established and new translational scientific teams.[8] The NCATS program stresses learning and developing true interdisciplinary collaborations between translational scientists within the funded institutions as well as between CTSA centers with the intent of developing infrastructures for the rapid translation of scientifically sound principles into clinically useful therapies then monitoring impact on various target populations.

With all of these opportunities and breadth of interest available, it would seem that young physician scientists should be in plentiful supply in academic medical centers. Yet this is simply not the case. Warnings about diminishing physician scientist supply in all disciplines have been sounded for over two decades.[9] Why is this the case? It begins with the (outdated) notion that all successful physician scientists must be "triple threats" (NIH-funded, high-level educator and accomplished clinician). While this may still be true in some centers with well-defined tracks, most medical school clinical faculty are required to have a substantial clinical load to maintain salary support. Even with investigators who have substantial NIH funding percentages, there are relatively few whose effort is 100% covered by NIH funds necessitating additional funds generated from clinical activity. Thus, their allegiance often is necessarily split between achieving relative value units targets and generating data for career advancement (promotion) and extramural funding. This divided priority structure usually comes from department chairs under pressure with increasingly challenged budgets from institutions that are often perpetually underfunded for the scholarly productivity that they desire to maintain. Add to this academic conundrum expectations to mentor clinical trainees from medical students to residents and fellows on rounds and in clinic as well as providing uncompensated lectures which require additional preparation time. All of this activity (although usually very personally fulfilling to the young faculty member) takes time away from research efforts that must have some level of extramural funding to be sustainable. Successful funding becomes a significant challenge (particularly with competitive applications from NIH and national disease-specific societies) because these busy young multitasking clinician scientists often compete with other research-focused applicants who enjoy considerably more protected research time and are often further along in their investigator development pathway. This brings up the conundrum of needing "protected time" to generate data for independent investigator funding, but this protected time is often available only to those who can pay for it (eg, already extramurally funded).

The problem can be made worse for some clinician scientists by the specific area of translational science that the individual faculty member chooses. In particular, a clinical trialist is sometimes not considered to be doing "real" research especially if they are participating in industry-sponsored trials. However, the very structured nature of these industry-sponsored trials provides excellent training opportunities for young investigators in the details of well-conducted T2 research studies as well as potential financial benefits to support salary and/or provide funding for other research projects. This training and financial benefit can lead to expanded opportunities such as investigator-initiated trials funded by industry or other private funding sources.[10] In addition, NIH funds clinical trials through a variety of mechanisms including R43/44 and more traditional R awards (R01, R03, R21, R35, etc) are clinical trial focused and can be successfully obtained by clinical trialists with demonstrated (eg, published) expertise and track record.

Another translational emphasis that is under-represented in clinician scientists is population science. Some physicians, often during their postgraduate training or early faculty appointments, obtain a Masters in Public Health degree which can provide the academic pedigree for population health research. If the medical center has a School of Public Health and/or an active epidemiology research group, a young clinician scientist can pursue this form of academic research development for career advancement. However, the challenges as noted previously can apply to this research track emphasis as well particularly since nonfederal research funding sources are often quite limited for population health–focused investigations. This is another example of how collaborations with basic and clinical science colleagues can be useful to the young population scientist.

With all of these challenges identified and the clear value of a clinician scientist as a member of the translational research team established, how can the junior clinician scientist progress in today's academic environment? The clear answer lies in the team science approach. The first step is to find a mentor or mentoring committee. This should ideally come from a senior departmental faculty member (such as a vice chair for faculty development) who can help the young clinician scientist define his/her research interests then pair them with a more established investigator with similar interests either inside or outside the department.

Some form of protected time must be considered even if it is limited in the beginning. Establishing joint basic-clinical science conferences can help everyone on the transitional research team—the clinician researchers can learn both current basic science and have discussions about nuances of experimental design, research technology, and data acquisition and analysis. The basic scientists can learn more about the "so what" of their study results in terms of clinical applicability and next steps.

There are other ways for mutual support between basic and clinical departments. Cross-appointments for faculty can provide a natural connection for future grant applications as the young people mature into scientists with meaningful potential for extramural funding. Most funding agencies have some form of multi-PI mechanisms available. So a clinician scientist on a basic mechanism application can add expertise that reviewers may find attractive depending on the translational level of the application. This can be useful whether the young clinical faculty serves early as a co-investigator or later in development as a multi-PI.

The major thrust of all these components of team science is to promote the development of diverse clinician scientists both in clinical as well as translational research expertise. In today's academic medical school environment, diverse responsibilities for young faculty with considerable potential as translational researchers threaten the academic faculty structure. There are multiple distinct values for clinician scientists, and this challenge must be met head on by academic leaders including division directors, chairs, and deans to the highest level of campus leadership. Diversity in the translational research portfolio for these young clinician scientists must be promoted and maintained.[11] The future research developments that will rapidly and effectively help our patients depend on it.

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