

Rebuilding the Pipeline of Investigators in Nephrology Research in the United States

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Introduction

The increasing prevalence of kidney diseases in recent decades has vastly outpaced the slow growth of the nephrology workforce. The resulting shortage of nephrologists has consequences not only for medical practice but also, for nephrology research, which—in research funded by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)—has historically been more MD driven than in other fields. Rebuilding a robust pipeline of investigators in nephrology research will require fresh perspectives on the composition of the research workforce and novel strategies for engaging and supporting talented scientists.

Nephrology Workforce Challenges: Slow Growth, Accelerating Need Clinical Workforce

Clinical nephrology workforce challenges are well documented (1–5). Approximately 60% of nephrology training tracks and 40% of nephrology training positions remained unfilled in 2016–2018 match years (3). Although recent National Resident Matching Program data suggest that the sharp spike in unfilled nephrology fellowship tracks and positions has begun to level off (3), much work remains.

Research Workforce

The nephrology community identifies workforce challenges as a major concern for advancing kidney research (1). Indeed, these issues are increasingly reflected in the NIDDK kidney research portfolio. An analysis of competing independent research grants (R01) showed that kidney research has accounted for a decreasing share of the NIDDK applications, awards, and total dollars between 2011 and 2017 (Table 1). Furthermore, the NIDDK has seen the share of kidney R01 awards led by principal investigators with MDs drop from 52% in 2011 to only 29% in 2017 (Figure 1), a trend driven by decreasing numbers of MD-led applications and increasing numbers of PhD-led applications. Additionally, the success rate (awards divided by applications) for MD investigators proposing kidney research has declined relative to that of their PhD and MD/PhD counterparts. These data raise critical questions about who will make up the nephrology research workforce and how best to recruit and train them.

Training is a particular challenge for the growing proportion of nephrology fellows who are non-United States medical school graduates (3), the majority of whom lack permanent United States residency and are excluded from traditional sources of research training funds, including most from the National Institutes of Health (NIH).

Accelerating Need

The somber picture of the nephrology workforce is bleaker in context of the rising numbers of people living with kidney diseases (6). In addition to fueling the demand for practicing nephrologists, this increased prevalence creates an ever more pressing need to engage and cultivate a diverse group of talented investigators capable of generating the scientific breakthroughs that will yield effective treatments.

Rebuilding the Pipeline

Keeping scientists engaged in nephrology research will require focused efforts to do the following.

Expand and Improve Nephrology Research Training Opportunities

More stable training opportunities must be made widely available early and throughout the research career, especially for individuals from populations under-represented in biomedical science. As previously suggested (1), these efforts must begin before graduate or professional school, providing research experience for high school and undergraduate students. To support young researchers during their progression toward independence, bridge programs must be expanded to enable stable transitions from fellowships to Career Development (K) Awards to R01s. Finally, continued efforts to extend the NIH training opportunities to non-United States medical school graduates who commit to conduct research in the United States may help develop and retain talented researchers in nephrology.

The NIDDK and other institutions must continuously evaluate and improve training programs. Effective programs should be expanded, and less effective programs should be discontinued or modified to address shortcomings. On the basis of such

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Table 1. Percentages of the National Institute of Diabetes and Digestive and Kidney Diseases applications, awards, and total dollars focused on kidney disease, 2011–2017

R01	2011	2012	2013	2014	2015	2016	2017
Applications	489/2317 (21%)	441/2241 (20%)	420/2329 (18%)	451/2434 (19%)	478/2737 (17%)	474/2935 (16%)	474/2766 (17%)
Awards	103/452 (23%)	74/372 (20%)	68/369 (18%)	98/474 (21%)	74/406 (18%)	88/518 (17%)	76/417 (18%)
Total dollars (millions)	42.2/195.4 (22%)	29.9/144.4 (21%)	23.8/140.7 (17%)	39.3/194.1 (20%)	30.6/174.0 (18%)	36.3/229.0 (16%)	32.5/191.7 (17%)

evaluation and feedback from the nephrology community, the NIDDK recently: 1) expanded the R25 Program to support early recruitment of undergraduates into kidney research, 2) increased support to individual fellowships, and 3) developed funding mechanisms (F99/K00, K99/R00) to support more stable transitions (1). The new F99/K00 aims to capture outstanding graduate students (including non-United States citizens) and provide a stable path to a post-doctoral fellowship in kidney research. Existing NIDDK research training opportunities are described at <https://www.niddk.nih.gov/research-funding/training-career-development>.

Recent evaluations of the NIDDK postdoctoral training programs suggest considerable variability in successful transition to subsequent NIH grants for trainees whose training ended between 2005 and 2010. Institutional training grants (T32s) had the lowest rate of trainees obtaining funding, with 21% receiving any subsequent grant and only 5% receiving an R01. This compares with the 42% of individual fellowship (F32) trainees who received a subsequent grant and 23% who received an R01. K awardees had the highest rate of transition to subsequent support, with 66% receiving a follow-up award and 49% receiving an R01. Compared with their PhD and MD/PhD counterparts, trainees with MDs are less likely to receive a subsequent

award when supported by a T32 or F but just as likely when supported by a K. A more comprehensive training analysis is clearly warranted and underway. In particular, the NIDDK is exploring strategies to improve successful retention of MDs trained *via* institutional T32 programs.

Integrate Transdisciplinary Approaches into Nephrology Research Training

Nephrologists are responsible for major previous advances in kidney research and provide essential clinical insight. However, the plight of the physician scientist remains (7), and clinical realities—including fewer hours available for research—may make relying predominantly on nephrologists to conduct nephrology research unsustainable. Furthermore, increasingly complex research questions may be best addressed by transdisciplinary teams. Training nephrologists in kidney research alongside scientists from other disciplines (*e.g.*, critical care, primary care, basic scientists, epidemiologists, engineers, social scientists, *etc.*) may extend the reach of nephrologists and better equip trainees from all academic backgrounds to tackle emerging challenges in nephrology. To facilitate participation of diverse researchers in kidney research, the NIDDK recently enhanced training offerings for nonmedical graduate and dual degree students and will continue to explore

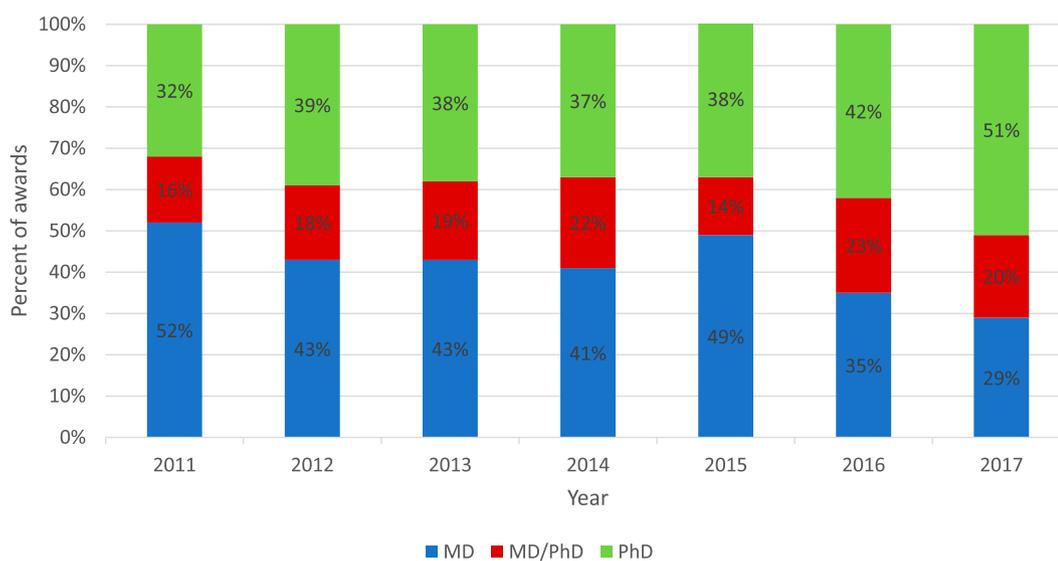


Figure 1. | Share of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) kidney competing R01 awards by degree. Within the NIDDK portfolio, the proportion of kidney-related R01 awards led by MDs has decreased over time relative to those led by other degree holders. PhDs have accounted for an increasing share of funded R01s, growing from 32% in 2011 to 51% in 2017, whereas MDs have accounted for a decreasing share, dropping from 52% in 2011 to 29% in 2017. MDs/PhDs have accounted for a relatively constant share.

opportunities to enable funding of the most promising kidney science by the most capable and talented investigators—regardless of degree.

Coordinate Training Efforts across the Nephrology Community

Fostering interest in kidney research among a talented and diverse cadre of physician and nonphysician scientists will require continued efforts from all stakeholders, including the NIH, academia, and professional associations. Each must continue to leverage their unique position to develop, evaluate, and enhance initiatives, which together can provide the training, mentorship, and support that will allow the next generation of talented research scientists to flourish in nephrology.

Attract Top Talent with Innovative Science

Several recent NIDDK projects, described previously (8,9), are intended to improve our understanding of human kidney biology, physiology, and disease [e.g., Kidney Precision Medicine Project, (Re)building a Kidney] and treatment options (pragmatic trials). Just as importantly, these efforts are intended to attract the best and brightest investigators—from all career stages and communities—into kidney research.

Conclusions

From basic science to precision medicine to pragmatic trials, future kidney research holds numerous exciting opportunities and novel challenges. Concerted efforts across the nephrology community are needed to rebuild a robust pipeline of researchers capable of leveraging these opportunities, achieving scientific breakthroughs, and ultimately, improving care for individuals with kidney diseases. More stable training support incorporating transdisciplinary approaches and experiences must be initiated early in the careers of scientists from diverse academic and demographic backgrounds. Support and coordination across all nephrology research stakeholders are essential to bringing these changes to fruition.

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Disclosures

None.

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