Academic Interventional Nephrology: A Model for Training, Research, and Patient Care

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Summary
Dialysis vascular access dysfunction is currently a huge clinical problem. We believe that comprehensive academic-based dialysis vascular access programs that go all the way from basic and translational science investigation to clinical research to a dedicated curriculum and opportunities in vascular access for nephrologists in training are essential for improving dialysis vascular access care. This paper reviews the fundamental concepts and requirements for us to move toward this vision.


Over the last 5 years, there has been a rapid growth in the number of dialysis access procedures (both for hemodialysis and peritoneal dialysis) performed by nephrologists interested in dialysis access or the interventional nephrologist (1–10). What started as an attempt by individual practicing nephrologists to provide optimal vascular access care to their patients has now expanded into multiple interventional nephrology centers (free-standing office- and hospital-based programs) that provide care outcomes that are comparable with those provided by surgery and radiology (11). The exact proportion of procedures currently performed by nephrologists is unclear, although recent financial data from the US Renal Data System suggest that surgeons, radiologists, and nephrologists are responsible for approximately 35%, 30%, and 25%, respectively, of vascular access costs, with the balance being split between anesthesiology and other specialties (12). The rapid growth of this young specialty has been greatly helped by the establishment of the American Society of Diagnostic and Interventional Nephrology, which has provided guidelines and support for the accreditation of interventional nephrologists (13,14).

The growth of interventional nephrology has been primarily in the private practice setting because of (1) the difficulties in establishing such programs in large academic centers and (2) the direct financial benefits of such interventional programs to large nephrology practice groups. More recently, such programs have also been started within academic centers (2,15). The number of such centers is likely to grow, and a survey in the work by Berns and O’Neill et al. (16) suggested that 20–30% of academic training programs in nephrology either had or were planning to set up an interventional nephrology program. However, the presence of an interventional nephrologist within an academic program does not automatically translate into an academic dialysis access center as described below in that, if fellows are indeed trained in procedures, their overall exposure is often short (less than 3 months). In this context, it needs to be emphasized that, as of last year, there were less than five centers that had a full 1-year interventional nephrology fellowship, and not all of these centers were academic centers. In addition, there are almost no academic centers that have clinical and basic science research programs.

It is our belief that interventional nephrology has reached the point where it needs to transform itself into a distinct discipline within nephrology that is focused on the multidisciplinary problem of dialysis access dysfunction. More importantly, it needs to be recognized as a key player within a multidisciplinary consortium of specialties focused on the improvement of dialysis vascular access care. To achieve this goal, however, interventional nephrology needs to become a well-rounded entity that encompasses not only patient care but also teaching and research. Although interventional nephrology will always have a strong base in private community practices and hospitals (which is true for many specialties in this country), there is a substantial need for the establishment of several academic dialysis access centers (ADACs). These centers would be essential for transforming interventional nephrology into a distinct discipline within nephrology similar to transplant nephrology. The purpose of this review is to articulate a pathway for this potential transformation of interventional nephrology within academic programs.

These ADACs (Figure 1) would perform three functions: teaching and training, clinical research, and translational or basic science research.

Teaching and Training
General Nephrology Fellows
In a manner akin to transplant nephrology, we believe that nephrology fellows should be exposed to a...
structured curriculum in interventional nephrology, which was first suggested by Saad (17) almost a decade ago (18). The learning goals for this would focus around the following core concepts: (1) an understanding of the pros and cons associated with the different access choices, (2) learning how to develop a life plan that is individualized for each patient and optimally uses all the different types of vascular access and also peritoneal dialysis (PD), and (3) learning how to do the access physical exam with an emphasis not just on the technique but also the rationale, the interpretation, and the follow-up actions that are needed. It is anticipated that these goals could be achieved through (1) a dialysis access (both hemodialysis and PD) lecture series; (2) rotation with an interventionalist (radiologist/interventional nephrologist/surgeon) to observe endovascular procedures and PD catheter placement and to learn the basics of physical examination, which we believe is absolutely fundamental to nephrology training; and (3) rotation with a surgeon for an understanding of the issues involved in the placement of arteriovenous fistulae, polytetrafluoroethylene grafts, and PD catheters. Although the actual performance of interventional procedures by the general nephrology fellow is not required, it is possible that interested and motivated general nephrology fellows will learn to place tunneled dialysis catheters.

Finally, these academic centers would jointly take the lead in disseminating dialysis access modules developed by them for general nephrology trainees, to all the nephrology training programs in the country. Individual ADACs would take on regional training activities for identified faculty within nephrology training programs in their immediate vicinity that do not have interventional nephrology programs (train the trainer courses).

Interventional Nephrology Fellows

Interventional nephrology fellowships would be initiated within these ADACs, which would involve the establishment of year-long training programs (with a structured curriculum) in interventional nephrology that would incorporate multiple modules. These modules would allow the trainee to (1) understand the biology and epidemiology of dialysis access, (2) attain expertise in a wide array of interventional procedures (angioplasty and thrombectomy of arteriovenous fistulae and polytetrafluoroethylene grafts; tunneled dialysis catheter placement, replacement, and removal; venograms, ultrasound examination of the vascular access, and PD catheter placement), (3) undertake a research project in the field of interventional nephrology with at least a basic understanding of the fundamental tenets of clinical trial research (including establishment of a database), and (4) understand and appreciate the multidisciplinary nature of dialysis access with at least some time spent in a surgical setting. Such a program would, therefore, go all the way from the biology and epidemiology of dialysis access dysfunction to the actual performance of interventional procedures to databases and clinical/outcomes research in this area; the output would be a well rounded physician versed in the pathogenesis, pathology, diagnosis, and treatment of dialysis access dysfunction. This training would result in recognition by organizations such as the American Society of Diagnostic and Interventional Nephrology and potentially, other societies.

In addition, interventional nephrology fellows interested in clinical, outcomes, or basic research would be encouraged to undertake additional training in clinical research that would lead to a Masters in public health or epidemiology or a more in-depth immersion in laboratory research (see below).

Finally, it is likely that the potential for acquiring interventional nephrology skills will attract trainees with a mix of procedural and intellectual interests and strengths in nephrology, who may, in the long run, enhance the stature and standing of not only interventional nephrology but also nephrology as a whole.

Clinical Research

A recent study by Kian and Asif (12) documents a significant increase in the number of manuscripts being published...
in this area, but they also point out that the majority of these publications were descriptive in nature, emphasizing the enormous need for high-quality research in this area (12). These ADACs would, therefore, be involved in active clinical and outcomes/quality improvement research (both industry- and investigator-initiated). Possible examples of such clinical research activities could include (1) identification of clinical and biologic predictors of dialysis access failure, (2) identification of process of care barriers to successful dialysis access placement and maintenance, (3) testing of novel devices to prevent stenosis, thrombosis, and infection, and (4) application of advanced imaging technology for the early identification of dialysis access dysfunction. These studies would require the participation of trained clinical research personnel with the ability to accurately collect and tabulate data (familiarity with databases) under the overall supervision of a principle investigator trained in clinical research methodologies. This process is particularly important, because we believe that interventional nephrology is currently a fertile substrate for the conduct of large, randomized multicenter trials. The publication of three large randomized studies in this field over the last 2 years is an important step in the right direction (19–21), but numerous unanswered questions remain. Establishment of clinical research centers focused on dialysis vascular access within the ADACs (funded through both the federal government and industry sources) could help to answer some of these questions and also improve the current dismal record of nephrology as a whole with regard to randomized clinical trials (22).

Translational or Basic Science Research
If possible, the ADACs would also be expected to establish basic or translational research programs (ideally supported through federal funding) in dialysis vascular access, although we recognize that academic programs with strong clinical research programs alone could also be very successful ADACs. We emphasize that dialysis vascular access could be ideally suited to translational research in areas such as (1) the pathogenesis of neointimal hyperplasia, (2) the use of local therapies (drugs, genes, cells, chemicals, and devices) to enhance vascular dilation and at the same time, inhibit neointimal hyperplasia, and (3) the development and application of powerful imaging techniques, including the use of computational fluid dynamics. In particular, it is likely that translational research in vascular access will result in the introduction of bioengineering, nanotechnology, and advanced imaging expertise within academic divisions of nephrology, which could then crossfertilize other more traditional renal areas, such as acute kidney injury and transplantation. In support of this concept, the American Society of Nephrology now has an abstract category called Bioengineering and Informatics.

As for the clinical procedures, translational and basic science research in this field would also benefit from a multidisciplinary approach, particularly in the context of collaborations with vascular biologists, molecular biologists, cardiologists, engineers, and individuals in the medical device industry. A particularly important interaction at the clinical, translational, and basic science levels would be the relationship (hopefully win–win) between the large dialysis organizations and the ADACs. In addition, it would be expected that such centers would also compete for research training program grants, such as the T32 training grant program, from the National Institutes of Health.

Finally, at a practical level, we would expect trainees to follow one of three pathways:

- A full 1-year interventional nephrology fellowship (after completing a general nephrology fellowship) with the expectation that a research project resulting in a manuscript will also be completed.
- A full 1-year interventional nephrology fellowship followed by 2 years of dedicated research in the field or alternatively, 2 years of a combination of research and part-time Masters degree in Epidemiology/Public Health or a similar subject (after completing either a general nephrology fellowship or the minimum clinical nephrology training requirement).
- Two years of dedicated research in this area after the required minimum clinical nephrology training without interventional training; this latter pathway would apply to nephrology fellows who want to do research in this area but do not want to become interventionalists.

The establishment of active research programs in these centers will reinforce the scientific uniqueness and financial viability of translational and basic science research in this area. This reinforcement will be apparent to nephrology division directors and program directors as well as the nephrology community as a whole and the multiple different specialties involved in the care of the patient with dialysis access dysfunction.

Interventional Training Curriculum
To stimulate education, clinical research, and translational and basic science research as part of the interventional nephrology training process, the Interventional Nephrology Advisory Group of the American Society of Nephrology has established a training curriculum, which could potentially be used by such centers. The purpose of this work is to define a comprehensive curriculum for academic-based interventional nephrology training programs. Although it may not be practical for some academic interventional nephrology training programs to provide the complete level of training described in the curriculum, all programs should strive to achieve these curricular goals in each component included in their program. The curriculum is designed to outline an additional up to 12-months training period for physicians who have completed their general nephrology fellowship and wish to pursue a career in interventional nephrology.

The curriculum outlines educational goals, provides a definition of primary operator, and identifies the following core areas of training: endovascular procedures, peritoneal catheter procedures, ultrasound, radiation safety, scholarly activities, and office management. The curriculum describes evaluation parameters according to the six core competencies of training, which include patient care, medical knowledge, practice-based learning, interpersonal and communication skills, professionalism, and systems-based practice.

In summary, we believe that the maturation of interventional nephrology into a distinct discipline within nephrology (similar to transplantation) with the ability to provide state of
the art dialysis access clinical care to dialysis patients, perform high-quality research, and establish well rounded training programs will (1) result in significant improvements in the care of dialysis patients, with a concomitant reduction in the costs associated with dialysis access dysfunction; (2) make nephrology a more attractive career option for internal medicine trainees; (3) facilitate the introduction of advanced clinical and research technologies, such as functional imaging, nanotechnology, computational fluid dynamics, and local therapies (drugs, cells, genes, chemicals, and devices) into the ambit of nephrology; and (4) provide a model for high-technology, patient centered, multidisciplinary care. To achieve these goals for interventional nephrology, however, it is critically important to obtain support for this endeavor from within nephrology (division directors and fellowship training program directors), internal medicine (department of medicine chairs), and academic specialties that are important partners in the care of patients with dialysis access dysfunction (radiology, transplant surgery, vascular surgery, and dialysis nursing).

Disclosures
None.

References

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