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Short Report

Advanced dialysis fellowship

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End-stage renal disease (ESRD) requiring dialysis or transplantation once thought to be an orphan disease now affects over 400,000 patients in the United States.[1] Currently, renal transplantation offers the best option for renal replacement therapy. However, majority of patients with ESRD are treated by dialysis. Significant advancements have been made in dialysis technology since chronic dialysis became a viable option in 1960 when Dr. Belding Scribner successfully connected an artery and vein with Teflon tubing permitting repeated access to the circulation for the purpose of performing long-term hemodialysis.[2] Over the past 50 years, the knowledge and understanding of the management of dialysis equipment and care of the dialysis patient has grown considerably. The potential for harm from improper management of dialysis patients in addition to the unawareness of complex reimbursement policies and regulatory oversight rules is ever present. The landscape of regulation and repayment for the services provided continue to be dynamic with strong focus on quality and outcome measures. Modifications are made yearly, and reimbursement for dialysis has become the first program to mandate penalties to dialysis providers for failure to meet quality benchmarks. As a nephrology trainee, it is often a daunting challenge to understand both the technical complexities of dialysis and the regulatory requirements that are incumbent on dialysis providers.

The duration of a typical nephrology fellowship is 2 to 3 years depending on whether a trainee is pursuing a research or clinical career. Due to the growth in all fields of nephrology, epidemiology, and laboratory science, there is a wealth of knowledge the trainee must master in this short period of time. Given the complexities of both the technical and logistical aspects of dialysis, it is important to provide trainees with the option of advanced training in this critical area of nephrology. Besides focusing on clinical and academic training, trainees may often feel a desire to participate in innovation or to become a medical director of dialysis unit. However, there is a lack of established training programs to help fulfill such objectives. In general, there is a lack of thorough understanding of the engineering and technical components of a dialysis machine and related technologies as it is not mandated to be taught to nephrology trainees by the Accreditation Council for Graduate Medical Education (ACGME). The lack of exposure to the technical aspects of dialysis has led to a dearth of interest or focus on improving the existing technology. Early innovations in dialysis technology relied heavily on clinician guidance and collaboration with scientists, engineers, and technicians.[3] Although dialysis technology has been refined over the years, not much progress has been made to bring additional technology and significant innovation to improve the morbidity and mortality of ESRD patients. The lack of structured mentorship and training has likely resulted in scarcity of clinician-driven innovation and research in the field of dialysis. Similarly, trained nephrologists also have only a minimum or no knowledge of regulatory issues associated with ESRD care. To address this gap in training, the University of Washington in collaboration with the Northwest Kidney Centers has created a 1-year advanced dialysis fellowship. The primary goals of the advanced dialysis fellowship are listed in Table 1.

Recognition of the necessity of such a fellowship came from the Division of Nephrology at the University of Washington under the leadership of Professor Suhail Ahmad. Early work and collaboration with the Northwest Kidney Centers led to the support of nephrology fellows in the form of both education and funding. The Northwest Kidney Center is a small non-profit dialysis provider serving the majority of dialysis patients in the northwest Puget Sound region with a mission of promoting the

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Table 1 Objectives of the advanced dialysis fellowship

- Perform a technical research project to gain a deeper understanding of the technical workings of dialysis machines and associated technologies.
- Perform clinical research to gain insight into current clinical challenges.
- Gain expertise in the regulatory and administrative requirements of dialysis providers.
- Participate in quality assessment and improvement toward better care of dialysis patients.

optimal health, quality of life, and independence of people with kidney disease, through patient care, education, and research. The unique relationship with University of Washington allows the fellows access to the inner workings of a dialysis provider through attendance at medical director meetings, medical staff meetings, and quality assessment and performance improvement committees.

The advanced dialysis fellowship is recognized and endorsed by the International Society for Hemodialysis (ISHD). Recognizing the need for advanced training in dialysis, ISHD has also set up an accreditation committee for similar programs by other institutions in future. The inauguration of the fellowship was in 2008, with Dr. Robert M. Winrow as its first fellow. Since then, there has been an enrollment of a fellow for each subsequent academic year. The founder of this fellowship, Dr. Suhail Ahmad, has participated in the evolution and innovation of dialysis therapy for a number of years. He envisions to bridge the divide between the clinician and inventor, ultimately leading to improved therapies for patients suffering from ESRD. A summary of the graduated fellows achievements and clinical focus is presented in Table 2.

A key element in the success of such a fellowship has been a multidisciplinary approach with active collaboration between the varied disciplines/professionals such as engineering, dialysis technicians, and scientists. During the dialysis fellowship, fellows are required to complete both a technical and clinical project in the area of dialysis. Pursuing these projects has led to lasting collaborations that have resulted in novel ways to provide dialysis such as online hemodiafiltration via a simple modification of the current hemodialysis machine using existing dialysis technology, and modified recycled albumin dialysis for the treatment of end-stage liver disease as a bridge to liver transplantation. Both of these therapies have been safely used at the University of Washington and Northwest

Table 2 Advanced dialysis fellows, their research focus, and publications

Trainee: year	Research focus	Publications
Robert M. Winrow, MD (2008–2009)	Intraoperative dialysis and citrate anticoagulation in liver failure Modified albumin dialysis Research thesis: non-biological extracorporeal liver support devices Online hemodiafiltration	Winrow RM, Davis C, Halldorson JB, Ahmad S. Intra-operative dialysis during liver transplantation with citrate dialysate. Case report. *Hemodial Int*. 2009; 13:257–260.
Jimmy S. Wu, MD (2010–2011)	Liver dialysis, clinical application	Bi S, Linke L, Wu J, Cheng L, Wang T, Ahmad S. Effects of beta-blocker use on volume status in hemodialysis patients. *Blood Purif*. 2012; 33(4):311–316.
Scott D. Bieber, DO (2011–2012)	Delivery of gene therapy utilizing a extracorporeal circuit Delivery of oxygen to a extracorporeal circuit in a novel fashion Online hemodiafiltration	Bieber S, Halldorson JB, Finn E, Ahmad S, Chamberlain JS, Odom GL. Extracorporeal delivery of rAAV with metabolic exchange and oxygenation. *Sci Rep*. 2013; 3:1538. Bieber S, Ahmad S. Electron-beam sterilized hemodialyzers and thrombocytopenia. *JAMA*. 2012; 307(7):665.
Raj Munshi, MD (2012–2013)	Green dialysis Patient and technique survival among home dialysis modalities Phosphate-binding gum	Munshi R, Ahmad S. Comparison of urea clearance in low-efficiency low flux vs high-efficiency high flux dialyzer membrane with reduced blood and dialysate flow: An in-vitro analysis. *Hemodial Int*. 2014; 18:172–174.
Kathryn Treit, MD (2013–2014)	Dialysate sodium effects on volume status/hypertension Outcomes of acute renal failure requiring outpatient dialysis	Treit K, Lam D, O'Hare AM. Timing of dialysis initiation in the geriatric population: Toward a patient-centered approach. *Semin Dial*. 2013; 26(6):682–689.

Kidney Centers. Other innovations have included extracorporeal circuits designed to deliver oxygen in a simple fashion and technologies to deliver regional circulating drug therapies to isolated tissue beds. Methods to improve the conservation of water and adaptation of technologies to recycle pure water from wasted dialysate are also being studied.

This additional year of training provides fellows with an insight into the historical evolution of our current management guidelines for measures such as dialysis dose, salt and volume control, hypertension, anemia management, and bone metabolism. Fellows spend additional time in the dialysis units with dialysis technicians, learning how dialysis machines are built and maintained, i.e., learning the "guts" of the dialysis machine. Fellows also get the opportunity to spend time with water system technicians and monitor dialysis center water quality. The integration of the dialysis fellow into Northwest Kidney Centers allows fellows to be exposed to dialysis facility problems such as water purity and get an opportunity to troubleshoot day-to-day problems that dialysis nurses, water technicians, machine technicians, and managers come across. Time is spent focusing on areas where the typical nephrologist does not interface in dialysis care. It is this deeper understanding that is lacking among younger nephrologists. This allows a trainee to identify limitations of the current technology and lean toward adopting the philosophy of an innovator and problem solver.

The advanced dialysis fellowship provides the most comprehensive exposure to the regulatory aspects of dialysis care, and is an effective avenue to further one's training toward becoming a medical director of a dialysis unit. In current practice, new medical directors are expected to learn on the job resulting in a steep learning curve and reliance on local medical directors for guidance. The advanced dialysis fellows are more comfortable assuming a leadership role in dialysis organizations for a variety of reasons. The trainees are invited to attend meetings for Northwest Kidney Centers as it builds its policy to optimize patient care and comply with the Centers for Medicare and Medicaid Services. Fellows are exposed and actively involved in meetings that review financial goals, conditions for reimbursement, and create action plans to provide optimum care under the current economic limitations.

As the advanced dialysis fellowship gains momentum, the hope of the authors is to expand the focus from predominantly in-center chronic hemodialysis to include a robust home dialysis component. The path to potential innovation will rely on collaboration with various fields of thought, as these collaborations have been proven to be successful in the past.[4] One of the authors, R. M., was the first pediatric nephrology fellow to join the advanced dialysis fellowship and hopes that some of these innovations will address the limitation of current technologies in providing renal replacement therapies for infants and young children.

In short, the advanced dialysis fellowship was created to allow the clinician with an academic interest in dialysis to begin to grasp the complexity of the technology involved in renal replacement therapy, its governmental regulations, and to identify limitations of dialysis therapy that can then be improved. The ongoing goal is to create an environment of innovation where scientists, engineers, clinicians, technicians, nurses, and pharmacists work in concert toward improving care of ESRD patients.

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