When Is the Right Time for Arteriovenous Fistula Placement in Patients with End-Stage Renal Disease?

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Vascular access for hemodialysis patients has a significant impact on the morbidity and mortality of patients with end-stage renal disease (ESRD). Although significant improvements in the number of patients with arteriovenous fistula (AVF) access in the United States have been made, 80% of patients in the United States that start hemodialysis have a catheter access [1]. While cardiovascular disease is the leading cause of death in patients with ESRD, the second most common cause is infection. Mortality is common in the first year after initiation of hemodialysis from bacteremia and sepsis from catheter access [1, 2]. Delay in AVF placement leads to increased reliability on catheter access which contributes significantly to morbidity, mortality and cost of providing hemodialysis.

The timing of AVF placement and avoidance of catheter access is critical to the successful transition from chronic kidney disease (CKD) to ESRD with hemodialysis. A staging system for CKD has been developed, which has identified specific interventions to enhance the health and outcomes of patients with ESRD. While these stages have been an effective means of communication among disciplines, they have not been able to determine the optimal time for AVF access. More simply put, CKD staging does not predict the time to start dialysis. There have been other attempts to define the best time for access placement. Oliver et al. [2] followed a large cohort of patients with early creation (at least 4 months prior to needing

dialysis), just prior (1–4 months) and late creations (within 1 month of dialysis start). They found that AVF creation at least 4 months before starting dialysis was associated with the lowest risk of sepsis and death.

The elderly, diabetics and women provide unique subsets of patients with increased risk when starting dialysis. In individuals with advanced CKD, particularly the elderly, women or those with multiple comorbid conditions, serum creatinine-based estimated glomerular filtration rate (eGFR) may be misleading due to the dependence of serum creatinine on creatinine generation from muscle mass. The rate of renal function decline may be slower with increased age and this may be due to decreased muscle mass in the elderly. The initiation of dialysis and urea clearance needs to be defined separately for this population of patients. This fact may contribute to the overall patency rate of primary AVF, which is lower in these high-risk groups. ESRD patients with advanced age and AVF access may die before the need to use the access. In individual cases, the need to start dialysis may be delayed due to patient preference. Close diet guidelines can prolong the start of hemodialysis, allowing for successful placement of AVF or an arteriovenous graft (AVG). We need to consider the overall comorbid conditions, life expectancy, age and patient preference when referring for permanent hemodialysis access.

The Japanese clearly have superior outcomes for AVF placement when compared to other countries. DOPPS data from 2012 to 2014 annual report show that 91% of prevalent patients in Japan on hemodialysis have an AVF, 75% have an AVF prior to starting hemodialysis, while 84% of incident patients starting hemodialysis have AVF [3]. Most striking is that in Japan, 94% of patients having AVF are cannulated in less than 4 weeks [3]. Early cannulation does not appear to be associated with AVF failure and may decrease the exposure time to catheter access. A recent study by Miyamoto et al. [4] has provided evidence that it may be better to wait until CKD advances prior to placing the access. This study followed the natural history of AVF patency when the access was placed at stage 5 CKD. A secondary analysis confirmed that older age and females have worse outcomes. It is of interest to review the Japanese hemodialysis access experience of cannulation, size of cannulation gauge and blood flow. Guidelines for Japan 2011 recommend that the AVF be constructed at least 2–4 weeks before the initial puncture. In the case of an AVG, the time from construction to initial puncture should be 3–4 weeks. [5]. Access outcomes in Japan far exceed other countries, and we need to take lessons from this experience as we move forward to improve the access outcomes for ESRD patients in others parts of the world.

Prior to access placement, an important first question that we need to define is: what is the optimal time to start hemodialysis? Clinical guidelines by KDIGO state that dialysis should be initiated when one or more of the following are present: symptoms or signs attributable to kidney failure (serositis, acid-base or electrolyte abnormalities, pruritus); inability to control volume status or blood pressure; a progressive deterioration in nutritional status refractory to dietary intervention; or cognitive impairment. This often but not invariably occurs in the GFR range between 5 and 10 mL/min/1.73 m² [6]. These guidelines, which are quite broad, are not based on quality evidence and are subject to individual clinical opinion and patient preference. To address this complex question, Cooper et al. [7] conducted a prospective clinical trial in 828 adult patients in 32 centers in Australia and New Zealand randomizing patients to begin dialysis treatment earlier (10–14 mL/min/1.73 m²; *n* = 404) or later (5–7 mL/min/1.73 m²; *n* = 424). The mean creatinine clearance at the time of start of initiation of dialysis in the early and late groups was 12.0 and 9.8 mL/min/1.73 m² (eGFR 9.0 vs. 7.8 mL/min/1.73 m²). There was no significant difference in time to death, cardiovascular, infectious events,

or complications of dialysis. This study showed that the initiation of dialysis cannot be based solely on the measurement of kidney function. Without a proven clinical algorithm, an individualized approach to timing dialysis initiation must be taken as many confounding factors are involved.

We need to redefine and update the guidelines for initiation of dialysis and timing of access placement. Until we understand the natural progression of renal failure in the late stages of CKD, we cannot reasonably predict when to place access. One recommendation is to evaluate the trend in loss of eGFR and place access when the slope or rate of change increases substantially. Another approach would be to validate a predictive score for uremia that includes the following parameters: creatinine based eGFR, proteinuria, nutritional status and clinical symptoms. Algorithms have been developed but are not used in clinical practice. As nephrologists, we carry the primary responsibility to ensure that access is placed and is functional prior to starting dialysis. We know some patients have renal function that stays stable over time, while others progress rapidly. We need clinical retrospective and prospective studies launched that look at the percent decline in eGFR prior to access placement rather than continue with the guide given by CKD staging systems. We need a new fresh approach to better define when to initiate dialysis and hence vascular access placement. This advancement in the care of the patient with ESRD on hemodialysis will make important improvements in the outcome of this population of patients.

Disclosure Statement

The author contributed intellectual content during the manuscript drafting and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved. The author has no financial interests to disclose.

References

- 1 US Renal Data System: USRDS 2016 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. Bethesda, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2016.
- 2 Oliver MJ, Rothwell DM, Fung K, Hux JE, Lok CE: Late creation of vascular access for hemodialysis and increased risk of sepsis. *J Am Soc Nephrol* 2004;15:1936–1942.

- 3 Pisoni RL, Zepel L, Port FK, Robinson BM: Trends in US vascular access use, patient preferences, and related practices: an update from the US DOPPS practice monitor with international comparisons. *Am J Kidney Dis* 2015; 65:905–915.
- 4 Miyamoto M, Kurita N, Suemitsu K, Murakami M: Fistula and survival outcomes after fistula creation among predialysis chronic kidney disease stage 5 patients. *Am J Nephrol* 2017;45:356–364.
- 5 Kukita K, Ohira S, Amano I, Naito H, Azuma N, Ikeda K, Satou T, Sugimoto T, Takemoto Y, Haruguchi H, Minakuchi J, Miyata A, Murotani N, Hirakata H, Tomo T, Akizawa T: 2011 update Japanese society for dialysis therapy guidelines of vascular access construction and repair for chronic hemodialysis. *Ther Apher Dial* 2015;19(suppl 1):1–39.
- 6 NKF-K/DOQI Clinical Practice Guidelines and Clinical Practice Recommendations 2006 Updates: Vascular Access. http://www.kidney.org/professional/kdoqi/guideline_uphd_pd_va.
- 7 Cooper BA, Branley P, Bulfone L, Collins JF, Craig JC, Fraenkel MB, Harris A, Johnson DW, Kesselhut J, Li JJ, Luxton G, Pilmore A, Tiller DJ, Harris DC, Pollock CA: A randomized, controlled trial of early versus late initiation of dialysis. *N Engl J Med* 2010;363:609–619.