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CKD Series: Improving the Timing and Quality of Predialysis Care

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The final, critical step in the care of patients with chronic kidney disease (CKD) is preparing patients for entry into the end-stage renal disease (ESRD) system and initiation of renal replacement therapy (RRT). Although this transition may be difficult and at times chaotic, a comprehensive and multidisciplinary CKD care plan can ensure that the process is as efficient and smooth as possible. Considerable time is needed prior to initiating dialysis to provide patients with adequate medical and psychological preparation for RRT. Thus, it is essential to identify patients with advancing CKD at an early stage so that multidisciplinary care strategies can be initiated.

There is growing recognition that morbidity and mortality of ESRD are influenced by the timing and quality of care prior to the start of dialysis.¹ Unlike the care of ESRD patients, which is tracked through a national database (ie, the United States Renal Data System [USRDS]²), the care of CKD patients is not uniformly monitored in the United States. Consequently, *incident* dialysis patients (ie, patients initiating dialysis) have been used to represent CKD patients in transition to ESRD. Many studies have sought to determine how well prepared this patient population is for dialysis by assessing such issues as the existence of an established relationship with a nephrologist and the presence of vascular or peritoneal access. What has been uniformly described is a patient group that is significantly under-prepared for transition to ESRD.

This final article in a 6-part series on evaluation and management of CKD examines the critical components of a CKD care plan that are important for preparing patients with advanced kidney disease for progression to ESRD and dialysis. A comprehensive and well-designed care plan should address several objectives, including early nephrology referral, patient education about ESRD and dialysis modalities, creation of permanent dialysis access, and timely initiation of RRT. It is hoped that through better timing and quality of

predialysis care, the mortality rate for this high-risk group will ultimately be reduced.

OPTIMIZING TIMING OF NEPHROLOGY REFERRAL

Although it is not entirely clear why incident dialysis patients are so poorly prepared to initiate RRT, much of this problem has been attributed to inappropriately late referral to specialty care teams. The definition of "late" varies slightly in the medical literature but generally is interpreted as less than 1 to 4 months before initiation of ESRD care and RRT. Based on USRDS data reported in 1997, only 39% of hemodialysis patients had seen a nephrologist at least 1 year in advance of dialysis initiation, and 25% of patients had seen a specialist less than 1 month before commencing dialysis.³ This situation has not changed appreciably over the past several years. A national prospective study of incident ESRD patients, reported in 2002, revealed that only about half of patients had seen a nephrologist at least 1 year prior to initiation of ESRD care, and 30% of patients had been seen less than 4 months before RRT was begun.⁴

Several factors have been identified that may contribute to late nephrology referral and inadequate preparation of predialysis patients for RRT. On the patient side, economic and other barriers (eg, lack of insurance or transportation) as well as denial, fear, or procrastination may exist.⁵ Provider factors such as under-appreciation of the severity of renal dysfunction, fear of alarming the patient, lack of a multidisciplinary care team, and inadequate frequency of patient follow-up also may contribute to the problem.⁵ An

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Table 1. Consequences of Late Nephrology Referral

Severe metabolic acidosis
Severe hyperphosphatemia
Marked anemia
Hypoalbuminemia
Severe hypertension and volume overload
Low prevalence of permanent dialysis access
Delayed referral for renal transplantation
Higher initial hospitalization rate
Higher costs of initiation of dialysis
Increased 1-year mortality rate
Decreased patient choice of RRT modality

RRT = renal replacement therapy.

analysis of demographic and clinical characteristics of a cohort of a patients with CKD that progressed to dialysis was recently performed to identify factors associated with delayed nephrologist referral (defined as initial evaluation of patients by a nephrologist < 90 days before initiation of RRT); older age and the lack of certain comorbidities (hypertension, coronary artery disease, cancer, and diabetes) were significantly associated with late referral.⁶ The most likely explanation for this finding is an under-appreciation for the severity of renal disease among the elderly, particularly if they are feeling relatively well, given that most practitioners rely on the serum creatinine concentration as a marker of renal function.

Thus, it would appear that late referral may result from patient or provider factors that might be targeted for remediation. Appropriate education of primary care providers about the various complex aspects of CKD could facilitate earlier referral. In fact, a primary goal of the National Kidney Foundation (NKF) clinical practice guidelines for CKD—the Kidney Disease Outcome Quality Initiative (K/DOQI)—is to establish a common definition of CKD and classification of the stages of CKD to facilitate communication among providers, patients, and their families.⁷

Consequences of Late Referral

It has been repeatedly shown that late nephrology referral is associated with diminished patient choice and involvement in one's own care, in addition to a host of adverse consequences (**Table 1**).^{4,8–16} Most notably, an established relationship with a nephrologist has been shown to importantly impact patient outcomes, including mortality risk. In a recent prospective

study, a clear and graded risk reduction in mortality and in the burden and severity of comorbid disease was documented for those patients who were referred early (> 12 months prior to initiation of dialysis).⁴ Documented adverse clinical outcomes also associated with late referral include severe hypertension and volume overload and severe metabolic abnormalities (metabolic acidosis, hyperphosphatemia, anemia, and hypoalbuminemia) at the time dialysis is initiated.^{12,13,15,16}

A low prevalence of permanent dialysis access and greater use of central vein catheterization for hemodialysis access also have been correlated with late nephrology referral. For example, a recent examination of administrative data from a large managed care organization documented that only 20% of incident dialysis patients had undergone a permanent vascular access procedure.¹⁷ A similar analysis of data from a cohort of 2398 incident hemodialysis patients revealed that those who were referred late (≤ 90 days before the onset of dialysis) were 42% more likely to require central venous access for hemodialysis compared with those who were seen early (> 90 days before dialysis).¹⁸ These data are quite disturbing, given the significant and well-known fact that permanent vascular access, particularly the native arteriovenous fistula (AVF), is associated with markedly reduced infection rates and improved longevity of the access.¹⁹

Late referral also has been associated with markedly fewer patients selecting peritoneal dialysis as a dialysis modality.¹¹ Peritoneal dialysis is administered at home by the patient, according to his or her own schedule. It is the preferred modality of RRT by some patients because of the lifestyle flexibility it offers. Late referral precludes the necessary patient education required to learn the technique and, hence, effectively restricts patient choice of RRT modality to hemodialysis. Indeed, an increase in peritoneal dialysis utilization rates has been shown to occur when patients have the opportunity to be exposed to a comprehensive predialysis education program.²⁰ Late nephrology referral also promotes delayed referral for renal transplantation evaluation and effectively eliminates any possibility for preemptive renal transplantation.¹⁵ Finally, resource utilization is significantly higher when referral occurs late in the course of CKD and includes higher initial hospitalization rates and cost of initiation of dialysis.^{11,14}

Benefits of Early Referral

It appears that earlier specialty referral offers many opportunities for improving the care of patients with advanced CKD, which could have a marked impact on overall patient outcomes (**Table 2**). An important

benefit is the opportunity to provide multidisciplinary predialysis care earlier in the course of illness. The availability of such an intervention has been associated with improved vocational outcomes, especially for blue-collar workers.²¹ Early referral also appears to delay the time to initiation of dialysis (ie, slows CKD progression), reduce requirements for urgent dialysis, and decrease hospital length of stay.^{11,14,16,22,23} Importantly, early referral has been associated with a significant improvement in the proportion of patients initiating RRT with an AVF, the preferred option for vascular access.^{11,14,16,22,23}

Determining Ideal Timing of Referral

One problem with data from the incident dialysis population is that all of these studies presuppose that it is easy to predict when RRT will need to be initiated in CKD patients. Although some have reported that the timing of dialysis initiation can be predicted by plotting the reciprocal of serum creatinine against time,²⁴ the appearance of uremic signs and symptoms may occur earlier than predicted by such plots. Given the adverse sequelae of late referral, it is clear the medical community requires a reasonable definition of the most appropriate time for nephrology referral.

The problem of late nephrology referral was highlighted in a 1994 National Institutes of Health (NIH) consensus conference statement, which recommends nephrology referral for all CKD patients with a serum creatinine concentration greater than 2.0 mg/dL (men) or 1.5 mg/dL (women).²⁵ This laboratory cutoff would maximize the opportunity for implementation of secondary CKD prevention strategies and improve overall patient preparation for RRT.²⁵ Since release of the NIH statement, concerns regarding adequacy of the nephrology workforce to manage the increasing number of pre-ESRD patients have emerged, as has an appreciation for the critical role that primary care providers will continue to play in the future care of this patient population.²⁶ To begin to address these concerns, the NKF recently has embarked on the development of a comprehensive set of CKD clinical practice guidelines, the K/DOQI.⁷ The hope is that these evidence-based guides will better define the parameters of optimal CKD care and suggest absolute referral points the primary care physician can use to facilitate referral to the nephrology team.⁷

Because serum creatinine level has been shown to be a poor predictor of glomerular filtration rate (GFR) in several patient subgroups, particularly the elderly, the NKF recommends the use of simplified GFR prediction equations to quantify renal function more accurately

Table 2. Benefits of Early Nephrology Referral

Improved vocational outcomes
Delayed need to initiate RRT
Increased proportion of patients with permanent vascular access, particularly AVF
Greater choice of treatment options; greater peritoneal dialysis utilization
Reduced need for urgent dialysis
Reduced hospital length of stay and health care costs
Better metabolic parameters at dialysis initiation
Better patient survival

AVF = arteriovenous fistula; RRT = renal replacement therapy.

(Table 3).⁷ The most widely used formula is the Modification of Diet in Renal Disease (MDRD) equation.^{7,27} Using the MDRD equation, the K/DOQI guidelines recommend referral at or before the point when GFR is less than 30 mL/min/1.73 m², which would permit the minimum period of time needed to prepare a patient for ESRD care and RRT. An alternate equation for estimating GFR is the Cockcroft-Gault formula.²⁸ This formula was recommended by the NKF because of its general familiarity to practitioners and ease of calculation; however, it is less precise than the MDRD equation.⁷ Use of the Cockcroft-Gault formula also is recommended in the Veterans Health Administration/Department of Defense pre-ESRD guidelines—the first set of comprehensive CKD guidelines published in the United States.²⁹ Calculators for these equations are available online at www.kidney.org/professionals/doqi/index.cfm. It is hoped that with greater physician familiarity with and access to these equations, the formulas will be increasingly used in practice and lead to improved recognition of patients with severe renal dysfunction.

OPTIMIZING PREDIALYSIS CARE Multidisciplinary Approach

Available evidence suggests that a comprehensive, multidisciplinary approach to predialysis care can positively impact outcomes for patients with advanced CKD. In one report of 2 studies in Canada—a retrospective review of outcomes before and after institution of a multidisciplinary predialysis program (Toronto study) and a prospective, nonrandomized comparison of patients who were or were not exposed to ongoing multidisciplinary predialysis care (Vancouver study)—the authors concluded that both studies demonstrated improved outcomes with multidisciplinary CKD care.¹⁴ In the

Table 3. Prediction Equations for Estimating GFR**Abbreviated MDRD Equation**^{7,27}

$$\text{GFR (mL/min/1.73 m}^2\text{)} = 186 \times (S_{Cr})^{-1.154} \times \text{age (years)}^{-0.203} \times 0.742 \text{ (if female)} \times 1.210 \text{ (if African American)}$$

Cockcroft-Gault Formula²⁸

$$C_{Cr} \text{ (mL/min)} = \frac{[140 - \text{age (years)}] \times \text{weight (kg)}}{72 \times S_{Cr}} \times 0.85 \text{ (if female)}$$

C_{Cr} = creatinine clearance; GFR = glomerular filtration rate; MDRD = Modification of Diet in Renal Disease; S_{Cr} = serum creatinine (in mg/dL).

Toronto study, a multidisciplinary predialysis program enhanced the likelihood of having permanent vascular access at the time of RRT initiation (83% of patients had permanent vascular access).¹⁴ In the Vancouver study, patients who received the usual standard of individualized physician care were compared with patients exposed to a multidisciplinary clinic-based education and follow-up program for at least 4 months before initiation of RRT. The intervention consisted of standardized patient education delivered in a step-wise fashion over multiple visits, with equal time spent with the nurse educator, physician, nutritionist, and social worker. The predialysis care program reduced the number of urgent dialysis starts to 13% from 35% noted in the usual care group. It also decreased the number of hospital days during the first month of RRT (from 13.5 to 6.5 days) and resulted in net dollar savings of \$4000 (Canadian dollars) per patient.¹⁴ Hence, a multidisciplinary team approach to CKD patient care improved preparedness for entry into the ESRD system and reduced health care resource utilization.

Although no randomized prospective study has yet shown that application of the disease management paradigm to CKD care is cost effective, there is reason to be cautiously optimistic.³⁰ As some authors have aptly noted, in order for a new care strategy (“new wine”) to be fully successful, it may be necessary to implement it in an integrated delivery system (“new bottle”).³¹

Components of a Predialysis Education and Care Plan

As they transition to ESRD, patients with advanced CKD need emotional and psychological support and a large amount of information in order to make well-informed decisions, including education about their disease process, treatment options, and the ESRD care plan. A variety of patient education materials are available through the NKF and other sources to help with this important initial instructional process (Table 4).

Approach to patient education. Ideally, patient education should be simple, focused, consistent, and repeti-

tive.²⁹ To avoid information overload and patient confusion,³² small amounts of new information should be introduced at successive visits. At follow-up visits, it is helpful for the primary provider to assess the patient’s understanding of information previously provided and to reinforce correctly understood concepts. It may be necessary to clarify misconceptions or erroneous understanding of earlier topics, as cognitive deficits may exist in advanced uremia.³³ Also, previously undetected barriers to understanding (eg, language barriers, cultural or personal health beliefs) need to be considered and addressed. More remediable, yet powerful barriers to learning during the initial instruction phase are anger, denial, fear, and anxiety. These obstacles can be overcome by providing emotional and psychological support, allowing for choices, assuring informed consent, encouraging independence, and promoting a sense of patient self control.³⁴

Emotional preparation of the patient. Prior to acquiring permanent dialysis access for RRT, the patient must make an informed choice about the mode of RRT that he or she ultimately wishes to pursue. An informed choice necessarily requires patient education about the various dialysis options. Although specifics of RRT can be left to the nephrologist, it is helpful for the primary physician to explain how advanced kidney disease progresses to ESRD and to discuss the irreversible nature of established kidney disease. The development of ESRD is emotionally traumatic news for most patients and may be met with outright denial, anger, or both—typical patient reactions to any major health loss. For this reason alone, early patient referral to a nephrologist is essential to allow adequate time for the dialysis care team to assist in the emotional preparation of the patient for the inevitable lifestyle changes that will occur.

Education about treatment modalities. Information about RRT options, including the specifics of hemodialysis, peritoneal dialysis, and preemptive renal transplantation, should be presented by the nephrologist. If peritoneal dialysis is the patient’s preferred

Table 4. Web-Based Sources of Patient Education Materials

Source	Web Site
National Kidney Foundation	www.kidney.org
American Association of Kidney Patients	www.aakp.org
American Kidney Fund	www.akfinc.org
American Society of Transplantation	www.a-s-t.org
Baxter Healthcare Renal Division	www.kidneydirections.com
Center for Medicaid and Medicare Services	www.cms.hhs.gov
DialysisFinder	www.dialysisfinder.com
HowStuffWorks “How Your Kidneys Work”	www.howstuffworks.com/kidney.htm
National Institute of Diabetes and Digestive and Kidney Diseases, National Kidney Disease Education Program	www.nkdep.nih.gov
National Kidney and Urologic Disease Information	www.niddk.nih.gov/health/kidney/kidney.htm
Nephron Information Center	www.nephron.com
United Network for Organ Sharing	www.unos.org

choice of RRT, the patient and/or the family can undergo peritoneal dialysis training prior to the actual initiation of RRT. Various training tools, including a dummy abdomen with peritoneal catheter and dialysis tubing and drainage bags, are useful in this training. In addition, the home environment should be assessed in advance by the dialysis team, and changes should be made to accommodate the peritoneal dialysis modality. Physical rearrangement of the patient’s home often is necessary to make space to store supplies and to permit appropriate peritoneal dialysis effluent drainage. Early resolution of these home issues often helps to reduce patient and family stress prior to the actual initiation of home RRT. Finally, the peritoneal dialysis catheter can generally be inserted approximately 2 weeks prior to initiation of RRT.

If the patient desires preemptive renal transplantation, this treatment option requires a significant amount of time to plan and complete medical testing. First, the patient will need to identify a living (related or unrelated) donor, and then both the patient and donor must undergo medical clearance for surgery. Finally, the donor must pass an evaluation to ensure donation suitability. This process often can take several months.

Planning for vascular access. If hemodialysis is selected, the plan for vascular access and the rationale for the preference of an AVF should be reviewed with the patient by the nephrologist or a nurse educator. The markedly lower infection risk and improved longevity of a native AVF over a synthetic arteriovenous graft,¹⁹ and certainly over a tunneled or temporary dialysis catheter, underscore the importance of early

vascular access planning. So as not to preclude future AVF options, patients should be counseled to protect their nondominant arm by limiting necessary phlebotomies to the back of the dominant hand only. The K/DOQI guidelines strongly encourage placement of permanent vascular access, preferably a forearm native AVF, when serum creatinine concentration is greater than 4 mg/dL, the creatinine clearance is less than 25 mL/min, or the development of ESRD is anticipated within 1 year.³⁵

Dietary modifications. As renal disease progresses to ESRD, dietary modifications are necessary to avoid life-threatening volume overload, hyperkalemia, protein and caloric malnutrition, exacerbation of metabolic acidosis, and divalent ion derangements. Consultation with a renal dietitian is essential to avoid or reduce the development of these complications.

Counseling and support. Initiation of RRT carries with it the potential for enormous lifestyle changes, including loss of employment and insurance, as well as marital and family upheaval. Ideally, the CKD care team should include a social worker who meets with the patient to review financial considerations of RRT and insurance coverage options, outline vocational rehabilitation options, and explore other common psychosocial issues (eg, depression) that may accompany CKD.³⁶

In some instances, patients may elect not to initiate RRT at all. In this difficult situation, explicit counseling that clearly outlines the absolute consequences of this choice is mandatory and should include one or more members of the patient’s family. In addition, an evaluation for major depression is required. The presence of

Table 5. Professional Education Resources on Management of Chronic Kidney Disease

National Kidney Foundation, Kidney Disease Outcome Quality Initiative (K/DOQI) www.kidney.org/professionals/doqi/index.cfm
National Kidney Disease Education Program www.nkdep.nih.gov
Veterans Affairs/Department of Defense clinical practice guideline on pre-ESRD care www.oqp.med.va.gov/cpg/ESRD/ESRD_Base.htm
Nephrology Section of Yale University School of Medicine http://kidney.med.yale.edu/pages/Entry.html

depression could preclude true informed consent and may necessitate further intervention by the family and judicial system (competence and conservatorship). If a patient ultimately chooses not to initiate RRT and this decision is supported by the family, preferences regarding end-of-life issues should be pursued, and referral to a hospice center would be appropriate.

TIMELY INITIATION OF RENAL REPLACEMENT THERAPY

The final step in preparing the CKD patient for entry into the ESRD system is the timely initiation of RRT. Although the absolute indications for dialysis—overt uremic serositis (especially pericarditis), uremic encephalopathy, refractory metabolic acidosis, hyperkalemia, or uncontrollable volume overload—are widely known, the ideal time for initiation of RRT remains a source of debate. Some experts advocate delaying dialysis initiation through dietary manipulation as long as malnutrition can be prevented,³⁷ whereas other authors recommend “early” initiation of dialysis; early initiation of RRT is considered if dialysis is begun in patients who are in the presymptomatic stage, when GFR falls below 10.5 mL/min/1.73 m², or creatinine clearance is 9 to 14 mL/min.³⁸

Analysis of practice patterns over the past 3 decades reveals a trend to initiate RRT at progressively higher levels of residual renal function, reflected by a lower serum creatinine concentration at the start of dialysis.¹ Most recently, the mean serum creatinine concentration and GFR of patients starting dialysis were reported as 8.5 ± 3.8 mg/dL and 7.1 ± 3.1 mL/min/1.73 m², respectively.^{1,7,39} Ultimately, initiation of RRT is based upon the combination of level of kidney function as assessed by GFR, the presence of signs or symptoms of uremia, and patient preference.

CONCLUSION

A critical component of the care of CKD patients is to provide the emotional and physical preparation needed to ensure stable entry into ESRD care or pre-emptive transplantation. A smooth and effective transition requires that CKD patients receive early referral to a nephrologist and, ideally, a multidisciplinary predialysis care program. An organized approach to pre-ESRD care can facilitate correction of the medical aspects of CKD outlined in previous articles in this series and ensure the provision of critical patient education and support as well as appropriate timing of initiation of RRT. Additional professional education resources of potential interest to physicians caring for CKD patients are listed in **Table 5**. **HP**

REFERENCES

- Obrador GT, Arora P, Kausz AT, Pereira BJ. Pre-end-stage renal disease care in the United States: a state of disrepair. *J Am Soc Nephrol* 1998;9(12 Suppl):S44–54.
- U.S. Renal Data System. USRDS 2002 annual data report: atlas of end-stage renal disease in the United States. Bethesda (MD): National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2002. Available at www.usrds.org. Accessed 9 Jul 2003.
- The USRDS Dialysis Morbidity and Mortality Study: Wave 2. United States Renal Data System. *Am J Kidney Dis* 1997;30(2 Suppl 1):S67–85.
- Kinchen KS, Sadler J, Fink N, et al. The timing of specialist evaluation in chronic kidney disease and mortality. *Ann Intern Med* 2002;137:479–86.
- Hood SA, Sondheimer JH. Impact of pre-ESRD management on dialysis outcomes: a review. *Semin Dial* 1998;11:175–80.
- Winkelmayer WC, Glynn RJ, Levin R, et al. Determinants of delayed nephrologist referral in patients with chronic kidney disease. *Am J Kidney Dis* 2001;38:1178–84.
- National Kidney Foundation (NKF) Kidney Disease Outcome Quality Initiative (K/DOQI) Advisory Board. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Kidney Disease Outcome Quality Initiative. *Am J Kidney Dis* 2002;39(2 Suppl 1):S1–246.
- Innes A, Rowe PA, Burden RP, Morgan AG. Early deaths on renal replacement therapy: the need for early nephrological referral. *Nephrol Dial Transplant* 1992;7:467–71.
- Ratcliffe PJ, Philips RE, Oliver DO. Late referral for maintenance dialysis. *Br Med J (Clin Res Ed)* 1984;288:441–3.
- Sesso R, Belasco AG. Late diagnosis of chronic renal failure and mortality on maintenance dialysis. *Nephrol Dial Transplant* 1996;11:2417–20.
- Schmidt RJ, Dominico JR, Sorkin MI, Hobbs G. Early

- referral and its impact on emergent first dialyses, health care costs, and outcome. *Am J Kidney Dis* 1998;32:278–83.
12. Ifudu O, Dawood M, Homel P, Friedman EA. Excess morbidity in patients starting uremia therapy without prior care by a nephrologist. *Am J Kidney Dis* 1996;28:841–5.
 13. Jungers P, Zingraff J, Albouze G, et al. Later referral to maintenance dialysis: detrimental consequences. *Nephrol Dial Transplant* 1993;8:1089–93.
 14. Levin A, Lewis M, Mortiboy P, et al. Multidisciplinary predialysis programs: quantification and limitations of their impact on patient outcomes in two Canadian settings. *Am J Kidney Dis* 1997;29:533–40.
 15. Levin A. Consequences of late referral on patient outcomes. *Nephrol Dial Transplant* 2000;15 Suppl 3:8–13.
 16. Mendelssohn DC, Barrett BJ, Brownscombe LM, et al. Elevated levels of serum creatinine: recommendations for management and referral. *CMAJ* 1999;162:413–7.
 17. London R, Solis A, Goldberg GA, et al. Health care resource utilization and the impact of anemia management in patients with chronic kidney disease. *Am J Kidney Dis* 2002;40:539–48.
 18. Avorn J, Winkelmayer WC, Bohn RL, et al. Delayed nephrologist referral and inadequate vascular access in patients with advanced chronic kidney failure. *J Clin Epidemiol* 2002;55:711–6.
 19. Churchill DN, Taylor DW, Cook RJ, et al. Canadian Hemodialysis Morbidity Study. *Am J Kidney Dis* 1992;19:214–34.
 20. Golper TA, Vonesh EF, Wolfson M, et al. The impact of pre-ESRD education on dialysis modality selection. *J Am Soc Nephrol* 2000;11:A1223.
 21. Ragson S, Schwankovsky L, James-Rogers A, et al. An intervention for employment maintenance among blue-collar workers with end-stage renal disease. *Am J Kidney Dis* 1993;22:403–12.
 22. Binik YK, Devins GM, Barre PE, et al. Live and learn: patient education delays the need to initiate renal replacement therapy in end stage renal disease. *J Nerv Ment Dis* 1993;181:371–6.
 23. Astor BC, Eustace JA, Powe NR, et al. Timing of nephrologist referral and arteriovenous access use: the CHOICE study. *Am J Kidney Dis* 2001;38:494–501.
 24. Mitch WE, Walser M. Nutritional therapy of renal disease. In: Brenner BM, Rector FC, editors. *Brenner and Rector's the kidney*. 6th ed. Philadelphia: WB Saunders Company; 2000:2298–340.
 25. Morbidity and mortality of renal dialysis: an NIH consensus conference statement. Consensus Development Conference Panel. *Ann Intern Med* 1994;121:62–70.
 26. Mitch W, McClellan WM. Patterns of patient care reported by nephrologists: implications for nephrology training. *Am J Kidney Dis* 1998;32:551–6.
 27. Levey AS, Bosch JP, Lewis JB, et al. A more accurate method to estimate glomerular filtration rate from serum creatinine: a new prediction equation. Modification of Diet in Renal Disease Study Group. *Ann Intern Med* 1999;130:461–70.
 28. Cockcroft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. *Nephron* 1976;16:31–41.
 29. Management of chronic kidney disease and pre-ESRD in the primary care setting. Washington (DC): VA/DoD Evidence-Based Clinical Practice Guideline Working Group, Veterans Health Administration, Department of Veterans Affairs, and Health Affairs, Department of Defense; 2000. Office of Quality and Performance publication 10Q-CPG/ESRD-00. Available at www.oqp.med.va.gov/cpg/ESRD/ESRD_Base.htm. Accessed 7 Jul 2003.
 30. Wrono EM, Hornberger J. Evaluating the consequences of multidisciplinary case management for patients with chronic renal failure [editorial]. *Am J Med* 1998;105:546–8.
 31. Harris JM Jr. Disease management: new wine in new bottles? *Ann Intern Med* 1996;124:838–42.
 32. Szczepanik ME. Assessment and selection considerations: ESRD patients and family education materials and media. *Adv Ren Replace Ther* 1995;2:207–16.
 33. Osberg JW, Meares GJ, McKee DC, Burnett GB. Intellectual functioning in renal failure and chronic dialysis. *J Chronic Dis* 1982;35:445–57.
 34. Hayslip DM, Suttle CD. Pre-ESRD patient education: a review of the literature. *Adv Ren Replace Ther* 1995;2:217–26.
 35. NKF K/DOQI clinical practice guidelines for vascular access: update 2000. *Am J Kidney Dis* 2001;37(1 Suppl 1):S137–81.
 36. Kimmel PL. Psychosocial factors in dialysis patients. *Kidney Int* 2001;59:1599–613.
 37. Walser M, Hill S. Can renal replacement be deferred by a supplemented very low protein diet? *J Am Soc Nephrol* 1999;10:110–6.
 38. II. NKF K/DOQI clinical practice guidelines for peritoneal dialysis adequacy: update 2000. *Am J Kidney Dis* 2001;37(1 Suppl 1):S65–136.
 39. Obrador GT, Arora P, Kausz AT, et al. Level of renal function at the initiation of dialysis in the U.S. end-stage renal disease population. *Kidney Int* 1999;56:2227–35.

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