Peritoneal Dialysis First: Rationale

Kunal Chaudhary,†* *Harbaksh Sangha,*† *and Ramesh Khanna*†

Summary

The use of peritoneal dialysis (PD) has become wide spread since the introduction of continuous ambulatory PD more than 25 years ago. Over this time, many advances have been made and PD is an alternative to hemodialysis (HD), with excellent comparable survival, lower cost, and improved quality of life. The percentage of prevalent PD patients in the United States is approximately 7%, which is significantly lower compared with the 15% PD prevalence from the mid-1980s. Despite comparable survival of HD and PD and improved PD technique survival over the last few years, the percentage of patients performing PD in the United States has declined. The increased numbers of in-center HD units, physician comfort with the modality, perceived superiority of HD, and reimbursement incentives have all contributed to the underutilization of PD. In addition to a higher transplantation rate among patients treated with PD in the United States, an important reason for the low PD prevalence is the transfer to HD. There are various reasons for the transfer (*e.g.*, episodes of peritonitis, membrane failure, patient fatigue, etc.). This review discusses the various factors that contribute to PD underutilization and the rationale and strategies to implement "PD first" and how to maintain it. The PD first concept implies that when feasible, PD should be offered as the first dialysis modality. This concept of PD first and HD second must not be seen as a competition between therapies, but rather that they are complementary, keeping in mind the long-term goals for the patient.

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*Harry S. Truman VA Hospital, Columbia, Missouri; and †Department of Internal Medicine, Division of Nephrology, University of Missouri, Columbia, Missouri

Correspondence: Dr. Kunal Chaudhary, Division of Nephrology, Department of Internal Medicine, University of Missouri, 1 Hospital Drive; CE 422, Columbia, MO 65212. Phone: 573-882-8556; Fax: 573-884-4820; E-mail: chaudharyk@health.missouri.edu

Introduction

As of December 31, 2007 of the approximately 368,000 patients undergoing dialysis in the United States, the point prevalence for peritoneal dialysis (PD) patients was only 7.2% (1). The percentage of incident PD patients in 2007 was even lower at 5.8%, which is a significant decline from the peak of 15% in the mid-1980s (1). There are numerous reasons contributing to the low incidence and prevalence of PD in this country (2,3). There are concerns regarding patient morbidity and mortality and the effect of a particular modality. There seems to be a perception among the U.S. nephrologists that survival on PD is inferior to hemodialysis (HD). Nephrologists are also concerned that infectious complications, particularly peritonitis in PD patients, are excessive. There seems to be a perception among nephrologists that there is inadequate small-solute clearance by PD, especially in large patients and in those with no residual renal function (RRF). The level of physician comfort in dealing with a particular therapy, especially when complications arise, may also influence the choice of therapy. There may be subtle financial incentives unique to the United States that can influence modality use. In the current pay-for-what-is-used system, providers may be able to make a bigger margin per patient when more "injectables" are used, and there is also less of a cost to put a patient on in-center HD because the infrastructure is already there. Contrary to prevailing practice, when U.S. nephrologists were surveyed regarding the best dialysis therapy they would offer, home therapies were the most common answer. In a survey of nephrology professionals, most picked continuous ambulatory peritoneal dialysis (CAPD)/ambulatory peritoneal dialysis (APD) as the best initial therapy for the patient. Of the >1000 nephrologists from the Americas, >40% picked CAPD/APD as the initial therapy (4).

Over time, few PD patients stay on PD ≥5 years from initiation of therapy. A large proportion of dialysis patients transfer from PD to HD every year (5,6). According to the U.S. Renal Data System (USRDS) database, approximately 19% of PD patients changed to HD over the 2-year period between 2002 and 2004, translating to an annual mean rate of 9.5% (1). Transfer to HD could be a significant cause for the underutilization of PD worldwide and particularly in the United States (Table 1). Modality issues such as recurrent episodes of peritonitis, inadequate dialysis, or ultrafiltration failure and system issues as well as personal or social reasons make up most reasons for the transfer to HD. In some patients, especially if a transplant is not immediately available, transfer to HD may improve survival (7). PD-to-HD switch rates of >35% have been reported in the first 2 years in the United States (6). Nevertheless, over the past 2 decades, two important causes of transfer—peritonitis and inadequate dialysis issues—have received great attention, and the incidences have consequently decreased, but the underutilization of PD still remains rather widespread. Strategies to prevent peritonitis, ultrafiltration failure, and catheter-related complications and improving adequacy of dialysis, education of patients, and medical staff may all help with increasing PD utilization (Table 2). In this review we will rationalize why the "PD first" approach to dial-

Table 1. Potential causes of underutilization and transfer to HD

Modality related
infections
peritonitis
tunnel infection, exit-site infections
inadequate dialysis
unable to meet clearance targets (Kt/V or creatinine clearance)
ultrafiltration failure
inability to achieve dry weight
persistent volume overload
mechanical problems
catheter problems
infections
mechanical complications
System related
lack of infrastructure
lack of patient modality education/training
transfer to a facility where PD is unavailable
center effect
provider expertise
physician reimbursement
ownership of dialysis facility
Patient related
patient burnout
social reasons, family, age, occupation, *etc.*
geography: distance to travel
loss of RRF
malnutrition/excess protein loss
diabetic complications: severe neuropathy, blindness
abdominal surgeries or development of hernia
respiratory problems, chronic cough
stroke or severe illness limiting manual dexterity

Table 2. Strategies to maintain PD

Modality related
peritonitis prophylaxis
membrane preservation: use of glucose polymers/ACE inhibitors
adjust dialysis prescription according to RRF
correction of catheter malfunction
System related
better infrastructure to support PD
patient education/training
physician education
incentives to physicians, dialysis centers
redirecting resources
Patient related
social support
psychological counseling (as needed)
assisted PD

ACE, angiotensin converting enzyme.

ysis initiation strategy is timely and appropriate, discuss the causes of transfer to HD, and suggest prevention strategies.

Why PD First?

Starting patients on PD as their initial treatment modality seems appropriate for many reasons. The most appealing reason appears to be to take advantage of the better survival of PD patients compared with HD patients during the first 2 years of dialysis treatment (1). There are other reasons to offer PD as the first-choice modality, including the lower cost of therapy, convenience of home therapy, a flexible schedule, and increased freedom from the patient's perspective. The revised National Kidney Foundation–Dialysis Outcomes Quality Initiative (NKF-DOQI) adequacy targets for PD are also more practical. Another compelling argument in favor of the PD first approach is the observation that since the last decade, infection-related complications are higher and appear to be increasing in HD patients, whereas such complications are steadily declining in PD patients over the past decade (1).

Survival Advantage

Studies comparing mortality outcomes in HD *versus* PD patients have shown conflicting results. In a study of 398,940 dialysis patients initiating therapy between 1995 and 2000, Vonesh *et al.* found that survival differences between HD and PD varied substantially according to the underlying cause of ESRD, age, and level of baseline comorbidity. The adjusted mortality rates were the same or higher for HD as compared with PD in most patient groups except in older diabetic patients (8). In another study of 4568 HD patients and 2443 PD patients from the Danish Terminal Uremia registry, Heaf and colleagues found a survival advantage for PD during the first 2 years of dialysis treatment (9) that has also been reported among Canadian patients (10). The Choices for Healthy Outcomes in Caring for ESRD (CHOICE) study showed that compared with HD, the adjusted risk for death was comparable in the two groups but worse in PD patients after the first year (11). The CHOICE study has been criticized for collection of data after dialysis initiation, recruitment bias, and data analysis. In another study comparing the outcomes of patients treated with HD or PD who were still undergoing treatment on day 90 of ESRD, the investigators reported higher 2-year mortality among patients treated with PD in the entire cohort. However, in a subgroup analysis, a progressive improvement in outcomes with PD was noted, and for patients who started treatment in 2004, there was no

difference in the mortality rates between patients treated with the two dialysis modalities (12). In a study including 6337 pairs of incident HD and PD patients matched by propensity scores, patients who started with PD on day 0 of ESRD had an 8% lower risk for death compared with those who started treatment with HD. The adjusted 4-year survival of incident HD and PD patients was 48% and 47%, respectively ($P = 0.50$) (13). A recent study of the USRDS database by Mehrotra *et al.* examined survival trends in three 3-year cohorts with up to 5 years of follow-up and found that the risk of death was no different in the most recent cohort (2002 to 2004) (14). It has also been shown that patients treated with PD have a lower risk for death early during the course of ESRD—the healthier the patient, the greater the apparent survival advantage (15). A study of 66,381 patients who were undergoing PD in the United States between 1996 and 2004 showed that for patients who started treatment in 2002 to 2004, the risk for death and transfer to HD were 45% and 38% lower, respectively, when compared with patients who started treatment between 1996 and 1998 (16). Although the 5-year survival for HD and PD patients have improved over the last few years, the increase has been greater in PD patients. For incident patients on HD or PD, survival probabilities in 1998 to 2002 were 7.2% and 14.8% higher, respectively, than in 1993 to 1997 (1). For patients with diabetes, survival between the two periods improved 12.9% for HD and 21.8% for PD, and for hypertensive patients the improvement was 4.0% and 13.2% for HD and PD, respectively (1). To conclude, there has long been a misconception in the United States that survival on PD is inferior to HD, although the converse is actually the case for most patient groups, particularly in the first few years of dialysis.

Infection Rates

Infection is the second leading cause of death among dialysis patients, accounting for 33 deaths per 1000 patient-years in the prevalent USRDS cohort for 2001 to 2003 (1). Rates of admission for bacteremia/septicemia are higher in HD patients, reaching 102 per 1000 patient-years in 2007, 1.5 to 2.3 times higher than the rates of 66.7 seen in PD patients (1). The rates of hospital admissions for septicemia are higher in HD patients than PD patients (17), and HD compared with PD as an initial modality doubles the risk for hospitalization for septicemia. Another study that examined infection rates among HD and PD patients in a single urban center found that the rates were the same but the types of infections were different (18). In another longitudinal cohort study of incident dialysis patients with 7 years of follow-up, 11.7% of 4005 HD patients and 9.4% of 913 PD patients had at least one episode of septicemia, and the adjusted risk of death from septicemia was almost 2 times higher in HD patients as compared with PD patients (9.79 *versus* 4.81, $P < 0.01$) (19).

Achieving Adequate Clearance

As with HD, small-solute clearance has been thought to be an important predictor of survival with PD. On the basis of the Canada-USA (CANUSA) study (20), the NKF-DOQI guidelines included a weekly Kt/V of 2.0 and weekly creatinine clearance of 60 L/1.73 m^2. These guidelines were difficult to achieve in larger and especially anuric patients. The ADEMEX study showed that increasing peritoneal small-solute clearance achievable in clinical practice did not improve survival in PD patients (21). In another trial of 320 incident CAPD patients from Hong Kong, the authors showed that there was no difference in outcome demonstrated for patients with Kt/V maintained >2.0 and between 1.7 and 2.0 (22). On the basis of these studies, current NKF-DOQI guidelines recommend achieving a Kt/V urea of 1.7 in PD patients, which is easier to achieve. Despite lower weekly urea clearances compared with HD, this has not translated into inferior survival of PD patients.

Home Therapy

PD offers the patient the opportunity to do dialysis at home rather than spending time in the dialysis unit. There is no traveling to be done, which is especially an advantage in adverse weather conditions. Most PD patients make visits to the dialysis center once or twice a month. PD offers a flexible schedule providing them with opportunities to travel and participate in other activities.

Short-Term PD in Patients Awaiting Renal Transplant

In patients listed for renal transplant and especially those with live donors, short-term PD while awaiting renal transplant is preferable given the fact that it has been shown that the incidence of delayed graft function is less and the drop in serum creatinine is faster in PD patients as compared with HD patients (23). There is a concern that the incidence of graft thrombosis is higher in PD patients as compared with HD patients, although renal survival has not been shown to be different (24–26). A study from the United States suggested that patients transplanted from PD (or if at least 50% of their pretransplant renal replacement therapy time was on PD) had a 6% lower risk of death and a 3% lower risk of graft failure than those transplanted from in-center HD (27).

Preservation of RRF

The importance of RRF in dialysis patients can only be appreciated when one considers its influence on nutrition, cardiovascular function, mineral metabolism, and maintenance of hemoglobin levels (28). Loss of RRF increases resting energy expenditure and inflammation and reduces small-solute and middle-molecule uremic toxin clearance; erythropoietin synthesis; and phosphorus, sodium, and fluid removal. These effects result in anemia, malnutrition, cardiac hypertrophy, congestive heart failure, atherosclerosis and arteriosclerosis, and vascular and valvular calcification, all of which lead to an increase in overall and

cardiovascular mortality and decreased quality of life. RRF has been closely associated with survival of PD patients. The initial contribution of RRF to total solute clearance depends on when PD is started and the initial prescription. Regardless of the rate of deterioration of RRF, it is imperative to periodically measure the delivered dose of PD and RRF and make upward adjustments to the dose as RRF is lost.

Lower Healthcare Cost

Per person, the per-year cost for HD and PD is $73,008 and $53,446, respectively (1). In 2001, the difference in cost to the Center for Medicare & Medicaid Services (CMS) between a HD *versus* a PD patient was $13,900, and although the cost of dialysis for both modalities has increased, the difference in cost has also increased to close to $20,000. Payment by CMS is currently on an as-treated basis: There is a fixed "composite rate" for dialysis-related services and an additional payment for "injectable" medications on an "as-used" basis. Thus, in addition to the composite rate, providers are also reimbursed for injectable medications (*e.g.*, erythropoiesis-stimulating agents [ESAs], intravenous [IV] iron, and vitamin D) on an as-used basis. On average, a PD patient tends to use less IV medications than an in-center HD patient, which contributes to the lesser cost of PD. Shih and colleagues (29) examined Medicare expenditures over a 3-year period after initiation of dialysis among 3423 patients with incident ESRD identified in the USRDS. After adjustment for differences in patient characteristics (*e.g.*, age, sex, race/ethnicity, comorbidities, and primary cause of ESRD), the estimated total annual Medicare expenditures were reported to be $11,446 lower for PD patients than for HD patients ($56,807 *versus* $68,253, $P < 0.001$). Bruns and colleagues identified 148 patients receiving PD ($n = 35$) or HD ($n = 113$) at the University of Pittsburgh Medical Center between July 1, 1994 and June 30, 1995. The unadjusted mean annual per-patient costs were $17,920 lower among those who received PD *versus* HD ($45,420 *versus* $63,340, respectively) (30). In a recent cost comparison study of 463 dialysis patients with a 12% incidence of PD, Berger *et al.* showed that PD patients were less likely than HD patients to be hospitalized in the year after initiation of dialysis and had significantly lower healthcare costs over a 12-month period compared with HD patients ($173,507 *versus* $129,997 for PD patients, $P = 0.03$) (31).

Satisfaction with Care

Feeling of well being and satisfaction with therapy are important considerations in choosing a therapy. Studies have shown that there is a favorable trend for patient satisfaction in PD patients as compared with HD patients. In a study involving 37 dialysis centers and more than 700 dialysis patients, PD patients were 1.5 times more likely than HD patients to rate their dialysis care as excellent (32).

Reasons for Transfer to HD and Prevention Strategies

Modality-Related Issues

Peritonitis and catheter-related infections. Over the last few years, the use of twin bags and the Y-set system has helped to significantly decrease the peritonitis rates (33). Still, a major cause for the switch from PD to HD is the high rate of peritonitis, especially within the first 1 to 2 years of initiating PD. Even if not the approximate cause of technique failure (TF), peritonitis episodes can cause ultrafiltration failure and membrane-related problems at a later time. Schaubel *et al.* studied the data from the Canadian Organ Replacement Registry (CORR) from 1981 to 1997 and estimated the crude CAPD switch rates to be 154 per 1000 patient-years. They reported that the rates decreased in the post-1990 period, with the adjusted relative risk of CAPD failure ranging from 0.75 to 0.83 in the years 1990 and onward as compared with years before 1990 (34). In a more recent study of 292 PD patients followed prospectively that involved 28 dialysis centers, the authors found that 24.8% of PD patients switched to HD during the study period: 40% of those patients switched within the first year and 70% within 2 years of starting PD (35). In their series, the most common reason for the switch was infection related (peritonitis and catheter related) at 36.9%, followed by volume overload at 18.5%. Peritonitis rates in randomized trials using double-bag systems have shown an incidence rate of peritonitis ranging from one episode per 24.8 months to one episode every 46.4 months (36). In a study of peritonitis rates in 12 PD units in the United Kingdom, the author reported peritonitis rates of one episode per 14.7 months for CAPD and one episode per 18.1 months for APD/continuous cycling PD patients, with a considerable variation between units (37). Patients receiving cephalosporins and a second antibiotic (*e.g.*, gentamycin) via an intraperitoneal route had the best cure rates of 94.55%, compared with patients receiving intraperitoneal vancomycin or oral cephalosporins. Catheter-related interventions, including changes in design and approach, have been tried in an effort to reduce peritonitis rates. In a review of 37 trials including 2822 patients, Strippoli *et al.* did not find statistical difference in peritonitis rates or TF with catheters inserted by laparoscopy *versus* laparotomy (33). In the same study, the authors did not find a significant difference in the risk of peritonitis or exit-site infections between catheters with a straight *versus* coiled intraperitoneal portion. In a 6-year analysis of presternal *versus* intraperitoneal PD catheters Twardowski *et al.* found that the peritonitis rate was one episode per 37.4 patient-months and one episode per 20.5 patient-months for presternal and abdominal catheters, respectively, but these differences were not statisti-

cally significant. However, the patients receiving the presternal catheters included obese patients (five patients with body mass indices > 45), and three patients had ostomies (38).

Proposed solutions. Prevention and better treatment of peritonitis and catheter-related infections will undoubtedly decrease the loss of some patients from PD. Prophylaxis against exit-site infection leads to subsequent fewer episodes of peritonitis, and mupirocin and gentamycin have been used for this. Bernardini *et al.* have shown that the use of gentamycin was more effective than mupirocin in preventing gram-negative infections and equally effective as mupirocin against gram-positive organisms (39). In certain centers APD has been associated with lower peritonitis rates and TF (40), and more widespread use of APD can offset some of the patients failing PD. In the study by Davenport discussed above (37), treatment of peritonitis using two antibiotics (one of which was a cephalosporin) had a better cure rate than a single agent, and dual initial coverage until the cultures and sensitivity come back should be considered as the standard practice. Examining the reasons for variability of peritonitis rates from one center to another in a geographical region as well as training techniques and center-specific protocols can help in minimizing peritonitis episodes.

Ultrafiltration failure. The inability to maintain volume homeostasis is another cause of failure of PD as a modality. The prevalence of ultrafiltration failure leading to TF has been reported to be between 1.7% and 13.7% (41).

A PD cohort followed in The Netherlands cooperative study also had a high rate of TF, with only 64% of patients remaining on PD after 2 years (42). In that cohort, the factors identified as independent predictors for the switch were urine volume, systolic BP, and peritoneal ultrafiltration. In a study of 224 patients from Japan, the authors reported a 50% overall survival at a mean of 5.5 years. In that study, failure of ultrafiltration was the biggest reason for withdrawal from CAPD (43). However, in both of these studies the major modality was CAPD and Icodextrin was not used. Long-term exposure to hypertonic glucose solutions changes the transport characteristics of the peritoneal membrane so that low or average transporters become high transporters, which may lead to greater use of high-strength dextrose solutions. The resulting volume expansion is often compounded over time because the RRF also declines over time. Ultrafiltration failure may be due to causes other than peritoneal membrane dysfunction. Dietary indiscretion, excessive sodium and fluid intake, an inadequate dialysis prescription, loss of RRF without adjustments in dialysis prescription, and catheter malfunction are often the causes of chronic volume expansion.

Proposed solutions. Glucose, the osmotic agent in standard PD solutions, has been known to cause changes in the membrane over time that eventually lead to membrane failure (44). Newer biocompatible solutions without dextrose have shown evidence of less membrane damage and can lead to better preservation of the peritoneal membrane (45). In a Japanese cohort of >7000 patients, Kuriyama *et al.* showed that the dropout rate in patients who used Icodextrin (8.9%) was significantly lower than those using dextrose (14.5%) ($P < 0.0001$) (46). More recently, a Dutch study showed that PD patients who were treated with inhibitors of the renin-angiotensin system had less increase in small-solute transport as compared with controls (47), which may have a positive effect on PD technique survival. Use of gene therapy to offset peritoneal fibrosis has been tried in animal models, but human studies are lacking (48). Maintaining RRF is of paramount importance in PD patients, and rates of decline of RRF have been associated with all-cause mortality and TF (49). Often the PD patient's prescription may not be changed to compensate for the loss in RRF. The use of biocompatible solutions with lower levels of glucose degradation products may preserve the RRF longer, although this effect may be volume related (50). Unfortunately these biocompatible solutions are not U.S. Food and Drug Administration (FDA) approved and are unavailable in the United States. The FDA policy categorizes PD solutions as a "drug" and the HD solution as a "device." Consequently, it is a challenge to get new PD solutions approved in the United States unless a specific indication or superiority over the existing solutions is established. To maintain RRF, nephrotoxic agents such as contrast and aminoglycosides should be avoided as much as possible and used only as a short course with drug level monitoring. Thus, close attention to the prescription and to protecting the peritoneal membrane as well as patient education about diet and dry weight are essential to achieving normovolemia in PD patients.

Catheter malfunction. Mechanical complications are a common reason for removal of PD catheters and transfer of patients to HD. Early and appropriate intervention can save many catheters, often without interrupting PD (51).

Proposed solutions. Many causes of catheter malfunction such as occlusion by the bladder or bowels can be corrected with use of laxatives or emptying the bladder. Obstruction due to clots can be dislodged by injecting heparinized saline, and if unsuccessful by instillation of tissue plasminogen activator or urokinase in the catheter. Common mechanical problems of omental trapping, adhesion formation, *etc.*, can be

corrected through laparoscopic means by performing omentopexy, adhesiolysis, resection of epiploic appendices, colopexy, *etc.* (52). Radiologic imaging should be done early and judiciously to get a better idea of the underlying problem; for example, migrated catheters can also be successfully corrected by a laparoscopic approach. The use of presternal catheters can allow certain types of patients (*i.e.*, obese) or those having a colostomy an opportunity to do PD.

System-Related Issues

The underutilization of PD is influenced by system factors such as the easy accessibility to HD, financial incentives, ownership of dialysis units (including units owned by large dialysis organization [LDOs]), as well as fellowship training and exposure to PD during training. HD is generally more readily available in the United States compared with some countries such as Canada or the United Kingdom, where accessibility to HD can be limited (53). Prevalence of PD is higher (20% to 30%) in countries such as Australia, New Zealand, China, Canada, and the United Kingdom, where PD delivery is supported and provided for by the government (54,55). In Hong Kong, where 80% of the dialysis population is on PD (HD is only permitted if there is a contraindication to PD), a 2-year technique survival of 82% (patient survival 91%) has been reported (56). In addition to reimbursement policies and possible genetic effects (57), the success of PD in Hong Kong is due to the high numbers of PD patients each unit has (*i.e.*, approximately 300), which increases the staff expertise. For example, the training duration for PD is only 4 to 5 days, and nephrologists perform many of the procedures such as catheter insertion and removal, which decreases surgical consultations and provides timely treatment. In the United States, where the government reimburses private providers for dialysis delivery, HD provides more reimbursement opportunities than PD. There is a lower requirement of ESAs (58,59); less opportunity for IV use of medications such as ESAs, vitamin D analogues, and iron; and less opportunity for investigational studies in PD as compared with HD. The two largest dialysis chains, Fresenius Medical Care and DaVita Corporation, treat approximately 70% of U.S. dialysis patients. In 2007, each company reported that approximately 20% of their dialysis revenue was from ESA use alone (60). In one study, the four largest for-profit dialysis chain facilities administered significantly more erythropoietin (31,915 units/week more) than the largest nonprofit chain (61). Similarly, in other countries such as Japan and Germany where private providers dominate dialysis delivery, prevalence of PD is low. Canada and the United Kingdom have shown decreasing prevalence trends, which most likely stem from decentralization of dialysis delivery (62,63).

In a recent study, during the 9-year period between 1996 and 2004, the number of LDOs in the United States increased by 53% (64). The number of patients undergoing dialysis in these units increased from 39% to 63% with no increase in the number of patients undergoing PD. Three of the five LDOs in the above study had consistently lower PD patients and higher risk of death in those patients than the other LDO and non-LDO units. Other studies have linked the low number of PD patients in a center to high TF and low patient survival (65,66). In a study using a Baxter Healthcare database by Guo and Mujais, an effect of center size was also seen: Dialysis centers that had <20 patients had a higher rate of TF than centers with >20 patients (6). High TF but not low patient survival has been shown by other investigators (5,6,67,68), including a recent paper that reported higher TF in units with ≤ 25 patients as compared with units with >25 patients, especially in the first year (5). A vicious cycle has developed in which low numbers of incident and prevalent PD patients lead to a lack of training/expertise (65–68), which in turn affects the decision to offer PD as an option to the patient as an initial therapy and subsequently the ability to problem-solve in the face of TF, which leads to low incidence. In a program director survey, 29% of U.S. training programs had less than five chronic PD patients per nephrology trainee. Similarly, in 14% of U.S. training programs, fellows spent $<5\%$ of their time receiving training for patients undergoing chronic PD and only 32% of renal fellows stated that they attended an outpatient PD clinic (69). Inadequate training in the modality may lead to a lack of comfort with the therapy, and nephrologists who are not comfortable with PD might not offer it.

Proposed Solutions

Optimizing size of a PD facility. It is our view that successful PD programs are usually of a size that allows nurses to assume primary responsibility for patient care and optimal ratios of nurses to patients are generally felt to be approximately 1:20. Nurses develop a rapport with patients that is professionally satisfying and they have a sense of autonomy that is particularly rewarding. Thus, conceptually, programs of ≥ 50 PD patients would seem to be optimum. This gives flexibility for nursing on-call schedules and nurses have the time to actively participate in educational programs. Thus, the goal of a smaller program should be to try and reach this threshold and/or consider consolidating on a regional basis to permit effective models of patient care.

Patient education/training. When first told about performing dialysis, the patients are often fearful and do not want to accept it. A predialysis program with multidisciplinary staff including nephrologists, nurses, dieticians, social workers, and even other dialysis patients where patients can be referred a few months before the need for dialysis can go a long way toward overcoming barriers and preparing the patient for PD (70). In a report from Hong Kong, 50% patients who were offered PD were reluctant to start

PD but agreed after predialysis counseling (71). Another report from United Kingdom showed that close to 50% patients who receive explanations for PD and HD through predialysis counseling would chose PD (72). The National Pre-ESRD Education Initiative, which involved 932 referring nephrologists and 28 educators from all over the United States, is the largest pre-ESRD program undertaken to date (73). It enrolled 15,000 patients who were educated regarding kidney function, kidney failure, and renal replacement therapies. The patients chose the dialysis modality after completion of the program, and 55% chose HD whereas 45% chose PD. Along with predialysis education, effective PD training of the patient is important for a successful PD program. A training program with a well structured curriculum may be associated with improved outcomes (74). PD training done at the patient's home has been shown to lower peritonitis rates (75). Thus, predialysis patient education and training is a key target for more widespread utilization of PD.

Physician education/training. To offset the concerns about nephrologists not being comfortable with PD, training programs must provide fellows adequate exposure to PD. Programs with limited access should offer fellows elective rotation in centers with larger PD populations and have a core curriculum for PD including text and visual aids. As an option, the current Residency Review Committee requirement of 12 months of clinical nephrology can perhaps be increased to 18 months to obtain more exposure.

Financial considerations. The issues related to physician and center reimbursement are more difficult to overcome, but it is hoped that the introduction of bundling dialysis care services (treatments, laboratory services, medications) into one payment as currently proposed may help indirectly in renewing more patients being treated with PD. In a few months the government will bring on a new payment system that will tighten payments under a bundled system. Commercial carriers such as Kaiser Healthcare have used this model to limit "ancillary costs." However, these third parties have generally reimbursed at significantly higher rates than Medicare. Current Medicare payments include a composite rate, which includes the dialysis procedure, supplies, routine laboratory tests, and personnel, whereas "separately billable services" include injectables such as erythropoietin, iron, and vitamin D analogs. The articles being considered to be combined under the bundling services will include composite rate services as well as injectables, certain oral medications, laboratory tests currently not a part of composite services, and some other supplies such as blood products. Thus PD, in which there is far less use of injectables and utilization of labor, may financially come out ahead of HD.

Patient-Related Issues

There are several patient-related factors that contribute to underutilization of PD in the United States. As discussed previously, getting inadequate predialysis education is one of them. In a study of dialysis patients, 66% of incident dialysis patients were not presented with the option of PD at the initiation of dialysis or thereafter. There was a strong relationship between the probabilities of offering PD as a treatment option and the selection of chronic PD as a treatment modality (76). Thus, the current cohort of dialysis patients does not necessarily reflect patient choice (77,78). Geography and distance play an important role, and the distance to travel to the dialysis unit may also be a factor. A recent report from Canada showed a significant trend toward decreasing PD TF with increasing distance from their nephrologist, and patients living within 50 miles of their nephrologist had a higher likelihood of PD utilization than patients living further away (79).

In a study of the Dutch registry from 1994 to 1999, the investigators did not find that diabetes and patient gender were related to TF (67). That advanced age affects patient survival is widely accepted, but whether it leads to TF is somewhat controversial. In that study, with a population of over 4000 unselected PD patients, the investigators found a decrease in technique survival with advancing age. In another study, the TF rates were the same with patients older and younger than 55 years of age. Diabetics had a slightly higher TF rate, but the results did not reach statistical significance (6). In a prospective study of 262 patients Jaar *et al.* (35) found that 18.2% of patients switched because of fluid overload problems. Abdominal surgeries and malnutrition were other leading causes of PD failure in the study. Although dialysis provides life-sustaining therapy for patients with irreversible renal failure, it does not restore a normal quality of life. Over time a certain level of fatigue may occur in PD patients as a result of their disease and of their constant requirement to perform life-sustaining dialysis. This chronic patient burnout is another reason for PD dropout, especially if adequate psychosocial support is not available.

Proposed solutions. Patients' "burnout" should be handled with counseling; providing psychosocial support in the form of home visits by nurses or health aides can minimize this problem. Programs using "assisted PD," in which the therapy was performed with the assistance of a visiting nurse or a family member, have shown good results, especially in elderly and unplanned starts (79). Family support has been associated with an increase in PD eligibility from 63% to 80% and an increase in PD use from 23% to 39% among patients who had a barrier to self-care PD (80). Thus, assisted PD can help certain patients stay on PD longer. General debilitation from chronic illnesses is difficult to overcome. Although not yet FDA approved in the United States, use of one exchange a day of amino-acid-containing dialysate in malnour-

ished patients has been shown to improve protein anabolism in PD patients (81).

Conclusions

In conclusion, PD continues to be underutilized in many countries, including the United States. There are many factors that contribute to this underutilization (*e.g.*, modality-, system-, and patient-related factors). Several of these factors are modifiable, and with a concerted effort PD utilization can be increased. Patient and physician education and comfort with using this modality are critical. Techniques to prevent and minimize episodes of peritonitis, use of more biocompatible solutions in preserving the peritoneal membrane, and careful management of volume status can sustain the patient on PD. Use of drugs such as angiotensin converting enzyme inhibitors and angiotensin receptor blockers can preserve the membrane longer. Timely radiologic and surgical interventions can prevent the malfunction and loss of PD catheters. Psychologic help and assisted PD with home aides can minimize the phenomenon of burnouts. Finally, one also hopes that with the introduction of bundling of services for dialysis care into one payment, PD would offer a cost-effective therapy and generate a renewed interest in the dialysis community resulting in an initiative of PD first.

Disclosures

None.

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