The Epidemiology of Renal Replacement Therapy

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Sana Waheed and Micah R. Chan

Epidemiology of End Stage Renal Disease

Approximately 14% of the US adult population (more than 20 million patients) is affected by chronic kidney disease (CKD) [1]. For an individual, lifetime risk of CKD is high; with more than half of US adults aged 30–64 years old likely to develop CKD (Hoerger et al. 2015). CKD progresses in a substantial proportion of these patients to the point of needing some form of RRT. In 2013 alone, 120,000 patients reached End Stage Renal Disease (ESRD), of which 88% of patients started HD, 9% began PD and 2.6% received a preemptive kidney transplant [1]. (Fig. 1.1) After a year-by-year rise in ESRD incidence over two decades from 1980 through 2000, it has been roughly stable from 2000 to 2013. Regardless, the prevalence of ESRD in the United States has grown in recent years. As of December 31, 2013, there were more than 660,000 prevalent cases of ESRD in the US- an increase of 3.5% since 2012 and an increase of 68% since 2000 [1]. The vast majority of prevalent ESRD population is undergoing in-center hemodialysis (ICHD).

S. Waheed, MD • M.R. Chan, MD MPH (✉)
University of Wisconsin School of Medicine and Public Health, Division of Nephrology, Madison, WI, USA
e-mail: swaheed@medicine.wisc.edu; mr.chan@hosp.wisc.edu

The incidence rates of ESRD increase with age and the majority of patients who develop ESRD have diabetes or hypertension as the underlying cause of their kidney disease. Moreover, there are significant ethnic differences in the prevalence of ESRD. Compared to whites, ESRD prevalence is about 3.7 times higher in African Americans [1]. Recently, this increased risk of kidney disease in this population have been linked to G1 and G2 high-risk alleles for a gene *APOL1* that is located on chromosome 22 [2]. These high-risk alleles provide resistance to disease causing trypanosomiases, which led to their natural selection in the population [3].

Since most symptoms of CKD do not appear till late in the disease process, delay in diagnosis of CKD and referral to nephrology remains a big problem. Based on the USRDS data for patients starting ESRD therapy in 2013, it appears that 25% of patients received no nephrology care and an additional 13% had unknown duration of nephrology care prior to initiation of ESRD therapy. The duration of pre-ESRD care is also associated with age and young patients are most likely to have a longer duration (> 12 months) of pre- ESRD care [1].

The quality of life and the life expectancy of most patients on dialysis are low. Dialysis patients have a much higher mortality rate than the general Medicare population and also compared to Medicare patients with diabetes, acute myocardial infarction, heart failure and cancer. Dialysis patients younger than 80 years old are

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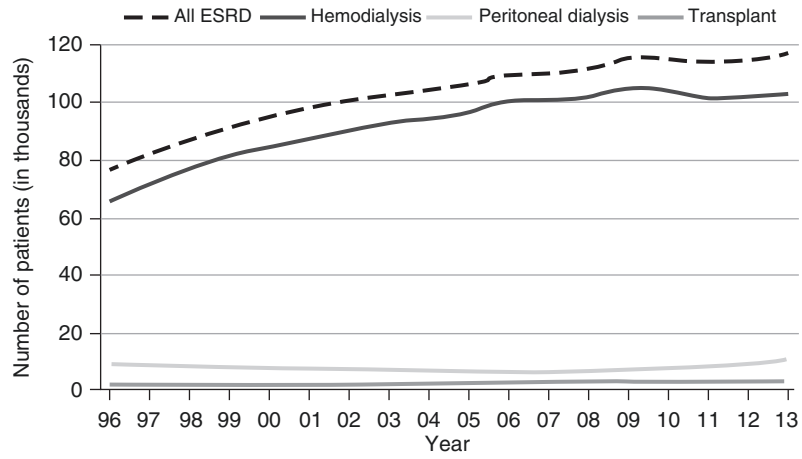

Fig. 1.1 Trends in the annual number of ESRD incident cases (in thousands) by modality, in the U.S. population, 1996–2013-USRDS ADR 2015 (USRDS-ADR [1])

expected to live less than one-third as long as their counterparts without ESRD. The major cause of death in these patients is related to cardiovascular events [1].

Unfortunately, in addition to the increased mortality rate, the quality of life for ESRD patients is adversely affected because of a high symptom burden. Moreover, they are often admitted to hospitals with volume overload, infections and access related complications. On average, ESRD patients are admitted to the hospital nearly twice a year, and about 30% have an unplanned re-hospitalization within the 30 days following discharge [4].

Cost

Chronic maintenance dialysis is an expensive procedure and Centers for Medicare and Medicaid Services extends coverage to all patients with ESRD who require dialysis or transplantation. When this was implemented in 1972, only about 10,000 patients were receiving dialysis, a number that has increased to over 469,000 patients with a cost of 30.9 billion dollars in 2013 [5]. This accounts for 7.1% of the overall Medicare paid claims cost for less than 1% of the total Medicare population [1].

The exact cost per patient per year depends upon the modality used, with HD being the most expensive at approximately $85,000 per patient per year (PPPY), followed by PD, which costs approximately $70,000 PPPY. Transplant is the most cost effective therapy with an expenditure of approximately $30,000 PPPY [1]. It is significant to point out that the difference in the expenditure of HD and PD in the US is not driven by a lower reimbursement to the dialysis units [6]. The amount paid to the dialysis units is the same for HD and PD but the higher cost for the HD population is mainly attributed to the cost of inpatient care and medication use [7]. Based on these numbers, one can deduce that PD is a financially attractive option for the ever-increasing population of ESRD patients in the US.

Utilization of Peritoneal Dialysis in United States

Although PD has been used as an RRT modality since 1976, the rapid growth of the ESRD population in the early 2000s was mostly due to patients undergoing ICHD [8]. Financial incentives for ICHD and concerns regarding the outcomes on PD were among the major reasons for this disproportionate increase in ICHD and as of 2008, less than 7% of the prevalent ESRD population was on PD [9]. The bundling of dialysis-related services led to a renewed interest in PD nationally with a 50% increase in the prevalent PD population from 2008 to 2013 (45,000 patients were on PD in 2013 compared to 30,000 in 2008) [1].

Despite this increase, the rate of PD utilization in the US is much lower than other countries like Hong Kong, Australia, New Zealand and Canada [10]. This difference cannot be solely attributed to

variance in patient characteristics but is rather a result of obstacles impeding the growth of PD in our health care system. Lack of informed decision-making in ESRD patients is the biggest barrier. A quarter of the patients starting dialysis receive no pre-ESRD care but even more worrying is the fact that two-thirds of the patients are not even offered PD as an option despite the fact that 87% of patients would be eligible for it [1, 11, 12]. It is extremely concerning that these numbers challenge the basic principles of autonomy and patient-centered care.

Another important issue is the lack of familiarization with PD in providers since most nephrology training programs focus on HD [13]. Based on the results of a recent survey, 88% of nephrology training program directors felt that PD fellow training was limited and 60% endorsed personal inadequate PD training [14]. As physicians, our practice is limited to what we are most comfortable with. Therefore, these training limitations translate into lower use of PD by providers during independent practice.

In addition to provider related aspects, the most important factor in determining dialysis modality selection is patient choice. Despite being presented with the option of PD, a substantial number of patients choose to undergo HD. Patients report the fear of something catastrophic happening at home without health care provider supervision, lack of space at home and feeling of social isolation as main barriers to selecting PD [15].

In summary, both provider and patient related issues limit the use of PD in the US, which have to be addressed at a national level. Several initiatives like the Home Dialysis University for fellows are addressing the deficiency in provider training. However, most importantly as a team of health care providers, we should emphasize enhancement in patient education and patient empowerment, allowing them to make a decision that suits their lifestyle.

Patient Selection for Peritoneal Dialysis

All ESRD patients should be assessed for PD eligibility. There are very few absolute contraindications to PD, which include lack of residence permitting PD, morbid obesity, large unrepaired abdominal wall hernias, expanding abdominal aortic aneurysm and active diverticulitis [16]. Most other factors like impaired vision, hearing, lack of dexterity to make PD connections, immobility and dementia are barriers, and these can potentially be overcome if a patient has assistance at home [16] (Table 1.1).

Table 1.1 Patient eligibility for peritoneal dialysis

Contraindications	Barriers
Place of residence does not permit PD	Impaired vision or hearing
Active diverticulitis	Insufficient strength or dexterity
Major abdominal surgeries	Immobility
Large unrepaired abdominal wall hernias	Dementia
Increasing abdominal aortic aneurysms	Poor hygiene
Acute psychiatric illness	Non-adherence

Modified from Blake and Quinn [16]

After evaluation of PD suitability, patients should then be offered a free choice as a part of modality education with written material, websites, videos, group lectures and one-to-one sessions on an as needed basis. The key here is to let the patients decide, as they are more likely to do better with the modality that they are interested in. Most studies show that half of the patients would choose PD if given the right [17].

Comparison of Peritoneal Dialysis to Hemodialysis

Historically, the studies comparing outcomes of PD and HD have focused on mortality and yielded controversial results. An ideal comparison would have been a randomized controlled trial, which has been attempted in the past with very low recruitment rates. Earlier epidemiologic studies based on US renal data system (USRDS) registry showed that PD was associated with a 19% increase in mortality [18]. This became the cornerstone of the argument that PD is somehow an inferior therapy compared to HD. However, there has been a significant improvement in outcomes of PD since then as shown in a study by Mehrotra et al., where the

composite outcome of mortality and change in modality over an 8 year period (between 1996 and 2003) showed a 17% improvement in PD outcomes as opposed to HD outcomes where there was no significant improvement [19]. More recent registry data from the USRDS and Denmark shows that there is no significant mortality difference based on the modality for RRT [20, 21]. In the US, the 5-year survival for patients starting RRT between 2002 and 2004 was 33% for PD compared to 35% for HD with no statistical difference.

Residual renal function (RRF) in dialysis patients contributes to small and middle molecular clearance and has effects on mortality with every 0.5 ml/min increase in glomerular filtration rate (GFR) being associated with a 9% lower risk of mortality [22]. HD is associated with a much faster rate of RRF decline (3.7 ml/min compared to 1.4 ml/min for PD at 12 months) which might be related to rapid changes in fluid homeostasis [23]. Moreover, selecting PD as an RRT method prior to transplantation has shown some positive effects on graft function [24].

However, patient outcomes are not only about biomedical outcomes but psychological outcomes are equally important-more so in some cases. PD is associated with more patient satisfaction. Patients receiving PD were much more likely than patients on HD to rate their dialysis care as excellent (86% vs 56% respectively) and including excellent ratings for each specific aspect of clinical care [25]. PD also allows greater flexibility in terms of travel and employment.

To summarize, PD and HD have similar medical outcomes but PD allows more flexibility. Ultimately the choice of RRT modality should be made by patients based on which modality is better suited to their lifestyle as the emphasis for patients is mostly on how they live-rather than how long [26].

Switching from Peritoneal Dialysis to Hemodialysis

The incident rates of PD in the US are lower than expected. Moreover, the probability of patients continuing the initial method of dialysis is much lower on PD compared to HD [27, 28]. A study of approximately 5000 incident PD patients resulted in a technique success of 58% at 5 years [29]. Other studies have shown that the majority of technique failure in PD occurs early (during the first year) and catheter dysfunction and psychosocial problems are more common during this period [30]. Despite the improvement in peritonitis rates in recent years, infections (peritonitis and catheter related) are the main reason for PD patients to transfer to HD overall [31].

Fluid overload likely secondary to ultrafiltration (UF) failure also results in transfer to HD. Loss of RRF and structural changes in the peritoneal membrane with increased lymphatic absorption and small solute transport are contributing to UF failure [32]. Abdominal surgeries, pancreatitis and malnutrition are some of the other reasons implicated in transfer of dialysis modality [33] (Table 1.2).

Risk factors for technique failure include older age, higher peritoneal membrane transport status, diabetes mellitus, lower neighborhood education level and increased body mass index [29, 33–35]. Interestingly, the center size is inversely related to the rate of technique survival. Centers with less than 20 patients have a 1.7 times higher likelihood of transferring to HD compared to centers with a higher number of patients [33]. A possible explanation for this trend is that centers caring for a large PD population are more experienced at dealing with complications and adjusting PD prescriptions to

Table 1.2 Factors involved in switching from PD to HD

Patient factors
Peritonitis
Catheter dysfunction
Ultrafiltration failure
Malnutrition
Patient preference
Abdominal surgeries
Pancreatitis
Patient preference
Provider factors
Center size
Lack of experience managing PD complications

Modified from Huisman and Nieuwenhuizen [33]

increase clearance and improving ultrafiltration without resorting to HD transfer.

It is often difficult to predict which patients will transfer to HD based on baseline characteristics and be able to predict patient success on PD. Therefore, the therapy should be offered to anyone who is interested in the absence of an absolute contraindication [28]. We should also limit the use of the term "technique failure" for transfer to HD as it implies that the patient or providers efforts were futile in some way. Rather, a more encouraging thought process is to consider that with the increased life expectancy of ESRD patients, they will likely need different RRT modalities during their lifetime. Even if someone was successfully able to do PD for 6 months, that's an extra 6 months spent at home instead of traveling to and from a HD unit. Only by this paradigm shift, will we be able to provide excellent care to our ESRD patients in the changing landscape of our healthcare system.

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