Relationship between Dialysis Modality and Mortality

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ABSTRACT

Mortality differences between peritoneal dialysis (PD) and hemodialysis (HD) are widely debated. In this
study, mortality was compared between patients treated with PD and HD (including home HD) using
data from 27,015 patients in the Australia and New Zealand Dialysis and Transplant Registry, 25,287 of
whom were still receiving PD or HD 90 d after entry into the registry. Overall mortality rates were
significantly lower during the 90- to 365-d period among those being treated with PD at day 90 (adjusted
hazard ratio [HR] 0.89; 95% confidence interval [CI] 0.81 to 0.99; $P < 0.001$). This effect, however, varied
in direction and size with the presence of comorbidities: Younger patients without comorbidities had a
mortality advantage with PD treatment, but other groups did not. After 12 mo, the use of PD at day 90
was associated with significantly increased mortality (adjusted HR 1.33; 95% CI 1.24 to 1.42; $P < 0.001$).
In a supplementary as-treated analysis, PD treatment was associated with lower mortality during the first
90 d (adjusted HR 0.67; 95% CI 0.56 to 0.81; $P < 0.001$). These data suggest that the effect of dialysis
modality on survival for an individual depends on time, age, and presence of comorbidities. Treatment
with PD may be advantageous initially but may be associated with higher mortality after 12 mo.

The merits of peritoneal dialysis (PD) compared
with hemodialysis (HD) therapy have been exten-
sively debated.[1] A key factor is the relative mortality
between modalities. The ideal vehicle for compari-
son is a randomized, controlled trial. Previous at-
tempts at such trials were complicated by lack of
statistical power[2] and poor recruitment.[3]

In the absence of trial evidence, large observa-
tional studies are of value, although they do not
directly offer evidence of causality. Several registry-
based or multicenter studies have been performed
but with conflicting results[4–17]; however, these
studies were performed in the United States or Eu-
rope, where rates of PD are generally lower than
those in Australia and New Zealand.[18]

Across Australia and New Zealand, PD is used to
treat between 20 and 40% of prevalent dialysis pa-
tients. Both modalities are available in all major
treatment centers. Thus, selection bias toward PD

either at a patient or a unit level is less likely than in
countries with lower PD usage.

RESULTS

Between October 1, 1991, and December 31, 2005,
28,460 people commenced renal replacement ther-
apy (RRT) in Australia or New Zealand. From this
group were excluded recipients of preemptive kid-

ney transplants ($n = 695$), those who were younger than 15 yr at RRT start ($n = 370$), those with a missing body mass index (BMI; $n = 193$), an extreme BMI (<15 [$n = 89$] or ≥ 50 kg/m^2 [$n = 98$]), and those who died ($n = 671$) or received a transplant in the first 90 d of RRT ($n = 301$) or had <90 d of follow-up recorded ($n = 692$) or a missing dialysis modality at 90 d ($n = 64$). This left 25,287 people for analysis, with 68,020 person-years of follow-up (Table 1). This included 44,679 person-years of HD treatment (including 7525 yr of home HD) and 23,341 person-years of PD (including 4234 yr of ambulatory PD). There were 11,066 deaths, with an overall mortality rate of 16.3 (95% confidence interval [CI] 16.0 to 16.6) per 100 person-years. There were differences in the prevalence of several comorbidities between dialysis modalities. The group receiving PD treatment at 90 d (PD$_{90}$) was older and more commonly obese. Coronary artery disease (CAD), type 2 diabetes, and peripheral vascular diseases wall ere more common among the PD$_{90}$ group. Smoking was less common among the PD$_{90}$ group, as was late referral. There was a temporal trend toward a decreasing frequency of PD$_{90}$. The proportion of

PD$_{90}$ in each treating unit ranged from 0 to 76% with a median value of 43%.

Prognosis by Dialysis Modality at 90 D

In univariate analysis, survival of the PD$_{90}$ group was inferior to those receiving HD ($P < 0.0001$, log-rank test), but this risk was not constant over time (Figure 1). The follow-up period was divided into 90 to 365 d and 1 to 2, 2 to 5, and ≥ 5 years after the start of RRT. In univariate analyses, mortality was similar in the first 12 mo ($P = 0.85$, log-rank test). In the period beyond 12 mo, there was a significantly higher mortality among those treated with PD at 90 d ($P < 0.0001$, log-rank test).

In multivariate analyses, there was lower mortality risk in the first year among those treated with PD at 90 d; however, from 1 yr, the PD group had an increased mortality risk (Table 2). This increase was similar across all periods after 12 mo. A subanalysis (data not shown) restricted to those with serum creatinine at commencement (i.e., commenced RRT from April 1, 1998) showed similar results.

Table 1. Characteristics of cohort by dialysis modality at 90 d after first RRT[a]

Characteristic	HD ($n = 14,733$; 39,163 person-years)	PD ($n = 10,554$; 28,857 person-years)	P
Person-years on PD (from day 90)	2481 (6%)	20,860 (72%)	
Modality at day 0 (among those on PD or HD at day 90)	14,353 HD (97%)	7042 (67%) PD	
Age (yr; median [IQR])	59.2 (46.6 to 69.9)	61.1 (48.8 to 69.8)	<0.001
BMI	1461 (10%)	1131 (11%)	<0.001
underweight	5326 (36%)	4055 (38%)	
normal	4605 (31%)	3401 (32%)	
overweight	3341 (23%)	1967 (19%)	
obese			
Male	9189 (62%)	5574 (53%)	<0.001
CAD	5416 (37%)	4282 (41%)	<0.001
Diabetes			<0.001
type 1	484 (4%)	595 (6%)	
type 2	4398 (30%)	3380 (32%)	
Chronic lung disease	2220 (15%)	1568 (15%)	0.600
Current cigarette smoking (at time of RRT start)	2082 (14%)	1328 (13%)	<0.001
Cerebrovascular disease	1933 (13%)	1641 (16%)	<0.001
Peripheral vascular disease	3480 (24%)	3027 (29%)	<0.001
Late referral	3736 (25%)	2420 (23%)	<0.001
Indigenous			
ATSI	1275 (9%)	567 (5%)	<0.001
Maori/PI	1093 (7%)	1409 (13%)	
Serum creatinine (quartiles at RRT start)[b]			<0.001
<581	2594 (27%)	1883 (31%)	
581 to 750	2475 (25%)	1688 (28%)	
751 to 950	2398 (25%)	1362 (22%)	
≥951	2321 (24%)	1144 (19%)	
Serum creatinine (μmol/L)[c]	673 (667 to 679)	644 (638 to 651)	<0.001
eGFR (ml/min per 1.73 m^2)[d]	7.10 (7.03 to 7.18)	7.27 (7.17 to 7.37)	<0.010

[a]ATSI, Aboriginal and Torres Strait Islander; eGFR, estimated GFR; IQR, interquartile range; PI, Pacific Islander.
[b]Only for those who started RRT from April 1, 1998; $n = 15865$ with reported creatinine.
[c]Harmonic mean.
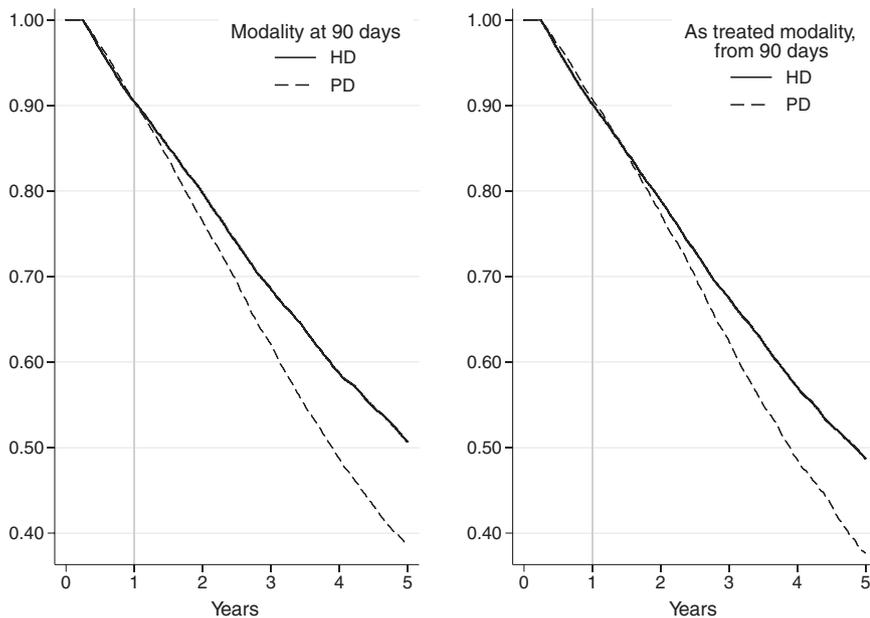[d]Arithmetic mean.

Figure 1. Kaplan-Meier survival curves, censored at transplantation, by RRT modality at 90 d (left) and as-treated modality, from 90 d. In the as-treated analyses, patients moved between groups at the date of treatment modality change. We then calculated the survivor function using the risk group at the point of each failure event.

Two-Way Interactions

In view of reports of interactions between BMI and dialysis modality, we stratified the analysis by BMI group. There was no interaction with 90- to 365-d mortality ($P = 0.2$ for interaction). A statistically significant interaction was observed with ≥ 12 mo mortality ($P = 0.0018$), although the effect size was clinically similar across all BMI categories (Figure 2). There was no interaction between the presence of diabetes at RRT start and the adjusted hazard ratio (HR) for PD:HD in either time period ($P = 0.6$ and 0.4, respectively).

There was a statistically significant interaction between vintage and the multivariate adjusted HR in the 90- to 365-d period ($P = 0.03$) and the adjusted HR from 1 yr ($P = 0.01$); however, this variation was of little clinical significance (Figure 3). There was also an interaction between age and the risk of PD for mortality in the 90- to 365-d period ($P < 0.001$) but not in the >1-yr period ($P = 0.7$). There was no statistically significant interaction of either the 90- to 365-d mortality or the ≥ 12

mo mortality with the proportion of PD treatment (at 90 d, divided at the median) within a treating renal unit.

Three-Way Interactions

Three-way interactions were specifically sought of the PD risk with age and diabetes and with age and the presence of any comorbidity (including diabetes). These were explored by combining age categories (split at 60 yr) with diabetes or any comorbidity as appropriate. There was no three-way interaction between dialysis modality and age and diabetes either in the first 12 mo ($P = 0.3$) or subsequently ($P = 0.4$); however, there was a statistically and clinically significant interaction among PD risk, age, and comorbidity: The benefit of PD in the first 12 mo was particularly great in the <60-yr group without comorbidities (Figure 4). The effect of this interaction is illustrated in Figure 5. The balance of risks in the first and later years leads to differing "crossover" points in each group.

Interactions with indigenous racial origin were also examined within each group. The only statistical significant variation was between the HR for death within 12 mo among the group with comorbidity <60 yr and with diabetes <60 yr; however, neither of these was clinically significant (data not shown).

Prognosis by "As Treated" Dialysis Modality

When examined using the dialysis modality actually delivered as a time-dependent variable, there was a progressive increase in the risk associated with PD over time (Figure 6). Sensitivity analyses in which analyses were repeated with modality changes occurring within 30 or 60 d of death ignored and death attributed to the previous modality showed a similar pattern of results.

Propensity Score Approaches

The logistic regression models used covariates for BMI, age, gender, race (nonindigenous/Aboriginal and Torres Strait

Table 2. HR for mortality associated with PD compared with HD using various methods

| Approach	HR for PD Compared with HD			
	90 to 365 d		≥366 d	
	HR (95% CI)	P	HR (95% CI)	P
Multivariate Cox model: Treatment at 90 d	0.80 (0.81 to 0.96)	0.004	1.32 (1.26 to 1.38)	<0.001
Multivariate Cox model: Treatment modality as time-varying factor	0.82 (0.75 to 0.81)	<0.001	1.29 (1.23 to 1.35)	<0.001
Propensity score: Matched cohort	0.99 (0.89 to 1.10)	0.800	1.35 (1.27 to 1.42)	<0.001
Weighted multivariate Cox model: inverse probability of treatment weight	0.93 (0.83 to 1.03)	0.180	1.31 (1.24 to 1.38)	<0.001
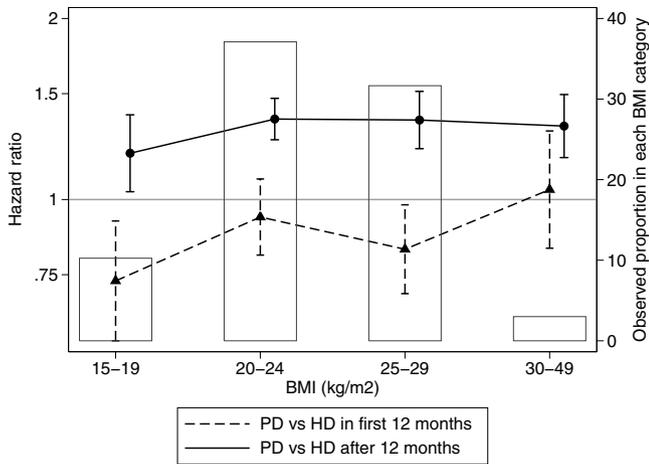
Figure 2. HR for mortality during PD *versus* during HD, by modality at 90 d, stratified by BMI at RRT start. ▲, Risk (95% CI) for death within 12 mo of RRT start; ●, risk for death ≥12 mo after dialysis start. Also shown is the proportion of the cohort in each BMI category.
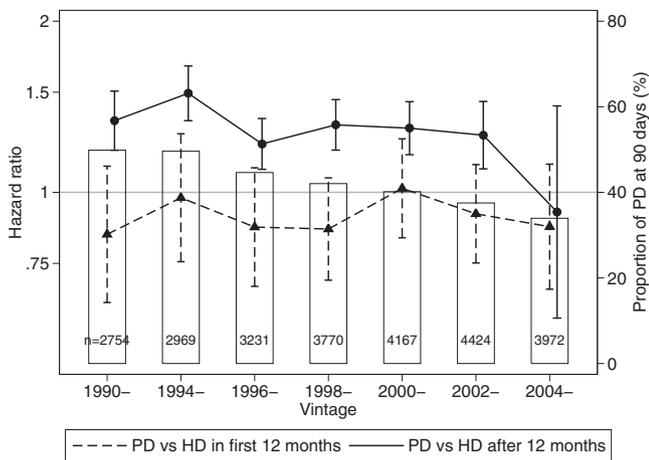

Figure 3. HR for PD *versus* HD by year of starting dialysis. ▲, Risk (95% CI) for death within 12 mo of RRT start; ●, risk for death ≥12 mo after dialysis start. The numbers above the x axis indicate the number in each subcohort.

Islander/Maori and Pacific Islander), comorbidities (CAD, peripheral vascular disease, chronic lung disease, diabetes), late referral, country of initial treatment (Australia/New Zealand), and vintage (in 2-yr blocks). This logistic regression model initially had only modest fit: The area under the receiver operating characteristic was 0.64 but improved to 0.71 with inclusion of treating center. The overall predicted probability of PD was only slightly different between those treated with PD and those treated with HD. The HR for mortality with PD did not vary across quartiles of predicted PD probability in the 90–365 day period; from 366 days onward there was some statistical although not clinical significant variation between quartiles groups ($P = 0.67$ for interaction with mortality 90 to 365 d and $P = 0.03$ for interaction with ≥12 mo mortality; Figure 7).
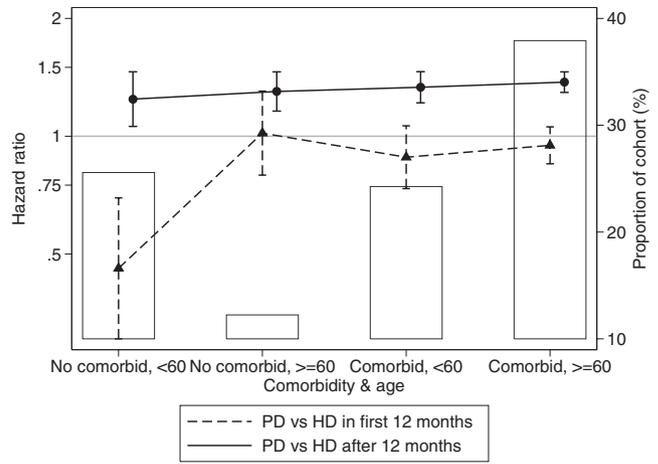

Figure 4. Risk of PD compared with HD stratified by age and the presence of any comorbidity. ▲, Risk (95% CI) for death within 12 mo of RRT start; ●, risk for death ≥12 mo after dialysis start. There is statistically significant variation in the risk for death in the 90- to 365-d group ($P = 0.005$ for interaction) but not for the >1-yr group ($P = 0.5$ for interaction).

Using nearest-neighbor matching, we conducted analyses among a matched cohort of 16,791 people (10,542 PD at 90 d and 6249 HD at 90 d). There was no difference in mortality over 90 to 365 d, but after 12 mo, there was excess mortality in the PD group, similar to the other approaches (Table 2).

Inverse Probability of Treatment Weights
Weighting of observations by the inverse probability of treatment led to similar results as other techniques (Table 2).

Outcomes among Modality "Switchers"
The group with the lowest mortality during the 90- to 365-d period were those who were treated with PD at both day 0 and day 90; the groups who started with HD had similar results in this period regardless of whether they stayed on HD or switched to PD, whereas those who began on PD and switched to HD had a higher mortality in the 90- to 365-d period (Table 3). In contrast, after 1 yr, the group who were treated with HD at both day 0 and day 90 had the lowest mortality, with the other three combinations similar to each other (Table 3).

Among those who survived to 1 yr, subsequent mortality risk was examined by modality at 90 and 365 d. Compared with those who were on HD treatment both at 90 and 365 d, all other groups had an increased risk, particularly those who changed from HD at 90 d to PD by 365 d (Table 4).

The First 90 D
In a further supplementary analysis, we also examined the relationship between "as treated" modality and outcome in the first 90 d. A total of 27,015 people fit the other inclusion criteria and commenced RRT; among whom there were 671 deaths
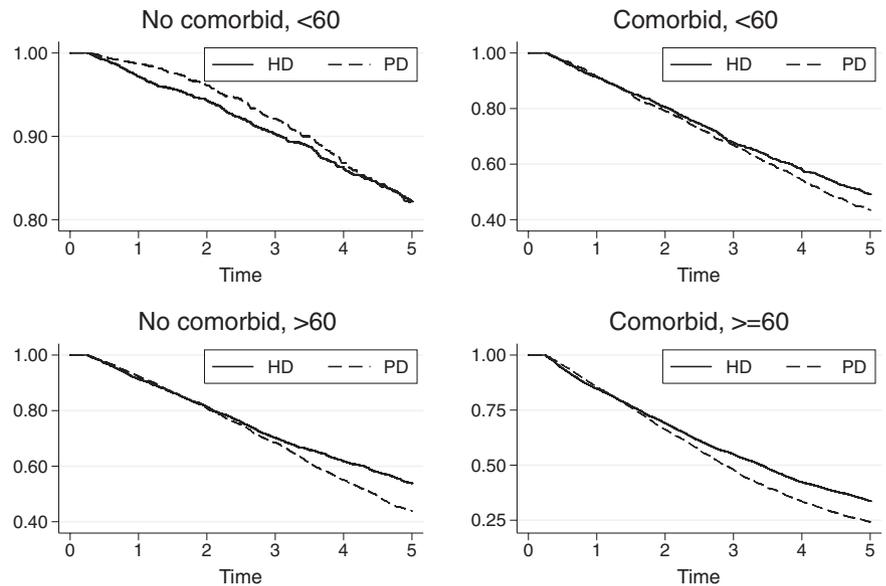
Figure 5. Kaplan-Meier graph by modality of treatment at 90 d, by presence of any comorbidity and age group at RRT start. ▲, Risk (95% CI) for death within 12 mo of RRT start; ●, risk for death ≥12 mo after dialysis start. Graphs are adjusted for vintage (to year 2000) and gender (to equal male and female numbers). Note that the y axes differ between panels.
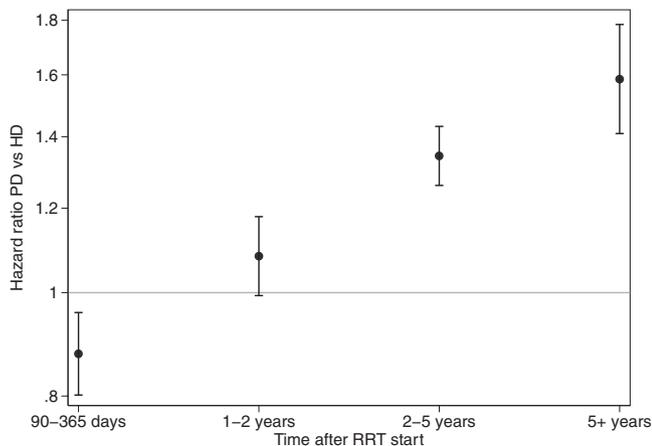

Figure 6. HR for mortality for patients treated with PD compared with HD, treating modality as a time-dependent covariate (*i.e.,* analyses of modality as treated). HR are adjusted for all measured covariates and derived from shared frailty Cox model.

before 90 d at a rate of 10.3 (95% CI 9.6 to 11.2) per 100 person-years. In this period, PD treatment was associated with lower mortality (adjusted HR 0.67; 95% CI 0.56 to 0.81; $P <$ 0.001), consistent with the trends shown over later time periods (Figure 6).

DISCUSSION

In a large registry-based data set, we showed mortality rates are lower in some groups in the 90- to 365-d period in the PD_{90} group than those receiving HD, especially when they were treated with PD from day 0. From 12 mo after dialysis start, however, the mortality risk was consistently higher among the PD group. This was shown in an environment that has a higher prevalence of PD treatment and where PD-treated patients tend to have more comorbidities, in contrast to most other
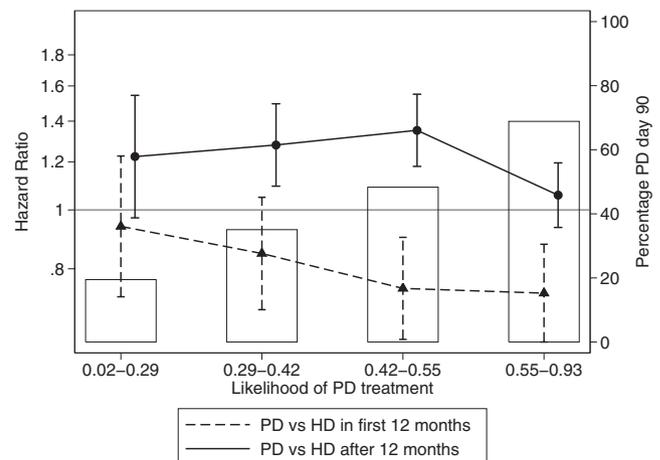

Figure 7. HR for mortality associated with PD treatment compared with HD, by quartile of predicted probability of PD treatment at 90 d. ▲, Risk (95% CI) for death within 12 mo of RRT start; ●, risk for death ≥12 mo after dialysis start. The bars indicate the observed proportion of people who received PD at 90 d in each quartile.

studies. Among younger patients (<60 yr) without comorbidity or diabetes, the PD_{90} group experienced better survival over 90 to 365 d. Of those who survived the first year, all comorbidity/age groups showed a higher mortality rate among those treated with PD from 12 mo, although the size of this effect was lesser among the patients who were younger than 60 yr at RRT start and had no comorbidity. The balance of these effects was such that, among the patients who were younger than 60 yr, had no comorbidities, and were treated with PD at 90 d, the initial survival advantage persisted until 4 yr. If the results of the supplementary analysis are valid, then this "crossover" would be further affected by the increased mortality among those treated with HD in the first 90 d.

Previous publications in this field have shown varying and

Table 3. Adjusted HR for mortality by dialysis modality at first treatment and 90 d

Parameter	HD at Day 0		PD at Day 0	
	HR (95% CI)	P	HR (95% CI)	P
90 to 365 d				
HD at day 90	1.00 (referent)		1.36 (1.04 to 1.78)	0.030
PD at day 90	1.09 (0.97 to 1.23)	0.140	0.87 (0.78 to 0.97)	0.010
≥366 d				
HD at day 90	1.00 (referent)		1.13 (0.95 to 1.34)	0.160
PD at day 90	1.34 (1.26 to 1.43)	<0.010	1.28 (1.22 to 1.31)	<0.001

Table 4. Adjusted HR for mortality by dialysis modality at 90 and 366 d[a]

Parameter	HD at Day 90		PD at Day 90		Totals
	HR (95% CI)	P	HR (95% CI)	P	
HD at 1 yr	HR = 1.0 (reference)		HR = 1.24 (1.13–1.37)		n = 11,424
	n = 10,466		n = 958	<0.001	
PD at 1 yr	HR = 1.56 (1.41–1.87)		HR = 1.38 (1.31–1.44)		n = 8375
	n = 856	<0.001	n = 7519	<0.001	
Total	n = 11,322		n = 8477		n = 19,799

[a]Total $n = 19,799$, because only 1-yr survivors are included. HR are relative to people who were receiving HD at day 90 and 1 yr. All of theses risks significantly differed from each other in addition to the HD_{90}/HD_{365} group. These risks did not significantly interact with BMI categories ($P = 0.2$ for interaction) or with comorbidity and age ($P = 0.14$ for interaction).

conflicting results. Three articles, based on US Renal System (USRDS) data sets, also showed interactions with comorbidities and follow-up time.[5,19,20] An area that has received particular attention is the interaction between obesity and RRT modality: Analysis of a large incident US cohort showed higher mortality rates among PD patients within the upper three BMI quintiles, apparent from 6 to 24 mo after dialysis initiation.[19] In contrast, in our analysis, the association of PD at 90 d with poorer survival was seen across all BMI groups from 12 mo. Comorbidities were also studied in a similar USRDS cohort, with similar results to those seen here. Ganesh et al.[20] found higher mortality risk associated with PD among patients who had diabetes with and without CAD and patients who did not have diabetes and had CAD but not in patients who did not have diabetes or CAD. Despite the similarities in results to those of our study, there were substantial differences in the composition of the US cohort (including a lower PD prevalence of 13%).[19,20] Similar conclusions were drawn from an analysis of a smaller cohort, also based on USRDS.[21] A higher mortality risk with PD in the 7- to 12-mo period was seen among patients with but not without diabetes in an inception cohort of ≥65-yr-old people in New Jersey, although the study power did not exclude an effect size similar to ours.[22] A different approach to confounding—restriction—was taken by Inrig et al.,[23] whose cohort was limited to those accepted onto the transplant waiting list. Not surprising, the absolute mortality rates were lower, but worse outcomes remained among people treated with PD, again with an interaction with obesity. In a separate (non-USRDS) study, Jaar et al.[14] examined a cohort of 1041 patients in 81 clinics in the United States and showed no mortality difference in the first year of treatment but an excess mortality from that point among those treated with PD.

Comparisons in other countries have shown varying results. A study of 2284 patients in Romania did not show any mortality difference among older patients but did show greater mortality among younger patients who had diabetes and were treated with HD.[24] Others have shown a similar pattern of progressive increase over time in PD compared with HD. A Danish registry study showed improved mortality in the first 2 yr among those treated with PD, with equivalent results thereafter.[25] An earlier Canadian registry–based study showed lower mortality rates among PD- compared with HD-treated patients among an incident cohort of 11,970 people.[13] A recent Dutch registry study[16] showed a substantial benefit to PD in early treatment among younger people without diabetes, with lesser benefit among other groups, with a subsequent change to increased longer term mortality associated with PD. Other groups have attempted comparisons but were limited by small numbers.[7,26,27]

Many studies have shown a changing risk over time, with an increase in the mortality risk of PD compared with HD. Several factors may influence this; better preservation of residual renal function associated with PD may explain this.[28] Residual renal function has been associated with a lower risk for death among PD[29,30] and HD patients.[31] In our data, the better survival among the PD_{90}/HD_{365} group compared with the PD_{90}/PD_{365} group was not consistent with this.

Another factor might be catheter use among HD patients; use of both tunneled and nontunneled catheters is associated with a higher mortality rate.[32] Rates of catheter use among incident and prevalent patients in Australia and New Zealand have increased in recent years but are still low by international standards.[33] Lower catheter rates than in other studies might explain an advantage for HD over PD and also a trend toward

HD over time since RRT start (as catheter use falls). This would be consistent with the higher mortality rate of the group who began RRT on HD then switched to PD at 90 d compared with those who began and stayed on PD.

A third possible factor is the start point of the cohort: Exclusion of patients who did not survive 90 d may exclude patients at risk for early mortality; if this group is more likely to be treated with HD, then this would tend to advantage HD. This is consistent with our supplementary analysis. Whether this is due to selection bias or technique issues (*i.e.*, catheter use) is not clear; however, the Australian and New Zealand Dialysis and Transplant (ANZDATA) Registry does not collect details of residual renal function or dates of catheter use among people receiving HD to examine possible mechanisms.

Although we did examine the relationship between as-treated modality and outcomes in the first 90 d, there are substantial and important limitations to analysis of this period. Inclusion in the ANZDATA Registry is based on a clinical diagnosis of end-stage kidney disease (ESKD) with an "intent" of long-term RRT. Thus, situations of prolonged acute renal failure may be included or cases of true ESKD not included (*e.g.*, if they present as acute on chronic renal failure and die) and bias comparisons in the first 90 d in this data set. The lower reported mortality in this period emphasizes the difficulty in interpreting outcomes during this early period in this data set. In addition, there was substantial instability of modality—people who commence HD and then change to PD by 90 d. Examination of this early period is an important issue but one that will require more detailed cohort definition and data collection than that available from the ANZDATA Registry to ensure an unbiased comparison. The difference in renal function at the commencement of dialysis suggests those treated with PD started RRT earlier in their disease course, suggesting "lead-time bias"[34]; however, this would tend to favor better survival among the PD group and thus does not explain our findings.

Like all cohort studies, our study is subject to biases that affect the comparability of our results with others. Treated ESKD incidence rates in Australia are approximately 100 per million per year, substantially lower than in the United States and slightly lower than many European countries.[35] The nature of our cohort does reduce some sources of bias: We included all patients who began RRT in either country during the time period, including centers with varying rates of PD and transplantation. Ultimately, statistical techniques can adjust only for measured factors, and the presence of unmeasured confounders in registry-based studies with limited comorbidity ascertainment is possible.

The results from the propensity score analyses were similar to those from the principal analyses. This is similar to other instances in which the use of propensity scores seems to have little effect on inferences drawn from observational studies.[36] The modest fit of the logistic model emphasizes that there are likely to be other unmeasured factors relevant to the outcome; however, the absence of an interaction of the dialysis modality–associated risk with the predicted probability of PD lends a clinical interpretation that the difference in outcomes applies to all types of patients: Those for whom PD is commonly used and those "harder" patients, for whom it is less used.

There are many reasons behind choice of dialysis modality, including quality of life, patient satisfaction, local practice and expertise, funding, and geography; however, mortality is a key consideration. From this perspective, for young patients without comorbidities, PD is a reasonable short- and medium-term therapy that seems to provide a survival advantage compared with HD during the first few years. For other groups, no initial survival advantage of PD relative to HD is apparent, and PD was associated with survival disadvantage after the first 1 to 2 yr. Whether this is causal cannot be inferred from an observational study, but our data suggest caution in the use of PD in many patients, particularly when this therapy is continued beyond 1 to 2 yr. The potential for bias in analyses of observational cohorts underlies the need for randomized trials. A further attempt at such a trial is in early stages.[37]

Despite their weaknesses, large registry-based cohort studies are likely to remain the best available form of evidence to guide dialysis modality choice for some time. A more detailed data collection and more precise definitions, likely part of a prospectively designed cohort study, will be needed to address more accurately issues of mortality within the first 90 d of commencing RRT.

CONCISE METHODS

We examined outcomes for all patients in the ANZDATA Registry who commenced dialysis from October 1, 1991 to October 1, 2005, comprising all incident patients with ESKD in Australia and New Zealand during that time. The registry includes all those who receive RRT in Australia and New Zealand with the intention of chronic treatment.

RRT modality was classified into HD (including hospital-, satellite-, and home-based HD), PD (including continuous ambulatory PD and automated PD), and transplantation. The dates of commencement and cessation of each modality were retrieved, with information available to December 31, 2005. Brief changes from PD to HD as dialysis modality (<30 d) are not recorded, because they are assumed to be temporary interruptions related to peritonitis or technical events. Other information available included mortal status at December 31, 2005, and comorbid conditions at commencement of RRT (reported as the presence of CAD, peripheral vascular disease, cerebrovascular disease, and chronic lung disease and presence and type of diabetes) together with cigarette smoking. Late nephrologist referral (<6 mo before dialysis start for those who commenced from April 1, 1994, to March 31, 1997, and <3 mo before dialysis for those who started after April 1, 1997) was collected for those who commenced from April 1, 1994. From height and weight at commencement of dialysis, BMI was calculated and categorized into underweight (<20 kg/m²), normal (20 to 24.9 kg/m²), overweight (25 to 29.9 kg/m²), and obese (≥30 kg/m²). Serum creatinine concentration at commencement of RRT was collected prospectively only for people

commencing RRT after April 1, 1998. A subanalysis was performed for those commencing after this date.

Patients who survived <90 d from the date of initial treatment were excluded from the main analyses. Survival analyses used Cox regression. Models were built using backward stepwise elimination and a threshold of 0.10 for retention. Unmeasured variation between treating centers was addressed by using a shared frailty Cox model, clustered by center. Records were censored at the date of first transplantation or December 31, 2005.

Six approaches to analysis were used. For the first two, we considered dialysis modality in two ways: As the modality in use at 90 d after initial treatment and as a time-dependent variable. These are analogous an intention-to-treat and as-treated analyses. For approaches 3 and 4, we used a propensity score method. We created a multiple logistic regression model with dialysis modality at 90 d as the dependent variable. All of the covariates available were used in creating this model.[38] We then calculated a predicted probability of PD treatment for each person (PS). We created models with and without the treating center as a covariate. For the third approach, we compared HD and PD groups (using modality in use at 90 d) in Cox models within PS quartiles on the basis of the predicted probabilities. In the fourth approach to analysis, we created a matched data set using the PS using "nearest neighbor" matching (where the PS was within 0.05). In approach 5, we performed comparisons between the PD and HD groups after the weighting by the inverse probability of treatment (at 90 d) for each individual.[39] This was implemented using the "iweight" facility of Stata. Finally, in approach 6, we compared outcomes among those whose dialysis modality at 12 mo differed from that at 90 d and those who started and remained on PD with those who remained on HD at both time points. In a supplementary analysis, we examined outcomes among the cohort in the first 90 d using the as-treated approach; the other inclusion criteria and methods were unchanged for this analysis.

ACKNOWLEDGMENTS

DISCLOSURES

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