Use and Outcomes of Peritoneal Dialysis among Aboriginal People in Canada

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There has been a dramatic increase in the incidence of ESRD among Aboriginal people in North America. Although peritoneal dialysis (PD) seems to be the dialysis modality of choice for this often rural-dwelling population, few data exist to confirm this. This study was conducted to evaluate rates of PD use, technique failure, and mortality among incident Aboriginal dialysis patients. Adults of white or Aboriginal race who initiated dialysis in three Canadian provinces between January 1, 1990, and December 31, 2000, were included and followed until December 31, 2001. Logistic regression and Cox proportional hazards models were used to examine adjusted associations between Aboriginal race and PD use, technique failure, and mortality. Among the 3823 patients of white (n = 3138; 82.1%) or Aboriginal (n = 685; 17.9%) race, 835 (21.8%) initiated dialysis on PD. After adjustment for age and comorbidity and comparison with white patients, Aboriginal patients were significantly less likely to initiate therapy on PD compared with white patients (odds ratio, 0.51; 95% confidence interval, 0.40 to 0.65), with a nonsignificant trend toward a higher risk for technique failure (hazards ratio, 1.46; 95% confidence interval, 0.95 to 2.23). Adjusted survival among Aboriginal PD patients seemed similar to both white PD patients and Aboriginal patients who were treated with hemodialysis. In summary, among people who were treated with dialysis in Canada, PD was used less frequently in Aboriginal patients than in those of white race. Although Aboriginal patients who initiate dialysis on PD seemed more likely to experience technique failure, their adjusted risk for death was similar to that of white patients. Future studies should address barriers to the initiation and maintenance of PD in the Aboriginal population, especially those who reside in rural locations.


In North America and elsewhere, the incidence of diabetic nephropathy and ESRD among adolescent and adult Aboriginals has risen dramatically (1–5). For instance, there was an approximately eightfold growth in the number of prevalent Aboriginal patients who received dialysis treatment in Canada between 1980 and 2000 (6).

In the Canadian prairie provinces (Alberta, Saskatchewan, and Manitoba), Aboriginals account for approximately 8% of the total population but approximately 16% of prevalent dialysis patients (7,8). In these provinces, Aboriginals with ESRD are more likely to reside in rural or Northern locations than other dialysis patients, where hemodialysis units may be hundreds of kilometers apart. Extended social support networks play a major role in Aboriginal culture (9–11). Therefore, peritoneal dialysis (PD) might be particularly attractive to Aboriginal people with ESRD, as it would enable them to continue residing in their local communities rather than relocating to a region served by a hemodialysis unit.

Older age and diabetic status seem to be powerful determinants of survival among patients who are treated with PD (12–15). Although Aboriginal patients with ESRD tend to be younger than non-Aboriginals, suggesting that their prognosis on PD might be favorable, the high prevalence of diabetes among this segment of the population may offset any survival advantage associated with younger age.

Despite the rapid growth in the global prevalence of Aboriginal people with ESRD, little is known about use of PD as a form of renal replacement therapy (RRT) in this population. In addition, there are few data describing the health outcomes of Aboriginals who are treated with PD. We conducted this study to evaluate rates of PD use, technique failure, and mortality.
among Aboriginal people who commenced renal replacement in the Canadian prairie provinces.

Materials and Methods

Study Population
We studied white or Aboriginal adult patients who initiated renal replacement in the three Canadian prairie provinces (Alberta, Saskatchewan, and Manitoba) between January 1, 1990, and December 31, 2000. The study was restricted to these provinces (where the majority of the Aboriginal population is from the Cree, Ojibway, and Blackfoot tribes) to increase the homogeneity of the population. Similarly, because differential access to transplantation might affect survival on dialysis, we considered only patients who were treated in centers with kidney transplant programs (approximately 80% of all individuals who initiated dialysis treatment within these provinces during the study period).

Data Sources
Deidentified data were provided by the sole Canadian national population-based organ failure registry, Canadian Organ Replacement Registry (CORR), to perform this study (8,16). Patient-specific data are submitted annually to CORR by all Canadian dialysis centers. The CORR registry records patient demographics, initial dialysis modality, and comorbid conditions at the time of first dialysis treatment. Changes in treatment modality (including transplantation), dates of allograft failure, and death are also recorded.

Outcomes
We examined the race-specific rates of PD use, PD technique failure, and all-cause mortality. PD technique failure was defined as a switch from PD to hemodialysis that was sustained for at least 90 d. We attempted to classify technique failure as peritonitis related or peritonitis unrelated but found that information on the cause of technique failure was missing in a large number of patients. Patients with more than one episode of technique failure were counted only once, with the date of their earliest technique failure used. We also examined switches from hemodialysis to PD, defined as at least 90 d of PD treatment in a patient who was previously maintained on hemodialysis. In all analyses, follow-up was censored at loss to follow-up, recovery of renal function, renal transplantation, or end of study (December 31, 2001). An additional analysis compared the risk for death associated with PD use between Aboriginals and whites but did not censor at time of transplantation. This was done to determine the impact of differential transplantation rates by race.

Classification of Patient Race
Patients for whom information on race was missing or inconsistent were excluded. In the CORR registry, patient race is categorized as white, black, Aboriginal, Asian, Indian subcontinent, Mideast/Arabian, Pacific Islander, other, and unknown. The CORR instruction manual for data collection defines Aboriginal race as people of “First Nations, Inuit, or Metis” origin, but determination of race is made at the discretion of the health care professional, because CORR procedure does not require that patients be asked directly about racial status. Because the focus of this study was on individuals of Aboriginal race and because nonwhite, non-Aboriginal individuals who require RRT have lower mortality rates than white individuals (17), the current analysis included only comparisons between white and Aboriginal patients.

We estimated socioeconomic status using the neighborhood income per person equivalent (IPPE), a household size–adjusted measure of household income, based on 1996 Canadian census summary data. Within each community, the average IPPE was used to rank all subcommunities, and then the population was divided into fifths, thus creating community-specific income quintiles (18). Community size, also obtained from census data, was used as a surrogate for location of residence, characterized by a four-level categorical variable ranging from <10,000 people (rural) to large centers with >500,000 people (urban).

Association among PD Use, PD Technique Failure, and Race
The frequency of initiating dialysis on PD was compared between whites and Aboriginals using the \( \chi^2 \) statistic. We used multivariate logistic regression analysis to determine the adjusted likelihood of commencing RRT on PD in patients of different race. Interaction terms were used to examine whether factors that influence the likelihood of PD varied by race.

In patients who initiated RRT on PD, the association of race and other factors with technique failure was determined in univariate and then multivariate Cox regression analyses. The adjusted time to technique failure in patients of Aboriginal and white race was estimated from the multivariate Cox regression analysis using the mean value of each covariate included in the final model (19).

Association between Switches from Hemodialysis to PD and Race
We used multivariate logistic regression analysis to determine the adjusted likelihood that Aboriginals who initiated renal replacement on hemodialysis would experience a sustained switch (≥90 d) to PD, compared with white patients.

Association between Dialytic Modality and Mortality in Aboriginal Patients
Cox proportional hazards models were used to determine the independent association between Aboriginal race and mortality among patients who commenced RRT on PD. Additional proportional hazards models were used to examine the relation between initial dialytic modality and mortality among Aboriginal patients. For these analyses, Aboriginal patients from the study population who commenced RRT on hemodialysis during the study period were used as control subjects. Because the hazard for mortality associated with PD (compared with HD) varied within periods defined by the time elapsed since dialysis inception (<2 yr and ≥2 yr), we used separate estimates of the hazard in these two time periods. We then used interaction terms between race and dialytic modality to determine whether the association between mortality and PD varied by racial group (15).

Factors that were considered in the logistic and Cox models included patient demographics, initial and subsequent dialytic modalities and submodalities (e.g., automated peritoneal dialysis), socioeconomic status (IPPE), smoking status, the year of dialysis initiation, community size, and dialysis center (to account for regional differences in clinical practice). Information on comorbid conditions and diseases including diabetes; coronary disease (angina, myocardial infarction, previous coronary artery bypass grafting); history of hypertension, chronic heart failure, stroke, chronic lung disease, and peripheral vascular disease (limb loss, gangrene, peripheral revascularization); known malignancy; and other serious illness that would be expected to reduce technique or patient survival were also included in the Cox regression analyses.

Statistical Analyses
We tested the proportional hazard assumption in all Cox models by examining plots of the log-negative-log of the within-group survivor-
ship functions versus log-time as well as comparing Kaplan-Meier (observed) with Cox (expected) survival curves. Statistical analyses were performed with SAS software version 8.2 (Cary, NC) and with STATA software version 8.0 (College Station, TX). The ethics review board at the University of Alberta approved the study.

Results

Patient Characteristics

Of 4840 individuals who commenced RRT during the study period, race could be determined for 4333 (89.5%) overall and for 951 (95.9%) of 992 of those who initiated treatment on PD. Aboriginal patients accounted for 685 (15.8%) of 4333 of the study population compared with 8.7% of the total population in the catchment area. This suggests that the unadjusted prevalence of ESRD is approximately twofold higher in Aboriginal people, compared with non-Aboriginals. The 510 patients who were neither Aboriginal nor white were excluded.

Demographic and clinical characteristics of the remaining 3823 patients are shown in Table 1. Aboriginal patients who commenced RRT were younger, more likely to be female, and more likely to have diabetes than white patients. Aboriginal patients were also less likely to receive a renal transplant, more likely to be in the lowest quintile of socioeconomic status, and more likely to live in a rural center compared with patients of white race.

In the 835 eligible study patients who initiated dialysis on PD, 101 (12.1%) were Aboriginal. Demographic differences by race among those who initiated PD were similar to those shown in Table 1. For instance, among those whose first dialytic modality was PD, 65.4% of Aboriginal patients lived in rural areas, compared with 33.2% of white patients ($P < 0.0001$; Table 2).

PD Use

In univariate analyses, Aboriginal patients were significantly less likely than those of white race to commence RRT on PD ($P < 0.0001$). This was true of Aboriginals who lived in both rural ($P < 0.001$) and urban locations ($P < 0.001$). Among those who commenced dialysis treatment on PD, the proportion who used automated PD was similar in Aboriginals and whites (20.8 versus 15.8%; $P = 0.20$). The proportion for whom PD was the initial modality significantly decreased during the study period for both Aboriginal and white patients (both $P < 0.005$ by Cochran-Armitage test; Figure 1). The decrease in the likelihood of initiating dialysis on PD was similar over time for

<table>
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<tr>
<th>Table 1. Demographic and clinical characteristics of white and Aboriginal patients who initiated renal replacement therapya</th>
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<tr>
<td>Aboriginal (n = 685)</td>
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<tr>
<td>Age (yr)$^b$</td>
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<tr>
<td>Male gender</td>
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<tr>
<td>Cause of ESRD</td>
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<tr>
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<td>glomerulonephritis</td>
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<td>Peritoneal dialysis as initial modality</td>
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<td>Transplantation during follow-up</td>
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<td>Residence in rural location</td>
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<td>Lowest quintile of socioeconomic status</td>
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$^a$N (%) or mean ± SD as appropriate. TIA, transient ischemic attack.

$^b$P for comparison between groups using t test.

$^c$Including patients with diabetic nephropathy.

$^d$Angina, myocardial infarction, or previous coronary artery bypass graft.
white and Aboriginal individuals in a logistic regression model
\((P = 0.54\) for interaction between race and year of dialysis initiation).
95% CI, 0.84 to 0.93), gender (OR for men, 0.79; 95% CI, 0.67 to 0.93), and residence in a rural location (OR, 1.22; 95% CI, 1.02 to 1.45). Patients with documented heart failure (OR, 0.80; 95% CI, 0.65 to 0.98) or a serious nonrenal condition that was believed to adversely affect life expectancy (OR, 0.57; 95% CI, 0.41 to 0.53) were less likely to commence RRT on PD.

Tests for interaction between these characteristics and race all were nonsignificant, suggesting that the associations between these characteristics and initial use of PD were similar in Aboriginal and white patients. However, additional tests for interaction suggested that the association between initial use of PD and low socioeconomic status differed between white and Aboriginal patients ($P = 0.04$). In subsequent analyses that stratified by race, low socioeconomic status was associated with lower rates of PD use in Aboriginal patients but not in white patients.

**PD Technique Failure**

Among Aboriginal patients who initiated RRT on PD, the unadjusted rate of technique failure was 16.0 per 100 patient-years (95% CI, 11.3 to 22.6) and did not differ from that in white patients (14.1; 95% CI, 12.2 to 16.2; $P = 0.5$). In the multivariate Cox regression, there was a trend to an increased likelihood of technique failure in association with Aboriginal race, although this was statistically nonsignificant (hazards ratio [HR], 1.46; 95% CI, 0.95 to 2.23; $P = 0.08$). Figure 2 displays the plot of time to technique failure for Aboriginal compared with white patients.

**Switches from Hemodialysis to PD**

In addition to initiating dialysis less frequently on PD, Aboriginal patients were less likely to switch from hemodialysis to PD than white patients. Among the 3382 patients who initiated RRT with hemodialysis, 18.0% of Aboriginal patients switched to PD during follow-up, as compared with 22.7% of white patients (adjusted HR for switch to PD, 0.66; 95% CI, 0.53 to 0.81).

**Mortality**

In models that censored follow-up at the time of renal transplantation, the age-adjusted risk for death after the initiation of PD was nonsignificantly higher in Aboriginal compared with white patients (HR, 1.32; 95% CI, 0.99 to 1.75; $P = 0.06$; Figure 3A). However, in the fully adjusted model, mortality rates among Aboriginal patients were similar to those in white patients (HR, 1.00; 95% CI, 0.71 to 1.40; $P = 0.99$; Figure 3B). Results were similar in models that did not censor follow-up at the time of transplantation (data not shown). Interaction terms between Aboriginal race and dialytic modality were statistically nonsignificant ($P > 0.2$), suggesting that any association between PD and mortality was similar in Aboriginal and white patients.

To address the possibility of bias as a result of the exclusion of patients with missing race, we performed additional analyses in which all such patients were first classified as Aboriginal and subsequently as white. In these analyses, Aboriginal pa-
tients remained significantly less likely to initiate dialysis on PD, were more likely to switch from PD to hemodialysis, and had a similar risk for death, as compared with white patients (data not shown).

Discussion

Aboriginal patients were significantly less likely than patients of white race to commence RRT on PD or to switch from hemodialysis to PD after initiating dialysis. These findings are striking when one considers that Aboriginal patients with ESRD were younger and more likely to reside in rural areas than whites and that both of these characteristics were independently associated with PD use. After adjustment for these and other factors that might influence choice of dialytic modality, the likelihood of PD use was approximately 50% lower in Aboriginal patients than in whites. In addition, among Aboriginal patients whose first dialytic modality was PD, the risk for PD technique failure also seemed higher than in white patients, although this was statistically nonsignificant. Despite this, survival among Aboriginal PD patients seemed similar to both white PD patients and Aboriginal patients who were treated with hemodialysis after adjustment for comorbidity, suggesting that factors that predispose to PD technique failure do not result in increased mortality.

PD is associated with good patient outcomes (21,22), reduced health care costs (23), and increased patient independence. Despite this, the rate of PD use declined substantially over time for both white and Aboriginal patients. Clinical experience suggests that PD may be particularly suitable for patients who live in remote areas because it obviates the need to relocate to a region that is served by a hemodialysis unit. This is relevant because the preservation of social and cultural networks by treating ESRD in the patient’s community seems to be a high priority for many Aboriginal people (9–11). Although additional satellite hemodialysis units might also reduce the need to relocate among Aboriginal people with ESRD, this option may not be feasible for many smaller communities. These observations suggest that future studies should investigate methods to increase PD uptake and reduce rates of technique failure among Aboriginal patients with ESRD.

Few data exist on PD usage rates in Aboriginal people. McDonald et al. (24) found that PD uptake rates were equivalent among indigenous and nonindigenous people with ESRD in the Antipodes, after adjustment for regional differences in PD use. In contrast, only 5 to 9% of Aboriginals who were treated in the Top End of the Northern Territory in Australia are treated with continuous ambulatory PD, for reasons that are unclear (10,25). We found that factors that were associated with PD treatment were similar in patients of both races, with the exception of low socioeconomic status, which was associated with less PD use in Aboriginal people but not in whites. This finding is provocative but is difficult to interpret without more detailed information on the rationale for modality choice.

Why was the use of PD so low among Aboriginal patients? One possibility is that, like other minority groups (26), Aboriginal people with kidney disease are referred or present late to nephrologists, increasing the risk that hemodialysis will be selected by default. However, this hypothesis would not explain our finding that Aboriginal patients were also less likely to switch to PD. A second possibility is that cultural preference for PD is lower among Aboriginal people (27). Third, patient compliance was identified by U.S. nephrologists as the most important factor when recommending a dialytic modality (28), and ethnic minorities may be considered less likely to adhere to medical advice (29,30). Such perceptions may have reduced the likelihood that PD was offered to Aboriginal patients. Although all of these possibilities are plausible, we cannot determine which, if any, were responsible for our findings.

The explanation for the nonsignificantly increased risk for PD technique failure among Aboriginal patients is similarly unclear. It might be related to the increased risk for peritonitis and associated complications among Aboriginal people (31). Alternatively, because PD is a form of self-care dialysis that often requires the assistance of family or others in the community, suboptimal education of the patients or their support networks may explain these observations. However, because we had no reliable data on the cause of technique failure, these suggestions are purely speculative.

Our study has several limitations. First, our findings could have been confounded by unmeasured comorbidity or socioeconomic factors, especially because they relied on registry data. However, given the robust nature of our findings, we believe that residual confounding is unlikely to have changed our conclusions. Second, we excluded patients of unknown race, who accounted for approximately 4% of those who initiated dialysis on PD. For this to have influenced our results, patients with missing data on race would have had to be systematically different in terms of both race and outcomes compared with those with complete data. Sensitivity analyses showed that reclassifying the race of such patients did not alter our conclusions. Nonetheless, the possibility that the exclusion of these patients or incorrect information on comorbidity was partially responsible for our findings should be considered. Third, we did not have information on compliance with therapy, specific contraindications to PD, living conditions, or social support, all of which might potentially have influenced PD use or technique failure. Finally, we did not have data on the cause of technique failure, making it difficult to determine how its rate in Aboriginal patients might be reduced.

In conclusion, we found that Aboriginal patients with ESRD were significantly less likely to be treated with PD compared with white individuals. Despite the nonsignificantly increased risk for PD technique failure, mortality in Aboriginal patients was similar to that in whites after adjustment for age and concomitant illness. Finally, there was no evidence that PD was associated with adverse outcomes in Aboriginal people who commenced RRT, compared with hemodialysis. Because PD may prevent the need for relocation to hemodialysis centers, with the associated potential for disruption of Aboriginal social and cultural networks, barriers to increased uptake of PD in this population should be determined and overcome.
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References