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Indigenous people in Australia, Canada, New Zealand and the United States are less likely to receive renal transplantation

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In Australia, Canada, New Zealand, and the United States indigenous people have high rates of chronic kidney disease but poor access to effective therapies. To more fully define these issues, we compared the demographics of renal transplantation of indigenous patients in these 4 countries. Data encompassing 312,507 indigenous and white patients (18–64 years of age) who initiated dialysis within an 11-year period ending in 2005 were obtained from each country's end-stage kidney disease registry. By the study's end, 88,173 patients had received a renal transplant and 130,261 had died without receiving such. Compared with white patients, the adjusted likelihood of receiving a transplant for indigenous patients was significantly lower in Australia (hazard ratio (HR) 0.23), Canada (HR 0.34), New Zealand (HR 0.23), and the United States (HR 0.44). In all four countries, indigenous patients had significantly longer overall median waiting times compared to white patients. Our study shows that despite marked differences in health care delivery systems, indigenous patients are less likely than white patients to receive a renal transplant in these countries. Understanding and addressing barriers to renal transplantation of indigenous patients remains an important concern.

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In Australia, Canada, New Zealand, and the United States, indigenous people experience substantially worse health outcomes than non-indigenous people.[1] Over the last two decades, the prevalence of chronic disease among indigenous people has risen dramatically, with a well documented excess burden of diabetes, heart disease, and kidney disease.[1–5] In Australia, New Zealand, and Canada, indigenous people experience more than twice the prevalence of end-stage kidney disease (ESKD) than whites. Similarly, in the United States, American Indians and Alaskan Natives have a 2.5 percent higher prevalence of ESKD as compared with white Americans.[1–8] Systematic differences in rates of utilization of primary care and preventive services contribute to poorer outcomes.[9] Indigenous patients also have unequal access to diagnostic and therapeutic procedures that are used to treat chronic diseases, such as angiography, percutaneous coronary interventions, and coronary artery bypass grafting for coronary artery disease, when compared with non-indigenous patients.[10–12]

Kidney transplantation is considered as the optimal treatment for most non-elderly patients with ESKD, conferring a significant survival advantage and improvement in quality of life over dialysis therapy.[13,14] However, analyses from individual countries, some regional in scope and others with limited adjustment for confounding factors, have shown that indigenous patients have low rates of kidney transplantation.[15–18] In this study, we compared renal transplant utilization by indigenous patients across four countries – Australia, Canada, New Zealand, and the United States – that have distinctly different health care systems. Our study had two primary objectives: (1) To assess transplantation rates (overall, and from deceased and living donors) among indigenous and white patients while controlling for comparable demographic and clinical variables across all four countries; and (2) to compare median transplant waiting times (by donor type) among indigenous and white patients in each country.

RESULTS

The cohort consisted of 312,507 patients from ages 18 to 64 years, including 9837 from Australia, 17,986 from Canada, 2771 from New Zealand, and 281,913 from the United States. By 31 December 2006, 28% of the cohort (88,173 patients) had received a renal transplant, and 41.6% (130,261) had died without receiving a transplant.

The characteristics of indigenous and white patients beginning maintenance dialysis in each country are depicted in Table 1. Indigenous patients represented 18% of the study cohort in Australia, 9% in Canada, 56% in New Zealand, and 3% in the United States. With the exception of New Zealand, there were significantly fewer men and more women in the indigenous cohorts when compared with the non-indigenous cohorts. In all four countries, indigenous patients were significantly more likely to have a body mass index (BMI) greater than 30 kg/m^2 and to have diabetes than whites. There were significantly higher rates of ischemic heart disease among indigenous patients in Australia and New Zealand, and higher rates of peripheral vascular disease among indigenous patients in all four countries. The rates of chronic lung disease and smoking were significantly lower in indigenous patients in the United States, and higher in Australia and New Zealand. Indigenous patients were significantly more likely to smoke in Australia, Canada, and New Zealand, but less likely to smoke in the United States.

In all four countries, indigenous patients had significantly lower crude transplant rates per 100 person-years than white patients (Table 2). Unadjusted transplant rates for indigenous recipients were different among the countries ($P<0.01$). Disparities in access to transplantation were observed from both living and deceased donor sources. The proportion of transplants from living donors was lower among indigenous than among white transplant recipients in Australia (21.9 vs 39.2%), New Zealand (34.2 vs 42.1%), and the United States (36.8 vs 44.2%). In contrast, the proportion of transplants from living donors was slightly higher for indigenous than for white recipients in Canada (39.5 vs 37.7%) (Table 2).

Table 3 displays unadjusted and adjusted hazard ratios (HRs) for renal transplantation overall and by donor type for indigenous patients relative to white patients. Unadjusted HRs for renal transplantation overall were 0.23 (CI 0.19–0.28) in Australia, 0.33 (CI 0.26–0.36) in Canada, 0.15 (CI 0.13–0.19) in New Zealand, and 0.42 (CI 0.36–0.42) in the United States. Age, sex, and comorbid conditions explained only a small portion of these disparities, as adjustment for these variables changed the respective HR in each country only minimally. In each country, disparities in access were similar for both deceased and living donor transplants (Table 3).

Table 4 presents median waiting times overall and by donor type for indigenous compared with white patients. In all four countries, indigenous patients had significantly longer overall median waiting times ($P<0.01$) when compared with white patients. Indigenous recipients waited

Table 1 | Demographic and clinical characteristics of indigenous and white patients in Australia, Canada, New Zealand, and the United States

	Australia		Canada		New Zealand		United States	
Country	White	Indigenous	White	Indigenous	White	Indigenous	White	Indigenous
N (%)	8058 (81.9)	1779 (18.1)	16,336 (90.8)	1650 (9.2)	1216 (43.9)	1555 (56.1)	274,125 (97.2)	7788 (2.8)
Age (N (%))								
18–29 years	819 (10.6)	114 (6.4)**	1109 (6.8)	151 (9.2)**	119 (9.8)	108 (6.9)**	16,870 (6.1)	404 (5.2)**
30–44 years	1987 (24.7)	522 (29.3)**	3817 (23.4)	346 (20.9)**	319 (26.2)	282 (18.1)**	57,454 (21.0)	1584 (20.3)**
45–65 years	5252 (64.7)	1143 (62.7)**	11,410 (69.8)	1153 (69.9)	778 (63.9)	1165 (74.9)**	199,801 (72.9)	5800 (74.5)**
Gender (N (%))								
Male	4919 (61.0)	824 (46.3)**	10,136 (62.1)	806 (48.9)**	740 (59.8)	873 (55.2)*	157,828 (57.6)	3846 (49.4)**
Female	3139 (38.9)	955 (53.7)**	6200 (37.9)	844 (51.1)**	476 (39.1)	682 (43.8)*	116,295 (42.4)	3942 (50.6)**
Body mass index (N (%))								
$<$18.5 mg/m^2	317 (3.9)	92 (5.2)**	538 (3.7)	30 (2.1)**	37 (3.0)	13 (0.8)**	12,904 (5.2)	266 (3.7)**
18.5–24.9 mg/m^2	3276 (40.9)	599 (33.9)**	5548 (38.4)	405 (27.7)**	536 (44.4)	269 (17.5)**	85,028 (34.1)	2101 (29.0)**
25–29.9 mg/m^2	2555 (31.9)	520 (29.5)**	4309 (29.9)	511 (35.0)**	394 (32.6)	493 (32.0)**	69,372 (27.9)	2247 (31.1)**
$\geqslant$30 mg/m^2	1849 (23.1)	522 (31.3)**	4038 (27.9)	514 (35.2)**	240 (19.9)	763 (49.6)**	81,698 (32.8)	2616 (36.2)**
Diabetes (N (%))	2255 (27.9)	1293 (72.7)**	5840 (35.8)	1011 (61.3)**	278 (22.9)	1072 (68.9)**	122,823 (44.8)	5122 (65.8)**
Cerebrovascular disease (*N* (%))	509 (6.3)	147 (8.3)*	1272 (8.6)	147 (9.5)	74 (6.1)	117 (7.5)	16,541 (6.0)	481 (6.2)
Ischemic heart disease (*N* (%))	1514 (18.9)	429 (24.1)**	2586 (15.7)	256 (15.5)	190 (15.6)	329 (21.2)**	54,134 (19.7)	1414 (18.2)**
Peripheral vascular disease (*N* (%))	1081 (13.4)	315 (17.7)**	2819 (17.3)	397 (24.1)**	144 (11.8)	288 (18.5)**	32,240 (11.8)	1235 (15.9)**
Chronic lung disease (*N* (%))	866 (10.7)	253 (14.2)**	1225 (7.5)	106 (6.4)	103 (8.5)	276 (17.8)**	13,345 (4.9)	217 (2.8)**
Current smoker (*N* (%))	1272 (15.8)	472 (26.5)**	2993 (18.3)	368 (22.3)**	197 (16.2)	384 (24.7)**	20,139 (7.3)	450 (5.8)**

*$P<0.05$.
**$P\leqslant0.01$.

Table 2 | Crude transplant rates[a] for indigenous and white patients in Australia, Canada, New Zealand, and the United States

Country	Ethnicity	All transplants Unadjusted rates (95% CI)	Deceased donor Unadjusted rates (95% CI)	Living donor Unadjusted rates (95% CI)	Living donor source (% of total)
Australia	Indigenous	3.3 (2.8–3.8)	2.6 (2.2–3.0)	0.7 (0.5–0.9)	21.9
	White	14.8 (14.3–15.3)	8.9 (8.6–9.4)	5.8 (5.4–6.0)	39.2
Canada	Indigenous	3.8 (3.3–4.3)	2.3 (1.8–2.6)	1.5 (1.2–1.8)	39.5
	White	11.8 (11.5–12.1)	7.2 (6.9–7.4)	4.6 (4.4–4.8)	37.7
New Zealand	Indigenous	2.8 (2.4–3.2)	1.8 (1.5–2.2)	0.9 (0.7–1.2)	34.2
	White	19.5 (17.8–21.0)	11.3 (10.1–12.4)	8.2 (7.1–9.4)	42.1
United States	Indigenous	4.1 (3.8–4.3)	2.6 (2.4–2.8)	1.4 (1.3–1.6)	36.8
	White	10.4 (10.3–10.4)	5.8 (5.7–5.8)	4.5 (4.4–4.6)	44.2

CI, confidence interval.

[a] Rates are calculated per 100 patient-years.

Table 3 | Unadjusted and adjusted hazard ratios for indigenous patients relative to white patients in Australia, Canada, New Zealand, and the United States

	All transplants		Deceased donor		Living donor	
Country	Unadjusted HR (95% CI)	Adjusted[a] HR (95% CI)	Unadjusted HR (95% CI)	Adjusted[a] HR (95% CI)	Unadjusted HR (95% CI)	Adjusted[a] HR (95% CI)
Australia	0.23 (0.20–0.26)	0.23 (0.19–0.27)	0.29 (0.24–0.33)	0.32 (0.27–0.37)	0.15 (0.10–0.19)	0.18 (0.13–025)
Canada	0.33 (0.28–0.37)	0.34 (0.29–0.40)	0.31 (0.26–0.37)	0.31 (0.26–0.37)	0.35 (0.28–0.43)	0.39 (0.30–0.49)
New Zealand	0.15 (0.12–0.18)	0.23 (0.19–0.28)	0.15 (0.13–0.18)	0.22 (0.17–0.28)	0.14 (0.10–0.18)	0.26 (0.18–0.37)
United States	0.42 (0.40–0.45)	0.44 (0.42–0.47)	0.46 (0.43–0.49)	0.49 (0.45–0.53)	0.37 (0.33–0.41)	0.40 (0.36–0.44)

CI, confidence interval; HR, hazard ratio.

[a] Adjusted for age, sex, primary cause of end-stage kidney disease, year of diagnosis, comorbidities (diabetes, cerebrovascular disease, ischemic heart disease, peripheral vascular disease, chronic lung disease, and current smoking), and region.

Table 4 | Median renal transplant wait times in years by country among transplant recipients

		All transplants		Deceased donor		Living donor	
Country	Ethnicity	Median (years)	Interquartile range	Median (years)	Interquartile range	Median (years)	Interquartile range
Australia	White	1.5	0.6–2.9	2.1	1.1–3.5	0.7	0.1–1.7
	Indigenous	2.4	1.3–3.9	2.6	1.5–3.6	2.7	1.8–4.3
Canada	White	1.5	0.6–2.7	1.9	1.0.3.3	0.8	0.2–1.6
	Indigenous	2.1	1.2–3.5	2.5	1.5–3.9	1.6	0.9–2.6
New Zealand	White	1.2	0.4–2.4	1.7	0.9–2.9	0.6	0.0–1.6
	Indigenous	2.2	1.2–3.6	2.7	1.9–4.2	1.2	0.3–2.2
United States	White	1.1	0.3–2.4	1.8	0.8–3.2	0.6	0.0–1.3
	Indigenous	2.1	1.1–3.8	3.0	1.6–4.4	1.2	0.5–2.0

longest for deceased donor transplants in the United States (3 years) and shortest in Canada (2.5 years). Waiting times for living donor transplants were significantly longer for indigenous compared with white patients in Australia (2.7 vs 0.7 years; $P<0.01$), Canada (1.6 vs 0.8 years; $P<0.01$), New Zealand (1.2 vs 0.6 years; $P=0.01$), and the United States (1.2 vs 0.6 years; $P<0.01$).

The cumulative incidence curves for time to first renal transplant (in years) for indigenous and white patients in each country are displayed in Figure 1. Indigenous patients in all four countries had similar curves showing lower cumulative incidence of renal transplantation when compared with whites. White patients in the United States had the lowest cumulative incidence of first renal transplants overall, followed by Canada, Australia, and New Zealand, respectively.

DISCUSSION

To our knowledge, this study is the first multinational evaluation of indigenous access to renal transplantation using similar methods to adjust for comparable variables from national renal registries over identical periods. Despite indigenous populations in each country bearing a significantly heavier burden of ESKD than whites, indigenous people on dialysis are undergoing renal transplantation at less than half the rate of white patients in their respective countries. Notwithstanding substantial differences in the health care systems, renal transplant programs and indigenous models of health care delivery in each country, the disparities in renal transplant rates for indigenous people are strikingly similar in magnitude across all four countries.

Our study provides several important insights regarding access to renal transplantation in the four countries studied.

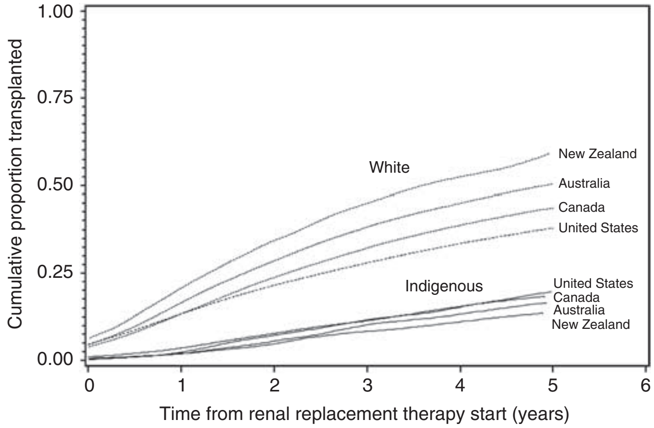

Figure 1 | Proportions of indigenous and white patients receiving renal transplant by country within 5 years after onset of renal replacement therapy. Note: curves start above zero for whites because of the higher proportion of preemptive renal transplants within this group.

First, the disparity in access to transplantation for indigenous patients in all four countries is significant for both deceased and living donor kidneys. Second, access to a first renal transplant for whites is poorest in the United States, followed by Canada, Australia, and New Zealand, respectively, particularly for deceased donor kidneys. As a result, the magnitude of disparity observed for indigenous patients, relative to white patients, between the countries is largely driven by the differences in white access to renal transplantation within each country. Hence, in the United States, utilization of renal transplants looks relatively better for Native Americans in comparison with the other countries studied. This is because of the low overall renal transplant rates among white Americans in comparison with Australia, Canada, and New Zealand.

Third, access to living donor kidneys is relatively better for indigenous patients in Canada and the United States than in Australia and New Zealand.

Disparities in living donor transplantation are concerning because this option is an increasingly important determinant of transplant access in the context of a global shortage of deceased donor kidneys. Within indigenous communities, awareness of living donor transplants as a treatment option, and the medical suitability of relatives and community members for donation are key issues to be addressed.

A number of potential mediators may contribute to low indigenous transplant rates, including language barriers, patient preferences, health practitioners' attitudes,[19] and the lack of culturally appropriate patient education programs. However, evidence regarding the relative importance of these factors remains scant. To our knowledge, culturally appropriate educational materials regarding kidney transplantation, specifically targeted to preferred ways of communicating and levels of health literacy of indigenous patients, have not been developed and implemented. Geographical remoteness has also been suggested as a factor associated with lower transplantation rates, but the evidence on this point is mixed.[20,21]

Other potential barriers for indigenous patients include delayed referral for transplant evaluation[22,23] and delays from initial referral to wait-listing,[15,17,24] as reflected in the near absence of preemptive transplants among indigenous patients in our study. All the countries studied have their own particular renal transplant organ allocation systems. In general, however, organ allocation among these systems is prioritized similarly by patient waiting time with immune matching carrying relatively less weight. Once patients have been successfully wait-listed, transplant allocation algorithms that favor higher levels of HLA-matching above waiting time will reduce access for patients from ethnic minorities, as deceased donors kidneys are predominantly drawn from the majority white population.[25,26] In addition, institutional bias or racism may impede indigenous patients' access to renal transplantation. People with complex, chronic diseases, such as kidney disease, must negotiate often fragmented health care systems to access necessary care.[27] Among the four countries studied, the Indian Health Service of the United States provides the most comprehensive indigenous health care system, and it also funds a substantial component of services managed by Indian tribes. Nonetheless, the presence of the Indian Health Service and tribal health councils in the United States is not associated with substantially better access to renal transplantation for American Indians and Alaskan Natives, probably because these organizations are mainly focused on primary and secondary care, and often face restricted access to tertiary services such as renal transplantation and major cardiac procedures.[12,15] Australia, Canada, and New Zealand have federally managed indigenous health agencies, and each of these countries has developed some community-controlled health services to improve access for indigenous patients. As in the United States, however, renal transplantation is a highly specialized procedure provided in tertiary centers that are not focused on indigenous patients. Therefore, communication across indigenous and non-indigenous health services is crucial to support indigenous patients' access to renal transplantation.

Our study has several strengths and limitations. Strengths of our study include the large inclusive cohorts of patients and the consistent adjustment for relevant clinical variables across the four countries. However, we were not able to verify the accuracy of indigenous designations or determine precisely how much time indigenous patients spent on transplant waiting lists (in both active and inactive status categories). In addition, we did not have access to accurate information regarding residence location of study patients in all registry data sets. This would have allowed us to address the possibility that a relationship exists between rural residence location and racial identity (indigenous or not) that impacts on renal transplant utilization in our study groups. This would have considerably strengthened the study. Lastly, we were unable to obtain data regarding clinical characteristics, such as HLA matching, from all registries, which would provide useful information for further analyses relating to organ allocation algorithms.

Substantial disparities in access to renal transplantation persist for indigenous people with ESKD across the diverse health care systems of Australia, Canada, New Zealand, and the United States. These findings suggest that reduced access may be strongly influenced by social determinants, operating beyond the confines of the respective health systems. Poverty and lower levels of educational attainment have been shown to reduce engagement in health care and to disproportionately affect indigenous populations. Without knowledge of barriers within and beyond health systems, success in improving access to renal transplantation, and other effective medical and surgical services for indigenous people will remain elusive.

METHODS

Data sources

We analyzed data from the respective national ESKD registries, including the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA),[28] Canadian Organ Replacement Register (CORR)[5] of the Canadian Institute for Health Information, and the United States Renal Data System (USRDS).[29] ANZDATA and CORR are voluntary registries that seek participation of all renal units providing dialysis and transplant services. ANZDATA includes essentially all patients with ESKD in Australia and New Zealand, whereas CORR includes over 80% of such patients in Canada. The USRDS has included all patients with ESKD in the United States since May 1995, because the Medicare End-Stage Renal Disease Program requires a Medicare Evidence form to be submitted for all patients regardless of their insurance and eligibility status.

A complete de-identified dataset of requested variables was acquired from each of the respective renal registries, and analyzed at the Canadian Institute for Health Information in Toronto, Canada. The study protocol was approved by the Research Ethics Board of Queen's University, the Human Studies Committee of Harvard Medical School and the Ethics Committee of the Sydney South Western Area Health Service in Sydney, Australia.

Study population

We examined data for all indigenous patients in Australia, Canada, New Zealand, and the United States who initiated maintenance dialysis for ESKD from 1 January 1995 through to 31 December 2005. Indigenous people were identified as Aboriginal Australians and Torres Strait Islanders in Australia; Maori, Samoans, Tongans, Pacific People, and Cook Islanders in New Zealand; Aboriginal people (including First Nations, Métis, and Inuit) in Canada; and American Indians and Alaska Natives in the United States. The majority population (termed 'white' in the current analysis) was designated 'white', 'Caucasian', or 'Caucasoid' in individual registries. Approximately 10% of patients in each country were missing race/ethnicity data and were therefore excluded, as were patients of other racial groups. We restricted our analysis to adult patients aged 18–64 years at initiation of dialysis, because older patients are less likely to be clinically appropriate for renal transplantation.

Study variables

Variables extracted from each national renal registry included patients' age, sex, primary renal diagnosis, comorbid conditions, height, weight, smoking status, and region of initial dialysis treatment. Race is reported to each registry by participating clinical facilities, on the basis of information recorded in patients' medical records. BMI (kg/m^2) was categorized according to World Health Organization criteria as underweight (BMI $<18.5\,\text{kg/m}^2$), normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2), and obese (BMI $\geqslant 30.0\,\text{kg/m}^2$).[30] Comorbid conditions recorded by each registry at the onset of ESKD included diabetes mellitus, ischemic heart disease (myocardial infarction or angina), peripheral vascular disease, cerebrovascular disease, chronic obstructive pulmonary disease, and current smoking.

Analysis

The demographic and clinical characteristics of indigenous and white patients were compared within each country using the Pearson's χ^2-test. The unadjusted transplant rates per 100 patient-years of treatment were calculated for indigenous and white patients in each country, with renal transplantation defined as a first living or deceased donor transplant. Crude transplant rates were compared between countries (with the United States as the reference group) using a Poisson model. Patients were followed up to the date of first renal transplant or to 31 December 2006 for Australia, Canada, and New Zealand with the exception of the United States, wherein follow-up was until 30 September 2006. Patients were censored at the date of death.

Cox proportional hazards regression models were used to compare the adjusted likelihood of renal transplantation from living and/or deceased donors for indigenous patients relative to white patients in each country, controlling for the demographic and clinical variables listed above. Median transplant wait times were calculated overall and by donor type from the initiation of renal replacement therapy to renal transplantation for indigenous and white patients in each country using the Wilcoxon rank-sum test. Cumulative incidence curves for renal transplantation were produced for indigenous vs white patients in each of the four countries.

SAS statistical software version 8.2 (Cary, North Carolina) was used for all analyses. Two-tailed *P*-values or 95% confidence intervals are presented for all statistical comparisons of indigenous and white patients.

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DISCLOSURE

KEY participated in designing the study, acquiring the datasets, and supervising and conducting the data analysis in addition to interpreting the data analyses, and writing and revising the paper. AC participated in designing the study, interpreting the data analyses, and writing and revising the paper. TDS participated in designing the study, interpreting the data analyses, and writing and revising the paper. SPM participated in designing the study, provision of some of the data (from the ANZDATA Registry), interpreting the data analyses, and writing and revising the paper. MJJ participated in designing the study, interpreting the data analyses, and writing and revising the paper. LT participated in designing the study, acquiring the datasets, and supervising and conducting the data analysis in addition to interpreting the data analyses, and writing and revising the paper. JZA participated in designing the study, interpreting the data analyses, and writing and revising the paper.
All the authors declared no competing interests.

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