Original Research Article

End-Stage Kidney Disease in Patients With Autosomal Dominant Polycystic Kidney Disease: A 12-Year Study Based on the Canadian Organ Replacement Registry

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Abstract

Background: Autosomal dominant polycystic kidney disease (ADPKD) is the most common hereditary kidney disease, with afflicted patients often progressing to end-stage kidney disease (ESKD) requiring renal replacement therapy (RRT). As the timelines to ESKD are predictable over decades, it follows that ADPKD patients should be optimized regarding kidney transplantation, home dialysis therapies, and vascular access.

Objectives: To examine the association of kidney transplantation, dialysis modalities, and vascular access in ADPKD patients compared with a matched, non-ADPKD cohort.

Setting: Canadian patients from 2001-2012 excluding Quebec.

Patients: All adult incident ESKD patients who received dialysis or a kidney transplant.

Measurements: ADPKD as defined by the treating physician.

Methods: ADPKD and non-ADPKD patients were propensity score (PS) matched (1:4) using demographics, comorbidities, and lab values. Conditional logistic regression and Cox proportional hazards models were used to examine associations with kidney transplantation (preemptive or any), dialysis modality (peritoneal, short daily, home, or in-center hemodialysis [HD]), vascular access (arteriovenous fistula [AVF], permanent or temporary central venous catheter [CVC]), and dialysis survival.

Results: We matched 2120 ADPKD (99.9%) with 8283 non-ADPKD with no significant imbalances between the groups. ADPKD was significantly associated with preemptive kidney transplantation (odds ratio [OR] = 7.13, 95% confidence interval [CI] = 5.74-8.87), any kidney transplant (OR = 2.37, 95% CI = 2.14-2.63), and initial therapy of nocturnal daily HD (OR = 2.74, 95% CI = 1.38-5.44), whereas in-center intermittent HD was significantly less likely in the ADPKD population (OR = 0.59, 95% CI = 0.54-0.65). There was no difference in peritoneal dialysis (PD) as initial RRT but lower use of any PD among the ADPKD group (OR = 0.85, 95% CI = 0.77-0.95). ADPKD patients were significantly more likely to have an AVF (OR = 3.25, 95% CI = 2.79-3.79) and less likely to have either a permanent (OR 0.68, 95% CI 0.59-0.78) or temporary (OR = 0.49, 95% CI = 0.41-0.59) CVC as compared with the non-ADPKD cohort. Survival on either in-center HD or PD was better for ADPKD patients (HD: hazard ratio [HR] 0.48, 95% CI 0.44-0.53; PD: HR 0.73, 95% CI 0.60-0.88).

Limitations: Conservative care patients were not captured; despite PS matching, the possibility of residual confounding remains.

Conclusions: ADPKD patients were more likely to receive a kidney transplant, use home HD, dialyze with an AVF, and have better survival relative to non-ADPKD patients. Conversely, they were less likely to receive PD either as initial therapy or anytime during ESKD. This may be attributed to higher transplantation or clinical decision-making processes susceptible to education and intervention.

Abrégé

Contexte : La maladie polykystique rénale autosomique dominante chez l'adulte (MPRAD) est la maladie rénale héréditaire la plus fréquente. Les patients qui en sont atteints développent souvent une insuffisance rénale terminale

(IRT) et nécessitent une thérapie de remplacement rénal (TRR). Étant donné que l'évolution vers l'IRT est prévisible sur plusieurs décennies, on devrait préparer la voie vers la greffe rénale, la dialyse à domicile et l'accès vasculaire pour les patients atteints de la MPRAD.

Objectifs : L'étude visait à comparer l'association avec la greffe rénale, les modalités de dialyse et l'accès vasculaire entre les patients atteints et non atteints.

Cadre de l'étude : L'étude s'est tenue entre 2001 et 2012 auprès de patients canadiens hors Québec.

Patients : Ont été inclus dans l'étude tous les patients adultes nouvellement atteints d'IRT qui ont reçu de la dialyse ou une greffe rénale.

Mesures : La maladie polykystique autosomique dominante des reins, telle que diagnostiquée par le médecin traitant.

Méthodologie : On a effectué l'appariement par scores de propension des patients MPRAD avec les sujets non-MPRAD (ratio 1:4) selon leur profil démographique, leurs comorbidités et leurs résultats de laboratoire. Avec des modèles conditionnels de régression logistique et de risques proportionnels de Cox, on a déterminé l'association avec la greffe rénale (préventive et tous types confondus), la modalité de dialyse (péritonéale, quotidienne courte, à domicile ou en centre), l'accès vasculaire (fistule artérioveineuse [FAV], cathéter veineux central [CVC] temporaire ou permanent) et de la survie du patient dialysé.

Résultats : Nous avons jumelé 2 120 patients MPRAD (99,9 %) à 8 283 patients non-MPRAD. Les deux groupes ne présentaient aucun déséquilibre notable. La MPRAD a été associée de façon significative à la greffe rénale préemptive (RC : 7,13; IC 95 % : 5,74-8,87), à tout type de greffe rénale (RC : 2,37; IC 95 % : 2,14-2,63) et à une thérapie initiale par hémodialyse quotidienne nocturne (RC : 2,74; IC 95 % : 1,38-5,44); alors que l'hémodialyse intermittente en centre s'est avérée beaucoup moins probable chez les patients MPRAD (RC : 0,59; IC 95 % : 0,54-0,65). Aucune différence n'a été observée en ce qui concerne le recours à la dialyse péritonéale (DP) comme TRR initiale, mais l'utilisation de la DP chez les patients du groupe MPRAD était inférieure (RC : 0,85; IC 95 % : 0,77-0,95). Pour ce qui est de l'accès vasculaire, les patients MPRAD étaient significativement plus susceptibles d'avoir recours à une FAV (RC : 3,25; IC 95 % : 2,79-3,79) et moins enclins à choisir le CVC permanent (RC : 0,68; IC 95 % : 0,59-0,78) ou temporaire (RC : 0,49; IC 95 % : 0,41-0,59) que le groupe témoin. Les perspectives de survie des patients, que ce soit avec l'hémodialyse (HD) en centre ou avec la DP, étaient meilleures pour le groupe MPRAD (RR : 0,48; IC 95 % : 0,44-0,53 pour l'HD; RR : 0,73; IC 95 % : 0,60-0,88 pour la DP).

Limites de l'étude : Les patients suivis pour des soins conservateurs n'ont pas été pris en compte; et bien que nous ayons jumelé les sujets par scores de propension, un facteur confusionnel résiduel pourrait subsister.

Conclusion: Les patients atteints de la MPRAD sont plus susceptibles de recourir à une greffe rénale, à l'hémodialyse à domicile et à un accès vasculaire par FAV; ils ont aussi de meilleures chances de survie que les patients non-MPRAD. Inversement, ils étaient moins susceptibles d'être traités par dialyse péritonéale, tant comme traitement initial qu'à n'importe quel autre moment en IRT. Ceci pourrait être attribuable au plus grand nombre de greffes ou à des processus décisionnels cliniques davantage portés vers la formation et l'intervention.

What was known before

Polycystic kidney disease is associated with progression to end-stage kidney disease often over the course of decades. European and US dialysis registries report a higher frequency of transplantation, home dialysis, and arteriovenous fistula use. However Canadian data are lacking.

What this adds

Adults with polycystic kidney disease in Canada are more likely to receive a kidney transplant, be on home hemodialysis (but not peritoneal dialysis), be dialyzed with an arteriovenous fistula, and have improved survival compared with non-ADPKD patients.

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Background

Autosomal dominant polycystic kidney disease (ADPKD) is the most common hereditary kidney disease, affecting between 1:800 and 1:1000 people.[1] ADPKD is characterized by cystic expansion of the kidneys, progressing to bilateral kidney enlargement, and various degrees of chronic kidney disease.[2] In addition, many patients experience flank and/or abdominal pain, hematuria, hypertension, and other related symptoms.[3] With ~50% of ADPKD patients progressing to end-stage kidney disease (ESKD) by age 70 years, ADPKD accounts for 5% to 10% of all patients requiring renal replacement therapy (RRT).[4,5] As such, it is essential to understand standard practice regarding the treatment of end-stage ADPKD via RRT.

In patients progressing to ESKD, studies have already shown superior outcomes in the survival of ADPKD patients on RRT vs non-ADPKD patients; furthermore, recent literature suggests that a disparity exists not only in survival but also in the choices of treatment strategies between these two matched cohorts.[4-6] With this in mind, information retrieved from the Canadian Organ Replacement Register (CORR) can highlight RRT trends in Canada and elucidate differences in treatment decisions for the ADPKD vs non-ADPKD populations progressing to ESKD. Detailed information regarding RRT modality choices and clinical outcomes specific to ADPKD may improve treatment guidelines and advance our current knowledge of this patient group.[7]

The aim of our study is to examine the association of ADPKD status with the use of home modalities, vascular access, and preemptive transplantation as compared with non-ADPKD. Clinical outcomes including the risk of all-cause mortality in these groups will be assessed broadly for all ESKD patients, as well as for the specific dialysis and vascular access subtypes.

Methods

Design and Setting

We conducted a registry-based retrospective cohort study in Canada (excluding Quebec) using data from the CORR. The study was conducted according to a prespecified protocol that was approved by the Research Ethics Board at The Ottawa Hospital (Ottawa, Ontario, Canada).

Study Population and Cohort Development

All adult incident patients requiring chronic renal replacement and captured by the CORR from January 1, 2001, to December 31, 2012, were included in the study cohort. CORR is a national administrative registry and is administered by the Canadian Institute for Health Information (CIHI).[8] CORR captures patient-level treatment and outcomes data for individuals on RRT including demographics, comorbidities, receipt of kidney transplantation, dialysis modality, vascular access, and follow-up.[9] CORR receives data from individual facilities using standardized forms or spreadsheets and is reported on a calendar-year basis. CORR captures the vast majority of incident RRT patients with validation studies reporting 93% of dialysis patients and 98% of transplantation patients.[10] Data are collected until death, loss of follow–up, or end of the study period.

Exposure, Comorbidities, and Outcomes

The exposure of interest was ADPKD that was defined as adult-type ADPKD as the treating physician's diagnosis. Comorbidities (acute coronary syndrome, diabetes [not cause of ESKD], stroke, peripheral vascular disease, coronary artery bypass graft, cancer, chronic obstructive pulmonary disease, hypertension, congestive heart failure, cigarette smoker, and any serious illness) were defined by the treating physician at the time of chronic dialysis initiation. Laboratory values (hemoglobin, albumin, phosphate, calcium) were recorded at the initiation of dialysis. Serious illness was defined as any illness that could shorten life expectancy to less than 5 years and is used to capture illnesses other than the usual comorbidities in CORR that may alter survival. Predialysis care was defined as receipt of care by a nephrologist prior to dialysis initiation. Distance to facility was calculated as the direct linear distance in kilometers between a patient's primary residence (estimated from postal code at time of dialysis initiation) to the nearest dialysis provider using Vincenty's formula.[11] The year of dialysis initiation, self-identified race, and geographic region were also captured. Missing data were as follows: cause of ESKD (5.9%), predialysis care (15.6%), albumin (14.9%), phosphate (13%), and calcium (12.1%).

The study outcomes of interest were (1) initial type of RRT (transplant, peritoneal dialysis [PD], intermittent in-center hemodialysis, short daily hemodialysis, or nocturnal hemodialysis), (2) initial vascular access (arteriovenous fistula [AVF], permanent central catheter, or temporary central catheter), and (3) all-cause mortality. Short daily or nocturnal hemodialysis could be either in-center or home-based. For all-cause mortality, patients were followed until death (event of interest) or the end of study (a censoring event).

Type of RRT was defined 2 ways: (1) at ESKD onset and (2) during any time on ESKD. Vascular access was categorized as AVF, permanent CVC, or temporary CVC. arteriovenous graft (AVG) use in Canada is relatively infrequent, comprising less than 2% of total vascular accesses and was categorized as AVF.[12,13] Patients with more than one type of vascular access listed (eg, CVC and AVF) were categorized as CVC.

Statistical Analysis

We used propensity score (PS) matching to match individuals with ADPKD to individuals without ADPKD using the

following variables in our model: age (per year), sex (male referent), year of ESKD, distance from facility, predialysis care, comorbidities at baseline (acute coronary syndrome, diabetes [not cause of ESKD], stroke, peripheral vascular disease, coronary artery bypass graft, cancer, chronic obstructive pulmonary disease, hypertension, congestive heart failure, cigarette smoker, and any serious illness], and laboratory values at baseline (hemoglobin, calcium, phosphate, albumin). Individuals with ADPKD were matched 1:4 to individuals without ADPKD on the logit of the PS (±0.0.1 of the standard deviation) without replacement.[14] We used standardized differences to assess differences in baseline characteristics between matched individuals by ADPKD status. Standardized differences describe differences between group means relative to the pooled standard deviation and are less sensitive to large sample sizes than traditional hypothesis testing.[15] A difference >10% was considered meaningful. We examined the association of ADPKD exposure on PS-matched pairs and the outcomes of kidney transplant, dialysis modality, and dialysis access at the initiation of ESKD or any time during ESKD using conditional logistic regression.[16] In a sensitivity analysis, we repeated our models with additional adjustments for covariates that were not balanced after PS matching (race, geographic region, predialysis care, hypertension, hemoglobin, and albumin).[14] All-cause mortality was modeled using stratified Cox proportional hazards models for patients whose initial ESKD modality was intermittent hemodialysis (IHD) or PD. The proportional hazards assumption was examined and met.[17]

To avoid exclusion of subjects due to missing covariates, multiple imputation was performed prior to analysis. The imputations were generated using a Markov Chain Monte Carlo algorithm (the data augmentation algorithm).[18] Ten multiple imputation data sets were generated with all variables included in analytical models specified as predictors in the multiple imputation model. Analyses were carried out for each multiple imputation data set and pooled across data sets using Rubin's rules.[19] All analyses were conducted with SAS 9.4. All hypothesis tests were 2 sided with statistical significance determined at a *P* value of <.05.

Results

Between January 1, 2001, and December 31, 2015, a total of 52 121 patients registered in the Canadian Organ Replacement Registry received RRT, comprising of 2122 ADPKD patients and 50 029 non-ADPKD patients. Of these patients, the average age was 56.7 years for ADPKD and 64.1 years for non-ADPKD patients, with 46.1% and 39.9% being female in each group, respectively (see Table 1). Prior to matching, there were significant differences between the two groups in terms of predialysis care, race, geographic region, comorbidities (vascular disease, diabetes, cancer, any serious illness), and laboratory values (hemoglobin, albumin) as indicated by a SD > 0.10. After PS matching, all covariates

were well balanced except for race, geographic region, predialysis care, hypertension, hemoglobin, and albumin. Four matches for each ADPKD patient were obtained in 97.7% of cases, whereas 197 ADPKD cases had only 3 matches.

Table 2 presents the differences for the study outcomes between the ADPKD and non-ADPKD population. Preemptive and receipt of any kidney transplant were significantly higher in the ADPKD population compared with non-ADPKD (preemptive: odds ratio [OR] = 7.13 95%, confidence interval [CI] = 5.74-8.87; any transplant: OR = 2.37, 95% CI = 2.14-2.63). With regard to dialysis, intermittent hemodialysis either as the initial or any dialysis therapy was significantly lower in ADPKD patients (IHD OR = 0.59, 95% CI = 0.54-0.65; any IHD OR = 0.59, 95% CI = 0.53-0.65). PD was similar to the initial RRT modality and was less likely during the course of ESKD for ADPKD patients (PD OR = 1.07, 95% CI = 0.96-1.20; any PD OR = 0.85, 95% CI = 0.77-0.95). There was no difference in short daily hemodialysis use; however, nocturnal hemodialysis was associated with ADPKD as initial or any time during ESKD (nocturnal hemodialysis [NHD] OR = 2.74, 95% CI = 1.38-5.44; any NHD OR = 1.53, 95% CI = 1.21-1.93). When examining vascular access results, ADPKD patients were more likely to start with an AVF and if a CVC was used, a permanent catheter (AVF OR = 3.25, 95% CI = 2.79-3.79; permanent CVC OR = 0.68, 95% CI = 0.59-0.79) compared with non-ADPKD patients. All results were consistent with additional sensitivity models adjusting for race, region, predialysis care, hypertension, hemoglobin, and albumin.

During the study period, a total of 3362 (ADPKD 445 [21.0%], non-ADPKD 2817 [34.1%]) patients died. Of those who started IHD as their initial therapy, 26.8% with ADPKD died (324/1209) and 39.0% (2231/5717) without ADPKD died. ADPKD patients treated with IHD as initial therapy were less likely to die compared with non-ADPKD patients (hazard ratio [HR] 0.65, 95% CI 0.58-0.73). Of those who started PD as their initial therapy, 17.4% with ADPKD (109/627) died and 24.7% without ADPKD died (570/2305). ADPKD patients whose initial therapy was PD were less likely to die compared with non-ADPKD patients (HR 0.74, 95% CI 0.61-0.89).

Discussion

In this Canadian study using data from the CORR, we found that there were clear differences in renal replacement therapies, dialysis modalities, and vascular access in ADPKD compared with matched non-ADPKD patients. Preemptive and receipt of any kidney transplant were more common in the ADPKD cohort. Nocturnal but not short daily hemodialysis was more likely in ADPKD patients, and PD as a dialysis modality was less likely in ADPKD patients. With respect to vascular access, ADPKD patients were more likely to receive an AVF, whereas non-ADPKD patients were more likely to receive a CVC (whether it be permanent or temporary). Last, survival for

Table 1. Demographics, Comorbidities, and Relevant Laboratory Values of ADPKD and Non-ADPKD Patients With End-Stage Kidney Disease Requiring Renal Replacement Therapy.[a]

	Total cohort (N = 52 151)			PS-matched (N = 10 403)		
	ADPKD	Non-ADPKD	Stan. D	ADPKD	Non-ADPKD	Stan. D
N	2122	50029		2120	8283	
Age (years, mean)	56.7 (SD 12.3)	64.1 (SD 15.4)	**0.53**	56.7 (SD 12.3)	57.4 (SD 18.3)	0.04
Sex (female, %)	46.1 (978)	39.9 (19 961)	0.13	46.0 (976)	46.2 (3828)	0.003
Distance to facility (median, km)	15.4 (IQR 5.8-63.6)	11.0(IQR 4.7-47.1)	0.04	15.4 (IQR 5.7-63.6)	11.7 (IQR 5.1-45.8)	0.01
Any predialysis care (%, n)	80.3 (1703)	84.5 (42 297)	0.11	80.2 (1701)	87.8 (7276)	**0.21**
Race			**0.36**			**0.36**
Caucasian	80.4 (1705)	69.3 (34 620)		80.4 (1704)	68.1 (5642)	
East Asian	3.1 (65)	6.6 (3281)		3.1 (65)	8.1 (669)	
Black	2.4 (50)	3.4 (1676)		2.4 (50)	3.9 (325)	
South Asian	3.1 (65)	4.4 (2216)		3.1 (65)	4.5 (373)	
Indigenous	0.9 (19)	6.0 (2983)		0.9 (19)	3.6 (374)	
Other	10.2 (216)	10.4 (5199)		10.2 (217)	10.9 (900)	
Year			0.07			0.05
2001-2004	31.8 (652)	30.9 (15 459)		31.8 (650)	32.1 (2661)	
2005-2008	36.2 (767)	33.0 (16 511)		36.2 (767)	33.6 (2783)	
2009-2012	33.2 (703)	36.0 (18 005)		33.2 (703)	34.3 (2839)	
Region[b]			**0.15**			**0.16**
Atlantic	14.1 (298)	9.5 (4760)		14.1 (298)	9.1 (752)	
Central	48.7 (1035)	52.8 (26 378)		48.7 (1033)	53.1 (4395)	
Prairies	20.6 (436)	21.6 (10 785)		20.6 (436)	20.3 (1685)	
Western	16.7 (353)	16.1 (8052)		16.7 (353)	17.5 (1451)	
Cause of ESKD						
Diabetes		35.7 (18 595)			5.5 (452)	
Ischemic		19.6 (10 221)			24.7 (2047)	
Glomerulonephritis		15.7 (8153)			32.7 (2708)	
Other		27.2 (13 571)			37.1 (3076)	
Comorbidities (%, *n*)						
ACS	7.4 (157)	18.4 (9214)	**0.33**	7.4 (157)	8.3 (690)	0.03
Diabetes	6.5 (137)	48.4 (24 239)	**1.07**	6.5 (137)	6.7 (557)	0.01
Stroke	6.0 (128)	13.1 (6561)	**0.24**	6.0 (128)	7.3 (607)	0.05
PVD	3.5 (75)	17.1 (8563)	**0.46**	3.5 (75)	4.2 (345)	0.03
CABG	6.0 (127)	13.3 (6637)	**0.25**	6.0 (127)	6.3 (518)	0.01
Cancer	6.2 (132)	11.9 (5924)	**0.20**	6.2 (132)	7.2 (599)	0.04
COPD	4.1 (86)	10.6 (5318)	**0.25**	4.1 (86)	4.5 (374)	0.02
HTN	73.4 (1558)	76.2 (38 142)	0.06	73.4 (1556)	79.8 (6613)	**0.15**
CHF	5.5 (117)	23.6 (11 784)	**0.53**	5.5 (117)	6.7 (554)	0.05
Cigarette smoker	12.1 (256)	12.6 (6286)	0.02	12.1 (255)	12.7 (1055)	0.02
Any serious illness	6.9 (2122)	11.8 (5905)	0.17	6.9 (147)	7.6 (630)	0.03
Labs (baseline):						
Hemoglobin (g/L, mean)	106.3 (SD 21.4)	100.6 (SD 24.3)	**0.25**	106.3 (SD 21.4)	104.0 (SD 23.7)	**0.10**
Calcium (mmol/L, mean)	2.2 (SD 0.3)	2.3 (SD 0.7)	0.01	2.2 (SD 0.3)	2.1 (SD 0.3)	0.03
Phosphate (mmol/L, mean)	1.0 (SD 3.2)	2.3 (SD 0.8)	0.01	1.4 (SD 2.0)	1.4 (SD 2.5)	0.02
Albumin (g/L, mean)	35.8 (SD 6.0)	32.0 (SD 8.2)	**0.58**	35.8 (SD 6.0)	34.8 (SD 6.0)	**0.15**

Note. PS = propensity score; ADPKD = polycystic kidney disease; Stan. D = standardized difference; IQR = interquartile range; ACS = acute coronary syndrome; PVD = peripheral vascular disease; CABG = coronary artery bypass grafting; COPD = chronic obstructive pulmonary disease; HTN = hypertension; CHF = congestive heart failure; ESKD = end-stage kidney disease.
[a]Bold text denotes statistically significant standardized differences.
[b]Regions were categorized as follows: Atlantic (Prince Edward Island, Newfoundland, New Brunswick, Nova Scotia), Central (Ontario), Prairies (Manitoba, Saskatchewan, Alberta), Western (British Columbia).

ADPKD patients who initiated IHD or PD as a first modality was higher than non-ADPKD patients. Taken together, these findings demonstrate ADPKD patients with ESKD are more likely to receive evidence-based and cost-effective therapies regarding transplant, nocturnal dialysis, and vascular access in Canada but suggest PD may be underutilized.

Table 2. Transplantation, Dialysis Modalities, and Vascular Access at Renal Replacement Therapy Initiation or During the Entire Course of End-Stage Kidney Disease for Propensity Score–Matched ADPKD and Non-ADPKD Patients.

Outcome	ADPKD (n = 2120) (%, n)	Non-ADPKD (8283) (%, n)	ADPKD Odds ratio (95% CI)	ADPKD[a] Odds ratio (95% CI)
Preemptive transplant[b]	11.9 (252)	2.3 (187)	7.13 (5.74-8.87)	7.79 (6.14-9.89)
Intermittent hemodialysis	57 (1209)	69 (5717)	0.59 (0.54-0.65)	0.79 (0.0.70-0.90)
Peritoneal dialysis	29.6 (627)	27.8 (2305)	1.07 (0.96-1.20)	1.08 (0.97-1.22)
Short daily hemodialysis	0.2 (5)	0.2 (22)	0.85 (0.32-2.25)	1.12 (0.39-3.20)
Nocturnal hemodialysis	0.6 (14)	0.2 (20)	2.74 (1.38-5.44)	2.54 (1.15-5.60)
Arteriovenous fistula	42.3 (525)	18.7 (1084)	3.25 (2.79-3.79)	2.36 (2.08-2.68)
Permanent catheter	32.0 (397)	40.2 (2330)	0.68 (0.59-0.79)	0.67 (0.59-0.76)
Temporary catheter	18.9 (235)	33.9 (1963)	0.49 (0.41-0.57)	0.52 (0.45-0.61)
Any transplant	45.8 (971)	27.3 (2262)	2.37 (2.14-2.63)	2.12 (1.89-2.38)
Any intermittent hemodialysis	69.2 (1,467)	79.4 (6578)	0.59 (0.53-0.65)	0.69 (0.62-0.77)
Any peritoneal dialysis	34.9 (739)	37.7 (3124)	0.85 (0.77-0.95)	0.86 (0.77-0.96)
Any short daily hemodialysis	2.5 (54)	2.1 (171)	1.22(0.89-1.65)	1.13 (0.82-1.55)
Any nocturnal hemodialysis	4.9 (104)	3.2 (266)	1.53 (1.21-1.93)	1.67 (1.31-2.14)

Note. ADPKD = polycystic kidney disease; CI = confidence interval.
[a]Additional adjustment for race, region, predialysis care, hypertension, hemoglobin, and albumin.
[b]Preemptive transplant models excluded predialysis care and hypertension.

Transplantation as a means of renal replacement was reported much more in the ADPKD group, both initially and at any point in treatment. This is supported in the literature and may be due to longer timelines for ESKD development or knowledge gain from family members with ESKD.[1,4,6,20-22] In addition, rates of transplantation in this population appear to be increasing.[21,23] Despite adjusting for potentially confounding variables, a patient requiring RRT was over 7 times more likely to initially receive preemptive renal transplantation if they had ADPKD. These data, coupled with the data from similar, large-scale European and US ADPKD studies, further support the notion that renal transplantation is more likely among patients with ADPKD who require RRT.[4,5,21,23] Previous reports in Europe and the United States attributed higher kidney transplantation rates in ADPKD patients due to the lack of limiting comorbidities compared with non-ADPKD patients. As our study design eliminated many measurable comorbidity differences between the two groups, other possibilities may include a larger and more willing living donor pool or other unmeasured factors (such as functional status) contributing.

Our findings on PD show that as an initial treatment option, there is no discernable difference between the ADPKD and non-ADPKD groups. However, the receipt of PD at any time throughout the course of treatment was significantly lower in ADPKD patients than in the non-ADPKD patients. It has been hypothesized that PD is relatively less preferred in ADPKD, as a result of decreased intraperitoneal space available for dialysate, as well as increased risk of abdominal herniation.[24,25] As such, the choice for PD among ADPKD patients may be inversely proportional to the volume of the kidneys in these patients.[26] Other reported concerns include increased abdominal wall herniation, hydrothorax, or risk of peritonitis.[27,28] In the United States, PD was reported to be more common in the ADPKD population as a first-line renal replacement than a matched non-ADPKD group.[29] Conversely, Spithoven et al reported lower PD use in ADPKD patients albeit in an unmatched study design.[4] This suggests other factors may be contributing to the lower PD uptake in the ADPKD population such as a higher likelihood of alternatives such as kidney transplant or home hemodialysis reducing the PD pool. Of concern is the possibility of practice variation. We previously reported considerable practice variation with regard to PD use in Canada, and this may apply directly to ADPKD as regional expertise and physician's beliefs may play a role.[30,31] As there are few evidence-based relative contraindications to PD, it should remain a viable and preferred modality for ADPKD patients. In an attempt to retain residual renal function, incremental PD may be a viable option.[32] Last, several studies have reported that survival and long-term therapy outcomes of ADPKD patients on PD did not differ significantly against matched non-ADPKD controls,[33,34] with 1 study reporting a notably high survival rate.[34] This was consistent with our findings that ADPKD patients with PD as an initial therapy demonstrated improved survival compared with non-ADPKD patients.

Nocturnal hemodialysis has numerous benefits over the conventional form of hemodialysis, including fewer cardiac and uremic complications, improved quality of life, and decreased drug usage.[35] It has also shown to be relatively equal to conventional hemodialysis with regard to survival, although reports have suggested that extended hemodialysis actually increases survival.[36] Our study is the first to look at

trends in nocturnal dialysis as related to ADPKD. The present research suggests that in Canada, nocturnal daily hemodialysis is more common among ADPKD patients in ESKD than matched non-ADPKD patients, though it is used infrequently.

While intermittent hemodialysis remained the most prevalent form of RRT overall but the least desirable for a variety of reasons, it was encouraging to find a lower likelihood of its use as an initial therapy or any time among ADPKD patients.[37-39] However, for ADPKD patients whose initial therapy was IHD, their survival was substantively better than non-ADPKD patients. This finding was consistent with other jurisdictions.[1,21,23] With regard to vascular access, AVF is shown to be significantly more prevalent in the ADPKD population, while a CVC is more common in the non-ADPKD population. Previous authors reported similar observations in Europe and the United States.[29,40] We further demonstrated a reduced likelihood of temporary CVC use that suggests the initiation of dialysis was likely less acute and planned. Future studies could examine the timing of dialysis initiation in ADPKD patients and the incidence of acute kidney injury (AKI).

Our study has some notable limitations. As ADPKD was identified by the treating physician, as opposed to radiologic imaging or genetic testing, there is a possibility of misclassification. We were unable to capture patients who did not undergo RRT (conservative care). Despite PS matching, the possibility of residual confounding remains as we lacked information on medications, functionality, or patient preference. We did not have data from Quebec, Canada's second largest province. We did not account for longitudinal modality changes or examine the risk of technique failure. The presence of comorbidities in CORR is underestimated, and this may differentially affect the non-ADPKD group more.[10] Last, we were unable to examine complications requiring hospitalizations such as infections or cardiac events. Those remain avenues of future investigation.

Conclusions

In a national study, we found ADPKD patients were more likely to receive a kidney transplant, use home hemodialysis, dialyze with an AVF, and have better survival relative to non-ADPKD patients. Conversely, they were less likely to receive any PD during ESKD. This may be attributed to higher transplantation or clinical decision-making processes susceptible to education and intervention.

Ethics Approval and Consent to Participate

Regional ethics board approval was obtained.

Consent for Publication

Obtained.

Availability of Data and Materials

No.

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