

# Frequency and Outcomes of Kidney Replacement Therapy Transitions in Canada



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**KEYWORDS:** hemodialysis; kidney failure; kidney transplant; peritoneal dialysis; transitions

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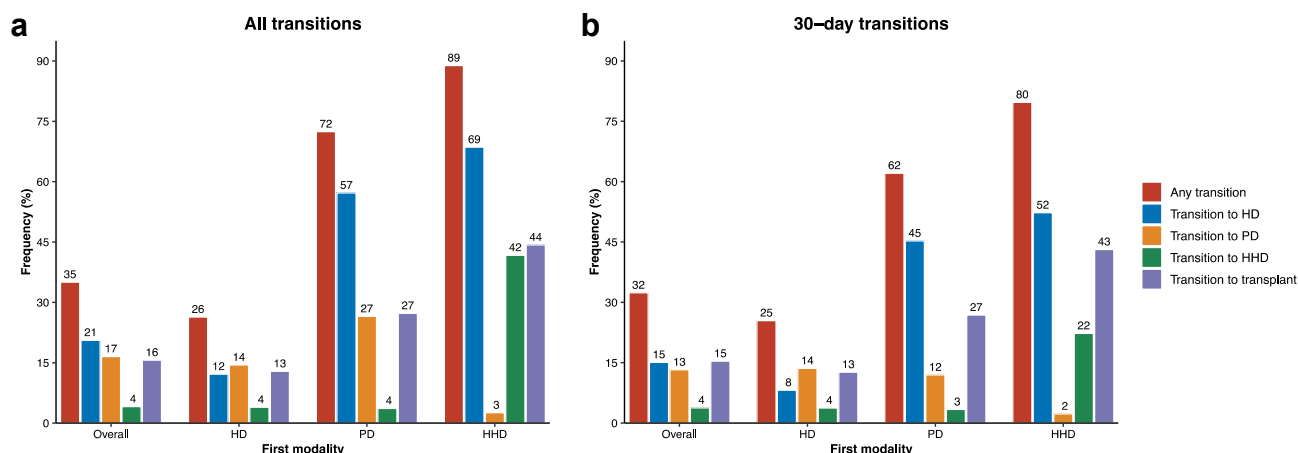
## INTRODUCTION

Kidney replacement therapy (KRT) is a dynamic rather than a static process. As patients' needs, comorbidities, and social support evolve, they often transition between different KRT modalities, either by choice or by necessity. Although some of these transitions improve patients' long-term quality of life (e.g., receiving a kidney transplant), most transitions have a negative influence, at least temporarily.<sup>1–3</sup> Modality transitions also bear a toll on caregivers, medical professionals, and health care expenditure. However, the population-level frequency and outcomes of replacement therapy modality transitions have been poorly investigated. Therefore, we aimed to characterize the patterns of modality transition in Canadian patients

initiating KRT between 2005 and 2018, using the Canadian Organ Replacement Register (CORR). Transitions between KRT modalities of at least 2 days in duration (herein excluding 1-day transitions) were assessed until December 31, 2019. The detailed methods used for this study can be found in the [Supplementary Methods](#).

## RESULTS

Of the 61,724 individuals initiating dialysis (baseline characteristics in [Supplementary Table S1](#)), 50,252 (81%) started on facility hemodialysis (HD), 11,122 (18%) started on peritoneal dialysis (PD), and 350 (0.6%) started on home HD (HHD) ([Supplementary Figure S1](#)). During a median follow-up of 2.9 years, 21,616 patients (35%) experienced a total of 59,330



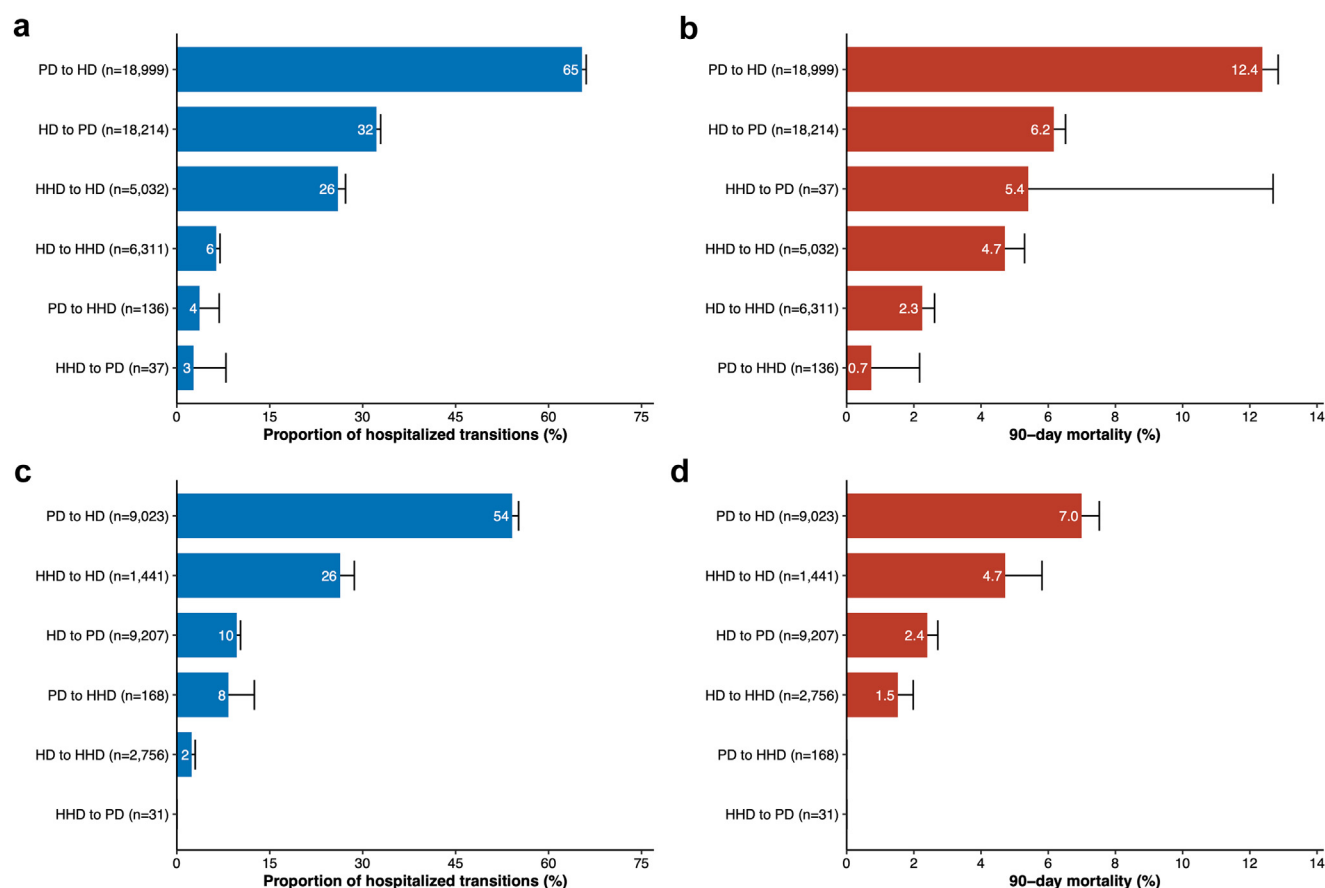
**Figure 1.** Transition frequencies by first modality and duration. This graph displays the proportion of patients experiencing at least 1 transition of each type before and after stratification according to the patients' first dialysis modality. (a) displays all transitions, whereas (b) displays transitions of at least 30 days in duration. Transitions from and to the same modality illustrate the cases of patients who transitioned from one modality to another and then transitioned back to their first dialysis modality. HD, hemodialysis; HHD, home hemodialysis; PD, peritoneal dialysis.

modality transitions (Figure 1a). Of the patients, 45% died without experiencing KRT transition, 20% were still on their initial modality at the end of follow-up, 29% experienced 2 different modalities, 6% experienced 3 modalities, and 0.4% experienced 4 modalities. Among patients experiencing the most transitions (95th percentile and above; 5 or more transfers), transitions to and from home modalities (PD or HHD) and facility HD were overrepresented compared with the overall population (96.3% vs. 81.8%). One-third of the modality transitions (19,862) occurred during the first year of the KRT (6807 [11%] in the first 90 days; [Supplementary Figure S2](#)), after which the rates plateaued until the third year and then decreased. Of the patients, 19% experienced a transition after their first year of KRT, compared with 25% after 2 years, and 33% after 5 years. Transitions from home dialysis to the facility were less likely to occur at earlier KRT vintages (28% in the first year and 7% in the first 90 days).

Patients with 1 or more modality transitions were younger, more likely to be from a racial minority group, and had a more favorable comorbidity profile

([Supplementary Table S1](#)) than patients who did not transition. When individuals were stratified according to their first dialysis modality (Figure 1a), 26% of patients beginning KRT on facility HD experienced a modality transition, among which the transition to PD was the most common. In contrast, 72% of patients starting PD and 89% of patients starting HHD experienced a transition, among which transitions to HD were the most frequently experienced, followed by transitions to transplantation.

After excluding transitions to and from transplantation, 15,514 patients (25%) experienced 48,729 transitions ([Supplementary Figure S3](#)), a proportion reaching 57% in patients starting PD, 69% in patients starting HHD, and 18% in patients starting HD. Of these transitions, 41% occurred during hospitalization, with PD-to-HD as the most frequent (65%; [Figure 2a](#)). Across all hospitalization transitions ([Supplementary Figure S4](#)), infection was the most common discharge diagnosis (32%, of which 51% were dialysis-related infections), followed by cardiovascular disease (21%). The overall 90-day mortality rate following the



**Figure 2.** Hospitalization and mortality rates associated with modality transitions. (a) and (c) display the proportion of modality transitions occurring during a hospitalization episode. (b) and (d) display the 90-day mortality of modality transitions. (a) and (b) display all transitions while (c) and (d) display transitions of at least 30 days in duration. The numbers in brackets indicate the number of transitions by type, whereas the 95th confidence intervals are displayed by whiskers. Transitions to kidney transplantation are not displayed because they are, by definition, associated with hospitalization. HD, hemodialysis; HHD, home hemodialysis; PD, peritoneal dialysis.

transition was 7.9%, with the highest mortality rate observed for the PD-to-HD transition (12.4%; [Figure 2b](#)). Similar trends were observed for the 30-day mortality ([Supplementary Figure S5](#)).

In contrast, when modality transitions were defined as at least 30 consecutive days, 19,983 patients (32%) experienced a total of 32,893 transitions ([Figure 1b](#)). Of the patients, 25% of those starting HD, 62% of those starting PD, and 80% of those starting HHD experienced at least one 30-day transition. The 90-day mortality and hospitalization rates followed similar patterns to the principal analysis ([Figure 2c and d](#)), with an overall 28% hospitalized transition and a 90-day mortality rate of 4.3%.

## DISCUSSION

Among our findings, patients experiencing modality transition were younger and had a more favorable comorbidity profile than nontransitioning patients. Such findings were expected because they reflect the characteristics of patients receiving kidney transplants or undergoing home dialysis. Nevertheless, in Canadian patients receiving KRT, dialysis-to-transplant transitions did not account for most modality transitions, even in those who started KRT on home dialysis. This highlights the need, especially among young individuals, to consider a dialysis life plan with the first and potentially subsequent modalities as a part of integrated KRT care.

We defined modality transitions as periods of at least 2 days, which mitigated the possibility of capturing “administrative transitions” (such as onetime facility HD before transplant or for medication issues in patients with HHD) as modality transitions. Given that some of these short-term transitions may be less meaningful for patients, we also used an alternative 30-day duration as the definition. Although the frequency of transitions diminished, as expected with this definition, a high proportion of modality transitions remained, particularly for home dialysis.

Modality transitions were associated with a meaningful clinical impact, with 41% of the transitions occurring during hospitalization and a 90-day mortality rate of 7.9%. The highest hospitalization and mortality rates were observed for the PD-to-HD transition, with a 30-day mortality rate similar to that following myocardial infarction in Canada (ranging between 6% and 7%).<sup>4</sup> Nonetheless, inverse causality might explain some of these findings, because clinical events associated with hospitalizations and mortality often precipitate a modality transition. In addition, patient characteristics associated with modality transfers (such as older age) may lead to increased hospitalization and mortality.

Nevertheless, these findings highlight the major health toll surrounding modality transitions, especially in patients transitioning from PD to HD.

Our study has several strengths, including its large sample size, national representation, and rigorous assessment of all modality transitions using 2 different definitions. It also has some limitations, including a lack of data on the causes of modality transitions and hospitalizations, potential for classification bias related to the use of registry data, the exclusion of patients from Manitoba and Quebec, as well as those with preemptive kidney transplantation or transfers for only 1 day.

In conclusion, more than a third of Canadian patients initiating dialysis experienced a modality transition during their follow-up, especially young patients on home dialysis. Of these transitions, 41% occurred during hospitalization, and 7.9% of the patients died within 90 days following a transition. These results illustrate the burden of modality transitions and the need for prompt interventions aimed at mitigating transition-related morbidity. The results will also help clinicians normalize modality transitions and highlight the importance of a dialysis “life plan.”

## DISCLOSURE

A-CN-F received an honorarium for educational presentations from Baxter Healthcare and is a Fonds de recherche du Québec-Santé – Société québécoise de néphrologie–Junior 2 Scholar. KKT has conducted advisory board/CME work with AstraZeneca, Bayer, Otsuka, GSK, and Vifor Pharmaceuticals; and has received investigator-initiated grant funding for research or education initiatives from Baxter and Otsuka. JP serves on a speaker’s bureau for Baxter Healthcare and Fresenius Medical Care; has received speaker fees from ARA, US Renal Care, and Davita Healthcare; has served as a consultant for Bayer, Baxter Healthcare, GSK, Otsuka, AstraZeneca, Amgen, Outset Medical; has stock or stock options in iREN Medical; has research support from the Arbor Research Collaborative for Health; and has stipends from ISPD and The American Society of Nephrology. CTC holds the R Fraser Elliott Chair in Home Dialysis and serves as a consultant for Medtronic, Quanta, and Dialco, Inc. He received an investigator-initiated grant from the Medtronic ERP Program. L-CD declared no competing interests.

## DATA AVAILABILITY STATEMENT

Data requests can be made to the Canadian Institute of Health Information (CIHI) to access the Canadian Organ Replacement Register data. Patient-level data cannot be openly shared by the authors because of data protection requirements from the CIHI.

## AUTHOR CONTRIBUTIONS

L-CD contributed to conceptualization, methodology, formal analysis, investigation, data curation, visualization, writing—original draft, and writing—review and editing. KKT contributed to writing—review and editing. JP contributed to writing—review and editing. CTC contributed to writing—review and editing. A-CN-F contributed to conceptualization, methodology, resources, data curation, writing—original draft, writing—review and editing, supervision, project administration, and funding acquisition.

## SUPPLEMENTARY MATERIAL

[Supplementary File \(PDF\)](#)

**Supplementary Methods.**

**Supplementary References.**

**Figure S1.** Study flowchart.

**Figure S2.** Instant transition rates during follow-up.

**Figure S3.** Transition frequencies by first modality (excluding transitions to and from kidney transplant).

**Figure S4.** Hospitalization causes during a dialysis modality transition.

**Figure S5.** Thirty-day mortality rates associated with modality transitions.

**Table S1.** Baseline characteristics according to the transition status.

**STROBE Checklist.**

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