Early Dialysis Initiation and Rates and Timing of Withdrawal From Dialysis in Canada

Amanda D. Ellwood, S. Vanita Jassal,† Rita S. Suri,* William F. Clark,* Yingo Na,‡ and Louise M. Moist*†§*

Summary

Background and objectives The number of elderly patients and those with higher estimated GFR (eGFR) initiating dialysis have recently increased. This study sought to determine rates of withdrawal from dialysis and variables associated with withdrawal.

Design, setting, participants, & measurements Canadian Organ Replacement Registry data were used to examine withdrawal rate and identify variables associated with withdrawal among the total cohort, patients age < 75 years, and patients age ≥ 75 years, along with those with early (eGFR > 10.5 ml/min per 1.73 m^2) and those with late (eGFR ≤ 10.5 ml/min per 1.73 m^2) initiation of dialysis, using a Cox proportional hazard model in patients starting dialysis between 2001 and 2009, with follow-up to December 31, 2009.

Results Median follow-up duration was 23.0 (interquartile range [IQR], 34.3) months. Rate of withdrawal per 100 patient-years doubled from 1.5 to 3.0, and withdrawal as cause of death increased from 7.9% to 19.5% between 2001 and 2009. Early initiation of dialysis was associated with increased withdrawal risk (hazard ratio, 1.17; 95% confidence interval, 1.06–1.30; P=0.002), as were older age, female sex, white race, and late referral to nephrologist. Patients age ≥ 75 years withdrew earlier after dialysis initiation (median, 15.9 [IQR, 27.9] months) compared to those age < 75 years (21.6 [IQR, 35.2] months). Early-start patients withdrew earlier (median, 15.6 [IQR, 28.5] months) compared with late-start patients (20.2 [IQR, 32.9] months).

Conclusions In Canada, withdrawal from dialysis has increased significantly over recent years, especially among patients starting with higher eGFRs and in the elderly.

Clin J Am Soc Nephrol 8: 265–270, 2013. doi: 10.2215/CJN.01000112

*Department of Medicine, Division of Nephrology, and §Department of Epidemiology and Biostatistics, Western University, London, Ontario, Canada; †Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada; and ‡Canadian Institute of Health Information, Toronto, Ontario, Canada

Correspondence: Dr. Louise M. Moist, London Health Sciences Centre, Victoria Hospital, Room A2-338, 800 Commissioners Road East, London, Ontario N6A 5W9 Canada. Email: louise.moist@lhsc.on.ca

Introduction

Withdrawal is a common cause of death among patients undergoing dialysis. The rates vary geographically, with higher rates in the United States (ranging from 12% to 22% of all deaths) and lower rates in European countries and Japan (1–6). Several studies have examined the risk factors associated with withdrawal in the United States, and more recently Australia and New Zealand (7), but none have analyzed Canadian data in the current era.

In recent years, the proportion of patients initiating dialysis with higher levels of residual renal function has increased significantly. A recent analysis of U.S. Renal Data System data (8) indicates that the fraction of patients with an early start on dialysis has nearly tripled from 1996 to 2008, and the rate of those starting dialysis with an estimated GFR (eGFR) >15 ml/min per 1.73 m^2 has nearly quadrupled. Similar trends have been reported in Canada. Clark *et al*. (9) reported that the mean eGFR at the time of dialysis initiation increased from 9.3 to 10.2 ml/min per 1.73 m^2 between 2001 and 2007 and the proportion of patients with an early initiation of dialysis (defined as an eGFR > 10.5 ml/min per 1.73 m^2) increased from 28% to 36%. Moreover, Rosansky *et al*. (8) report a significant increase in elderly patients starting dialysis with higher eGFRs. The percentage of those >75 years who started dialysis with an eGFR >10 ml/min per 1.73 m^2 increased from 25% to 54% between 1996 and 2005. Kurella *et al*. (10) found a similar rise in eGFR among octogenarians and nonoctogenarians from a mean of 8.3 to 10.5 ml/min per 1.73 m^2 between 1996 and 2003. The effects of the significant increase in early initiation of dialysis, especially among the elderly, on the rates of withdrawal from dialysis have not been explored.

To study these effects, we examined data from the Canadian Organ Replacement Registry (CORR) to describe rates of withdrawal from dialysis and the variables associated with withdrawal among patients initiating dialysis between 2001 and 2009. We specifically explored the association of an early start, defined as an eGFR >10.5 ml/min per 1.73 m^2, and older age (≥75 years) on the rates and timing of withdrawal from dialysis. The hypothesis tested was that increased rates of withdrawal from dialysis will be associated with early initiation of dialysis and with older age.

Materials and Methods

Patient Population

The CORR collects and records the incidence, prevalence, and outcome of all long-term dialysis and solid organ transplant patients in Canada. Data have been collected by voluntary completion of survey forms for each patient at the start of dialysis and yearly ending October 31. A change-of-status form is completed for all modality and treatment changes, transfers, withdrawals, deaths, and both cause of withdrawal and death. Withdrawal from dialysis does not include patients who stopped dialysis because of return of kidney function. All adult patients >18 years of age starting hemodialysis or peritoneal dialysis between January 1, 2001, and December 31, 2009, were included in this study, with follow-up until December 31, 2009.

Comorbid conditions present at the start of dialysis are documented at the time of dialysis initiation. Information on the presence or absence of coronary artery disease (including angina, myocardial infarction, and coronary artery bypass surgery), peripheral vascular disease, hypertension, diabetes mellitus, and cerebrovascular disease are documented in three categories: "yes," "no," and "unknown." The "unknowns" are combined into the "no" group. All classifications of diabetes are combined. Late referral is defined as first seeing a nephrologist within 3 months of starting dialysis. Early dialysis is defined as initiating dialysis with an eGFR $>$ 10.5 ml/min per 1.73 m^2, and late initiation of dialysis is defined as initiating dialysis with an eGFR $\leq$ 10.5 ml/min per 1.73 m^2. Body mass index (BMI) is calculated using the height and weight collected at the start of dialysis. Normal BMI is defined as 18.5–24.9 kg/m^2; overweight, 25.0–29.9 kg/m^2; and obese, $\geq$30 kg/m^2. A recent article by Moist *et al*. (11) has validated the accuracy of the CORR comorbidity data.

Statistical Analyses

Baseline patient characteristics were compared for patients who withdrew from dialysis and those who did not withdraw using chi-squared or Kruskal-Wallis tests as appropriate. Withdrawal rates were calculated as the total number of withdrawals from dialysis per 100 patient-years of dialysis. The rate of death due to withdrawal, in the group with a date of death, was calculated as the total number of deaths divided by the total number of withdrawals. We used robust inference (sandwich estimate of the covariance matrix) for the Cox proportional hazards model by aggregating patients at facility level. The following variables, obtained at the start of dialysis, were included in the analysis: age, sex, race, province, BMI, ESRD primary diagnosis, hemodialysis location (home versus in-center), modality of dialysis, era (2001–2005 versus 2006–2009), hemoglobin, albumin, eGFR in ml/min per 1.73 m^2 at initiation of dialysis (calculated using the Modification of Diet in Renal Disease formula [12]), time to referral to a nephrologist relative to dialysis initiation, and comorbid conditions per the modified ESRD comorbidity index (13). A separate analysis was performed for patients <75 years and those $\geq$75 years of age. Hazard ratios (HRs) were calculated for each variable using this multivariable analysis with 95% confidence intervals (CIs). A two-sided P value < 0.05 was considered to represent a statistically significant difference. Model estimates are presented with 95% CIs. All analyses were conducted using SAS software, version 9.1.3 (SAS Institute, Cary, NC).

Results

Baseline Characteristics of Incident Dialysis Patients

The baseline patient characteristics for those who withdrew from dialysis and those who did not withdraw are listed in Table 1. There were several important differences between these groups. The mean age was significantly higher among those who withdrew than among those who did not: 73 years versus 63 years. Of those who withdrew, 51.5% were age $\geq$75 years, compared with 26.9% of those who did not. The withdrawal cohort had higher rates of early initiation of dialysis and more late referrals compared with the nonwithdrawal cohort: 39.8% versus 34.4% and 42.2% versus 34.6%, respectively. There were also higher percentages of women, white patients, and patients with increased comorbidity in the cohort who withdrew from dialysis.

Withdrawal Rates and Cause for Withdrawal

The rate of withdrawal per 100 patient-years of dialysis doubled from 1.5 in 2001 to 3.0 in 2009. The date of death was not available for 25% of patients who withdrew. Among those with a date of death, withdrawal as the cause of death more than doubled, from 7.9% of all deaths in 2001 to 19.5% in 2009, as indicated in Table 2. The reasons for withdrawal were as follows: 38% psychosocial, 11% cancer, 8% vascular disease, 4% dementia, 4% cardiovascular disease, 4% infection, 17% unknown, and 14% other.

Time to Withdrawal

The median follow-up time was 23.0 (interquartile range [IQR], 34.3) months. The median time to withdrawal for all patients was 18.4 (IQR, 31.4) months. Patients age $\geq$75 years withdrew earlier after dialysis initiation (median time, 15.9 [IQR, 27.9] months) compared with those age <75 years (median time 21.6 [IQR, 35.2] months). Patients who started dialysis early withdrew earlier (median, 15.6 [IQR, 28.5] months) compared with patients who started dialysis late (median, 20.2 [IQR, 32.9] months).

Variables Associated with Withdrawal from Dialysis

The HR for withdrawal from dialysis for each covariate tested is shown in Table 3. Variables associated with withdrawal for the entire cohort are listed in the first column of Table 3. Variables associated with increased withdrawal include increasing age (HR, 1.81 per 10 years; 95% CI, 1.75–1.88) and early initiation of dialysis (HR, 1.17; 95% CI, 1.06–1.30). Additionally, a BMI <18.5 kg/m^2 (HR, 1.37; 95% CI, 1.16–1.61), late referral (HR, 1.27; 95% CI, 1.16–1.39), and initiation of dialysis in 2006–2009 versus 2001–2005 (HR, 1.15; 95% CI, 1.02–1.30) were associated with increased rates of withdrawal. Diabetes as cause of ESRD (HR, 1.58; 95% CI, 1.37–1.82) and renovascular disease (HR, 1.26; 95% CI, 1.06–1.49) were also associated with increased risk for withdrawal, as were comorbid conditions, including diabetes, peripheral and cerebral vascular disease, and malignancy.

Table 1. Baseline characteristics of incident dialysis patients, 2001–2009: Withdrawal versus no withdrawal from dialysis

Variable	Withdrawal from Dialysis (*n*=3339)	No Withdrawal from Dialysis (*n*=42,842)
Age (yr)	73.2±10.4	63.0±16.1
Age > 75 yr (%)	51.5	26.9
Women (%)	45.5	40.2
Race (%)		
White	86.5	72.4
Black	1.1	3.5
Asian	2.6	6.0
BMI (kg/m^2)	26.5±6.9	27.4±7.0
Urban dweller (%)	82.1	82.6
Hemodialysis (%)	89.6	80.7
Primary ESRD diagnosis (%)		
GN	6.3	12.0
Diabetes	33.7	35.0
Renovascular disease	26.1	18.9
Other[a]	18.9	20.3
Albumin (g/L)	32.1±6.6	32.7±7.0
Hemoglobin (g/dl)	102.4±17.5	102.3±18.0
Late referral (%)[b]	42.2	34.6
eGFR (ml/min per 1.73 m^2)[c]	9.5 (5.7)	8.8 (5.2)
Early initiation[d]	39.8	34.4
Comorbidity index	2.4±2.2	1.9±2.1
Comorbid conditions (%)		
Coronary artery disease	40.3	31.3
Peripheral vascular disease	25.0	17.6
Cerebrovascular disease	19.3	12.5
Diabetes mellitus	45.2	45.0
Hypertension	80.2	80.2
Congestive heart failure	27.2	22.8
Lung disease	15.7	11.7
Malignancy/other serious disease	30.0	19.2

Values expressed with a plus/minus sign are the mean ± SD. BMI, body mass index; eGFR, estimated GFR.
[a]Includes such diseases as multiple myeloma, amyloid, acute tubular necrosis, pyelonephritis, interstitial nephritis not specified, and gout.
[b]Defined as first seen by a nephrologist <90 days before initiation of dialysis.
[c]Calculated using the Modification of Diet in Renal Disease formula, reported as the median (interquartile range).
[d]Defined as eGFR > 10.5 ml/min per 1.73 m^2 at the start of dialysis.

Table 2. Withdrawals per 100 patient-years of dialysis and withdrawal as a cause of death

Year	Total Withdrawals (*n*)	Withdrawal Rate per 100 Patient-Years of Dialysis (%)	Withdrawal as Cause of Death (%)[a]
2001	233	1.5	7.9
2002	303	1.8	9.9
2003	376	2.2	11.8
2004	441	2.4	13.8
2005	543	2.8	16.1
2006	538	2.7	15.4
2007	657	3.2	18.4
2008	660	3.1	18.3
2009	667	3.0	19.5

[a]Date of death not available in 25% of patients who withdrew from dialysis.

Variables associated with lower rates of withdrawal were as follows: male sex (HR, 0.85; 95% CI, 0.79–0.92), nonwhite race or ethnicity (black: HR, 0.31 [95% CI, 0.22–0.44]; Asian: HR, 0.38 [95% CI, 0.28–0.51]; and native Canadian: HR, 0.76 [95% CI, 0.59– 0.99]), higher albumin level, and community-center versus hospital-centered dialysis. There were also provincial differences in association with withdrawal from dialysis compared with the Canadian average. Patients in Alberta and New Brunswick were less likely to withdraw from dialysis compared with the Canadian average (HR, 0.41 [95% CI, 0.19–0.86] and 0.76 [95% CI, 0.61–0.94]), respectively. Those in Manitoba, Newfoundland, Nova Scotia, and Quebec were found to have a higher risk for withdrawal (HR, 1.21 [95% CI, 1.01–1.44], 1.19 [95% CI, 1.02–1.40], 1.67 [95% CI, 1.40–2.00], and 1.31 [CI, 1.05–1.62]). Rates in British Columbia, Ontario, and Saskatchewan were similar to the Canadian average.

A separate analysis was done for patients age <75 and patients age ≥75 years. There was no significant change in the direction of the associations by age group.

Discussion

This study identifies three significant findings regarding withdrawal from dialysis in Canada. First, the rate of withdrawal and the rate of death from withdrawal have more than doubled between 2001 and 2009. Second, early initiation of dialysis and older age are associated with higher rates of withdrawal. Third, early initiation of dialysis and initiation at an older age result in an earlier time to withdrawal from dialysis. These findings have important implications for the assessment of the elderly and those with early start for initiation of dialysis.

Data from several countries, including Canada, demonstrate an increase in dialysis initiation among those age ≥75 years over the past decade; they also show that this age group has the highest incidence rate of ESRD (14,15). In addition, there has been a trend for earlier initiation of dialysis in several countries (8–10,16). In the United States, the percentage of new dialysis starts with an eGFR >10 ml/min per 1.73 m^2 in patients with diabetes and without diabetes increased from 25% to 55% and from 16% to 48%, respectively, between 1996 and 2008 (17). In Canada between 2001 and 2007, mean eGFR at the time of dialysis initiation increased from 9.3 to 10.2 ml/min per 1.73 m^2, and the proportion of early starts rose from 28% to 36%

Table 3. Variables associated with withdrawal from dialysis for all patients and per age group

Variable	Hazard Ratio (95% CI)		
	All Patients	Patients Age < 75 yr	Patients Age ≥ 75 yr
Demographic			
Age (10-yr increments)	1.81 (1.75–1.88)	1.80 (1.69–1.91)	1.92 (1.72–1.15)
Male versus female	0.85 (0.79–0.92)	0.89 (0.81–0.97)	0.83 (0.75–0.93)
Race	1.00	1.00	1.00
White (reference)			
Black	0.31 (0.22–0.44)	0.29 (0.19–0.43)	0.37 (0.24–0.56)
Asian	0.38 (0.28–0.51)	0.42 (0.29–0.59)	0.36 (0.25–0.51)
Native Canadian	0.76 (0.59–0.99)	0.87 (0.63–1.20)	0.58 (0.35–0.97)
Weight	1.00	1.00	1.00
Normal (BMI > 18.5–24.9 kg/m^2)			
Underweight (BMI < 18.5 kg/m^2)	1.37 (1.16–1.61)	1.45 (1.12–1.86)	1.30 (1.05–1.62)
Overweight (BMI, 25–29.9 kg/m^2)	0.92 (0.83–1.02)	0.90 (0.78–1.05)	0.93 (0.82–1.06)
Obese (BMI ≥ 30 kg/m^2)	0.93 (0.84–1.03)	0.93 (0.81–1.07)	093 (0.81–1.0)
Urban versus rural dewller	0.89 (0.80–1.00)	0.97 (0.82–1.14)	0.82 (0.73–0.93)
Income quintile	1.00	1.00	1.0
1 (lowest) (reference)			
2	0.98 (0.88–1.10	1.00 (0.87–1.17)	0.97 (0.84–1.12)
3	0.90 (0.80–1.01)	0.96 (0.81–1.14)	0.84 (0.71–0.99)
4	0.91 (0.80–1.04)	0.92 (0.77–1.12)	0.89 (0.75–1.06)
5	0.94 (0.84–1.05)	0.98 (0.84–1.14)	0.91 (0.76–1.09)
Hemodialysis versus peritoneal dialysis	1.09 (0.79,1.50)	1.13 (0.71–1.80)	1.01 (0.58–1.75)
Home versus in-center hemodialysis	0.78 (0.56–1.09)	0.80 (0.48–1.33)	0.75 (0.45–1.24)
Community center versus hospital	0.50 (0.26–0.94)	0.52 (0.19–1.42)	0.46 (0.20–1.06)
Laboratory values			
Hemoglobin (g/dl)	1.00 (0.97–1.02)	0.99 (0.96–1.02)	1.01 (0.97–1.04)
Albumin (g/L)	0.86 (0.80–0.92)	0.83 (0.74–0.92)	0.90 (0.81–0.99)
Timing			
Early versus late initiation[a]	1.17 (1.06–1.30)	1.17(1.03,1.32)	1.16 (1.03–1.32)
Late versus early referral[b]	1.27 (1.16–1.39)	1.30 (1.15–1.47)	1.23 (1.09–1.38)
Era: dialysis initiation 2006–2009 versus 2001–2005	1.15 (1.02–1.30)	1.18 (1.02,1.36)	1.13 (0.97–1.31)
ESRD primary diagnosis			
GN (reference)	1.0	1.0	1.0
Diabetes	1.58 (1.37–1.82)	1.86 (1.50–2.32)	1.31 (1.10–1.57)
Renovascular	1.26 (1.06–1.49)	1.43 (1.12–1.82)	1.07 (0.86–1.32)
Other	1.46 (1.23–1.72)	1.68 (1.32–2.14)	1.25 (1.00–1.57)
Comorbid conditions			
Coronary artery disease	1.04 (0.96–1.12)	1.04 (0.93–1.17)	1.03 (0.94–1.13)
Peripheral vascular disease	1.19 (1.08–1.31)	1.26 (1.11–1.42)	1.13 (0.99–1.30)
Diabetes	1.15 (1.02–1.31)	1.15 (0.94–1.40)	1.15 (0.98–1.36)
Hypertension	0.75 (0.67–0.85)	0.73 (0.64–0.84)	0.78 (0.68–0.91)
Congestive heart failure	0.97 (0.87–1.08)	1.01 (0.87–1.17)	0.94 (0.81–1.08)
Cerebrovascular disease	1.30 (1.21–1.41)	1.39(1.22,1.59)	1.24(1.11,1.37)
Lung disease	1.04 (0.9–1.18)	1.04 (0.88–1.23)	1.04 (0.89–1.21)
Malignancy	1.62 (1.47–1.78)	2.01 (1.75–2.30)	1.35 (1.19–1.54)
Provinces (compared with Canada)			
Ontario	1.15 (0.96–1.38)	1.18 (0.96,1.46)	1.11 (0.93–1.33)
Alberta	0.41 (0.19–0.86)	0.39 (0.17–0.90)	0.42 (0.21–0.86)
British Columbia	0.88 (0.74–1.05)	0.86(0.67–1.09)	0.91 (0.74–1.11)
Manitoba	1.21 (1.01–1.44)	1.17 (1.00–1.37)	1.28 (0.96–1.71)
New Brunswick	0.76 (0.61–0.94)	0.72 (0.51–1.03)	0.69 (0.52–0.92)
Newfoundland	1.19 (1.02–1.40)	0.98 (0.61–1.56)	1.44 (1.18–1.76)
Nova Scotia	1.67 (1.40–2.00)	1.84 (1.54–2.20)	1.53 (1.18–1.98)
Quebec	1.31 (1.05–1.62)	1.45 (1.13–1.86)	1.16 (0.92–1.46)
Saskatchewan	1.01 (0.96–1.38)	0.96 (0.75–1.25)	1.04 (0.71–1.51)

CI, confidence interval; BMI, body mass index.

[a]Early initiation defined as estimated GFR > 10.5 ml/min per 1.73 m^2; late initiation defined as estimated GFR ≤ 10.5 ml/min per 1.73 m^2.

[b]Late referral defined as first seen by a nephrologist <90 days before initiation of dialysis.

(9). There was also an associated risk for death with early starts even after adjustment for patient characteristics.

The outcome of elderly patients starting dialysis has been well described. Jassal *et al*. (18) studied the living status and residence of octogenarians who start dialysis in Canada. Within the first 6 months of dialysis, nearly one third of patients required assistance or moved to a nursing home. Moreover, Kurella Tamura *et al*. (19) found that among elderly patients who resided in a nursing home before their first renal replacement treatment in the United States, nearly 9 of 10 had died or had a decrease in functional status by 12 months of dialysis. The authors explain that functional decline continues despite the initiation of dialysis and that the periods before and after starting dialysis are times of high risk; nearly all patients showed worsening disability, which is often permanent. These findings indicate that although dialysis can extend lives, it does not restore functional status to these elderly patients.

Additional findings in our study include previously reported risk factors for dialysis withdrawal, such as increasing age, female sex, and white race (4,5,7). The reasons that nonwhite patients withdraw less often are unclear; however, it is likely that religious and cultural beliefs play a significant role (20). Withdrawal was also higher in patients with more comorbid diseases, including diabetes, also previously reported (2,4–7). In our study, modality type was not associated with withdrawal, but dialysis at home, in a community setting, and in an urban center were associated with fewer withdrawals, perhaps because of increased home and community supports. In contrast, Chan *et al*. (7) found that patients undergoing hemodialysis were more likely to withdraw than those undergoing peritoneal dialysis. The authors surmised that the greater sense of personal control over treatment facilitated adherence to treatment, leading to less withdrawal; however, they could not rule out selection bias and unmeasured confounders leading to this result because frail patients are more likely to begin renal replacement therapy with hemodialysis.

Furthermore, we found the province of residence to be associated with significant variability with respect to withdrawal rates compared with Canada as a reference. Although these findings are intriguing, the reason for them is unclear, and further evaluation is necessary to better understand these interprovincial differences. Notably, O'Hare and colleagues (21) studied regional differences in treatment practices for ESRD in older adults and found the rate of withdrawal was nearly double, 44.3% versus 22.2%, in regions with the lowest end-of-life expenditure index quintile compared with regions with the highest quintile. They felt that these differences were unlikely to be explained by differences in patient preferences alone and call for the need to evaluate end-of-life care practices to ensure care is consistent with the patient's wishes. We espouse this recommendation on the basis of our results. In addition, a recent viewpoint article by Rosansky further emphasizes the importance of discussing the risks and benefits of dialysis versus nondialysis care with elderly patients (22).

A low BMI was associated with increased withdrawal, probably reflecting a poor nutritional and health state. Of note, we found an era effect in terms of withdrawal. Patients starting dialysis between 2006 and 2009 were more likely to withdraw than those starting between 2001 and 2005. Further studies are necessary to elucidate the reasons for this, which may represent a combination of increased reporting of withdrawal; more frequent discussions by health care personnel of withdrawal as an option; and more patients who are poor candidates for dialysis being initiated, only to withdraw soon after. Chan *et al*. (23) studied the mortality of incident long-term dialysis patients immediately after dialysis initiation and during their first year of renal replacement. They report the mortality rate to be highest in the first 2 weeks of dialysis and then decrease by 90 days. Whether this spike in mortality represents palliative patients who withdraw soon after initiation is unknown; however, our findings would support this hypothesis.

This study had some limitations inherent to all observational studies. Withdrawal does not include patients who stop dialysis because of a return of function, but we cannot distinguish those who withdraw with terminal cancer and for whom death is imminent from those who withdraw because of the burden of kidney disease. In addition, we do not have a date of death for all patients who withdrew, so the cause of death due to withdrawal may be underreported.

In conclusion, we have demonstrated an increased risk and earlier time to withdrawal associated with early initiation of dialysis and with increasing age. In addition, withdrawal is increasing as a cause of death in this same population.

Acknowledgments

We would like to thank the Canadian Organ Replacement Registry for allowing us to use their database in this research. The authors thank the staff of the renal units throughout Canada submitting information to CORR and the staff at CORR for maintaining the database.

Disclosures

None.

References

1. Sehgal AR, Weisheit C, Miura Y, Butzlaff M, Kielstein R, Taguchi Y: Advance directives and withdrawal of dialysis in the United States, Germany, and Japan. *JAMA* 276: 1652–1656, 1996
2. Mailloux LU, Bellucci AG, Napolitano B, Mossey RT, Wilkes BM, Bluestone PA: Death by withdrawal from dialysis: A 20-year clinical experience. *J Am Soc Nephrol* 3: 1631–1637, 1993
3. Kurella M, Kimmel PL, Young BS, Chertow GM: Suicide in the United States end-stage renal disease program. *J Am Soc Nephrol* 16: 774–781, 2005
4. Fissell RB, Bragg-Gresham JL, Lopes AA, Cruz JM, Fukuhara S, Asano Y, Brown WW, Keen ML, Port FK, Young EW: Factors associated with "do not resuscitate" orders and rates of withdrawal from hemodialysis in the international DOPPS. *Kidney Int* 68: 1282–1288, 2005
5. Leggat JE Jr, Bloembergen WE, Levine G, Hulbert-Shearon TE, Port FK: An analysis of risk factors for withdrawal from dialysis before death. *J Am Soc Nephrol* 8: 1755–1763, 1997
6. Neu S, Kjellstrand CM: Stopping long-term dialysis. An empirical study of withdrawal of life-supporting treatment. *N Engl J Med* 314: 14–20, 1986
7. Chan HW, Clayton PA, McDonald SP, Agar JWM, Jose MD: Risk factors for dialysis withdrawal: An analysis of the Australia and New Zealand Dialysis and Transplant (ANZDATA) Registry, 1999-2008. *Clin J Am Soc Nephrol* 7: 775–781, 2012

8. Rosansky SJ, Clark WF, Eggers P, Glassock RJ: Initiation of dialysis at higher GFRs: is the apparent rising tide of early dialysis harmful or helpful? *Kidney Int* 76: 257–261, 2009
9. Clark WF, Na Y, Rosansky SJ, Sontrop JM, Macnab JJ, Glassock RJ, Eggers PW, Jackson K, Moist L: Association between estimated glomerular filtration rate at initiation of dialysis and mortality. *CMAJ* 183: 47–53, 2011
10. Kurella M, Covinsky KE, Collins AJ, Chertow GM: Octogenarians and nonagenarians starting dialysis in the United States. *Ann Intern Med* 146: 177–183, 2007
11. Moist LM, Richards HA, Miskulin D, Lok CE, Yeates K, Garg AX, Trpeski L, Chapman A, Amuah J, Hemmelgarn BR: A validation study of the Canadian Organ Replacement Register. *Clin J Am Soc Nephrol* 6: 813–818, 2011
12. Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D; Modification of Diet in Renal Disease Study Group; : A more accurate method to estimate glomerular filtration rate from serum creatinine: a new prediction equation. *Ann Intern Med* 130: 461–470, 1999
13. Hemmelgarn BR, Manns BJ, Quan H, Ghali WA: Adapting the Charlson Comorbidity Index for use in patients with ESRD. *Am J Kidney Dis* 42: 125–132, 2003
14. Canadian Institute for Health Information: *Treatment of End Stage Organ Failure in Canada, CORR 2010 Annual Report*, Ottawa, ONCanadian Institute for Health Information, 2010
15. U.S. Renal Data System: *USRDS 2010 Annual Data Report. Atlas of Chronic Kidney Disease and End Stage Renal Disease in the United States*, Bethesda, MD, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2010
16. Stel VS, Dekker FW, Ansell D, Augustijn H, Casino FG, Collart F, Finne P, Ioannidis GA, Salomone M, Traynor JP, Zurriaga O, Verrina E, Jager KJ: Residual renal function at the start of dialysis and clinical outcomes. *Nephrol Dial Transplant* 24: 3175–3182, 2009
17. Rosansky S, Glassock RJ, Clark WF: Early start of dialysis: A critical review. *Clin J Am Soc Nephrol* 6: 1222–1228, 2011
18. Jassal SV, Chiu E, Hladunewich M: Loss of independence in patients starting dialysis at 80 years of age or older. *N Engl J Med* 361: 1612–1613, 2009
19. Kurella Tamura M, Covinsky KE, Chertow GM, Yaffe K, Landefeld CS, McCulloch CE: Functional status of elderly adults before and after initiation of dialysis. *N Engl J Med* 361: 1539–1547, 2009
20. Kurella Tamura M, Goldstein MK, Pérez-Stable EJ: Preferences for dialysis withdrawal and engagement in advance care planning within a diverse sample of dialysis patients. *Nephrol Dial Transplant* 25: 237–242, 2010
21. O'Hare AM, Rodriguez RA, Hailpern SM, Larson EB, Kurella Tamura M: Regional variation in health care intensity and treatment practices for end-stage renal disease in older adults. *JAMA* 304: 180–186, 2010
22. Rosansky SJ: The sad truth about early initiation of dialysis in elderly patients. *JAMA* 307: 1919–1920, 2012
23. Chan KE, Maddux FW, Tolkoff-Rubin N, Karumanchi SA, Thadhani R, Hakim RM: Early outcomes among those initiating chronic dialysis in the United States. *Clin J Am Soc Nephrol* 6: 2642–2649, 2011

Received: January 27, 2012 **Accepted:** September 24, 2012

Published online ahead of print. Publication date available at www.cjasn.org.

See related editorial, "Initiation of Dialysis at Higher Levels of Estimated GFR and Subsequent Withdrawal," on pages 179–181.