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Inadequate predialysis care and mortality after initiation of renal replacement therapy

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Adequacy of chronic kidney disease (CKD) care is traditionally measured as early or late, but this does not reflect the effect of cumulative or consistent care. Here we relate alternate measures of CKD care to mortality and other outcomes in patients with end-stage renal disease (ESRD) who started renal replacement therapy (RRT) between 1998 and 2008. CKD care was defined traditionally as early or late, and alternatively as cumulative care (total visits) and consistency of care in the critical period immediately prior to start of RRT (consistent critical period care required visits in 3 or more of the 6 months prior to RRT start). The primary outcome was 1-year mortality, with secondary outcomes of inpatient start and access creation. Of 12,143 patients aged 18–97 years at the start of RRT, 75.9% had early CKD care. Only 38.3% of the early group had high cumulative (over 10 visits) and consistent critical period care. The 1-year mortality of 15.8% was more likely with late care, lower cumulative care, and inconsistent critical period care. Both cumulative care and consistent critical period care independently predicted mortality, as well as secondary outcomes. Alternate measures of CKD care are important predictors of outcomes in ESRD and should be considered when reporting adequacy of care. Thus, patients traditionally classified as receiving early CKD care often do not receive adequate care immediately prior to initiating RRT.

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Traditional measures of chronic kidney disease (CKD) care focus on timing of the first visit relative to start of renal replacement therapy (RRT). Many studies demonstrate an association between late CKD care and adverse outcomes, such as lack of modality choice,[1–3] inpatient start of RRT,[2,4] use of a hemodialysis (HD) catheter,[2,4–6] and mortality.[4,7–11] However, despite early renal referral, rates of suboptimal starts and mortality remain high.[12–14] Even when patients are in CKD care for >12 months, the rate of suboptimal dialysis starts is high.[15]

Very few studies have looked at the effect of cumulative CKD care or care immediately prior to start of dialysis. One American study[16] suggests that consistency of care in the 6-month period prior to start of dialysis affects survival 1 year after start; those with visits in only 1 or 2 of the 6 months prior to start had 28% higher mortality compared with those with visits in $\geqslant 3$ months. Although these findings suggest that a measure of frequency of visits in a critical period prior to start affects mortality, it is not known whether this effect is independent of timing of start of care. Another American study found that <5 visits in the 12 months prior to start of RRT predicted 15% higher mortality in the first year of HD compared with $\geqslant 5$ visits[5] even after adjusting for timing of care. Because it often takes time for patients to accept the need for dialysis, make a modality decision, and plan for access creation, it makes clinical sense that cumulative CKD care would benefit patients. Similarly, many critical decisions are made immediately prior to dialysis start, so CKD care in this period may affect hospitalization or catheter use.

Another limitation of 'late referral' studies is that they often do not exclude cases of acute kidney injury, which may contribute to the poor outcomes associated with late referral.[17,18] An English study found that roughly 60% of those presenting <90 days prior to start had acute and irreversible renal failure[17] and were more likely to have other major comorbidities such as malignancy or systemic vasculitis,[16,17] which may lead to early withdrawal of dialysis or mortality.[17] To reduce bias, studies of CKD care could minimize patients with acute kidney injury as they may not have had the opportunity to receive CKD care. Potential methods to reduce acute kidney injury in a study population would be excluding patients who have no nephrologist

contact prior to starting dialysis, who start with continuous RRT, and who recover renal function.

The primary objective of this study was to determine whether alternate measures of CKD care would predict mortality in a large, generalizable Canadian population with end-stage renal disease (ESRD) who initiated RRT. A secondary objective was to determine whether alternate measures of CKD care would predict the secondary outcomes of inpatient start of RRT and prior arteriovenous access creation, which may in part explain mortality effects.

RESULTS

Study population

A total of 12,143 adults with prior outpatient nephrology care were eligible for the study. Baseline characteristics were categorized by the traditional measure of early versus late CKD care and are described in Table 1. Ages of the patients ranged from 19 to 97 years, with 22.4% being over the age of 75 years at the start of RRT; 41% were women, and 52.3% had diabetes. Only 2.3% of patients had transplant as incident RRT modality, 22.7% had peritoneal dialysis, and the vast majority had HD.

CKD care

In this cohort with a reduced likelihood of acute kidney injury, prevalence of late CKD care was 24.1%. Median duration of CKD care was 20.9 (interquartile range (IQR) = 6.4, 33.0) months. Total visits ranged from 1 to 55 over 3 years, with a median of 8 (IQR = 4, 13). 52.0% of patients received consistent critical period care.

In the early group, duration of care was 28.4 (IQR = 16.3, 34.0) months, with a median of 10 (IQR = 7, 15) cumulative visits. Gaps in CKD care can be exposed by examining alternate measures of care in the early group. As seen in Figure 1, 19.1% of patients had low cumulative care ($\leqslant$5 visits) and 39.7% had inconsistent critical period care despite early start of care. Of the 19.1% of patients of the early care group with low cumulative care, 21.5% had consistent critical period care. This leaves 78.5% of patients with inconsistent critical period care, implying that 15.0% of the early care group had both low cumulative care and inconsistent critical period care. Of the 32.7% with moderate cumulative care, 54.7% had consistent critical period care. Of the 48.2% with high cumulative care, 79.5% had consistent critical period care, implying that only 38.3% of the early care group and 29.1% of the overall study population had all three measures of adequate CKD care.

In the late group, duration of care was 1.4 (IQR = 0.3, 3.5) months, with a median of 2 (IQR = 1, 3) cumulative visits. The majority of late care patients (93.3%) had low cumulative care ($\leqslant$5 visits) and inconsistent critical period care (73.8%).

CKD care and outcomes

Effect of CKD care on primary outcome: 1-year mortality. One year after start of RRT, 15.8% of the population had died. A 1-year mortality was more likely with late care, lower cumulative care, and inconsistent critical period care (Figure 2). Each of the three CKD care measures independently predicted 1-year mortality (Table 2). Late care predicted increased mortality 1 year after start of RRT (adjusted odds ratio or AOR = 1.31 (95% confidence interval (CI) = 1.13, 1.53)). A graded survival benefit was seen with cumulative visits ($AOR_{6\text{-}10:1\text{-}5\ visits} = 0.75$ (95% CI = 0.64, 0.88; $AOR_{>10:1\text{-}5\ visits} = 0.68$ (95% CI = 0.57, 0.81)), and reduced mortality was also seen with consistent critical period care (AOR = 0.73; 95% CI = 0.64, 0.82). Other factors predictive of death at 1 year included advanced age, diabetes, increased morbidity (higher collapsed Aggregated Diagnostic Group (ADG) count), and incident modality. Model discrimination was good (c-statistic = 0.752).

Table 1 | Baseline characteristics by early and late referral for CKD care

Factor	All patients $n = 12{,}143$	Early care ($\geqslant$6 mos) $n = 9214$	Late care ($<$6 mos) $n = 2929$	*P*-value
Median age, years (IQR)	65 (52,74)	64 (51,73)	69 (56,77)	<0.0001
Age $>$75 years (%)	2613 (21.5)	1743 (18.9)	870 (29.7)	<0.0001
Female gender (%)	4980 (41.0)	3752 (40.7)	1228 (41.9)	0.2471
Low socioeconomic status (%)	2906 (23.1)	2196 (23.8)	710 (24.2)	0.6519
Rural residence (%)	1300 (10.7)	961 (10.4)	339 (11.6)	0.0812
Diabetes mellitus (%)	6350 (52.3)	4954 (53.8)	1396 (47.7)	<0.0001
CADG count, median (IQR)	6 (5, 7)	6 (5, 7)	6 (5, 7)	0.9292
Duration of care, median months (IQR)	20.9 (6.4, 33.0)	28.4 (16.3, 34.0)	1.4 (0.3, 3.5)	<0.0001
Cumulative visits, median[a] (IQR)	8 (4, 13)	10 (7,15)	2 (1, 3)	<0.0001
Consistent critical period care[b] (%)	6321 (52.0)	5553 (60.3)	768 (26.2)	<0.0001
Initial RRT modality				
Transplant, %	2.3	3.0	—	<0.0001
Peritoneal dialysis, %	22.7	24.6	16.3	<0.0001
Hemodialysis, %	75.0	72.4	83.7	<0.0001

Abbreviations: CADG, collapsed Aggregated Diagnostic Groups; CKD, chronic kidney disease; mos, months; RRT, renal replacement therapy.
[a]Cumulative care was captured by sum of CKD visits in the 36 months prior to start of RRT.
[b]Consistent critical period care required individuals to be seen in 3 or more of the 6 months prior to start of RRT.