Clinical Outcomes and Healthcare Use Associated With Optimal ESRD Starts

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ABSTRACT

OBJECTIVES: To assess the association between optimal end-stage renal disease (ESRD) starts and clinical and utilization outcomes in an integrated healthcare delivery system.

STUDY DESIGN: Retrospective observational cohort study in 6 regions of an integrated healthcare delivery system, 2011-2013.

METHODS: Propensity score techniques were used to match 1826 patients who experienced an optimal start of renal replacement therapy (initial therapy of hemodialysis via an arteriovenous fistula or graft, peritoneal dialysis, or pre-emptive transplant) to 1826 patients who experienced a nonoptimal start (hemodialysis via a central venous catheter). Outcomes included 12-month rates of sepsis, mortality, and utilization (inpatient stays, total inpatient days, emergency department visits, and outpatient visits to primary care and specialty care).

RESULTS: Optimal starts were associated with a 65% reduction in sepsis (odds ratio, 0.35; 95% CI, 0.29-0.42) and a 56% reduction in 12-month mortality (hazard ratio, 0.44; 95% CI, 0.36-0.53). Optimal starts were also associated with lower utilization, except for nephrology visits. Large utilization differences were observed for total inpatient days (9.4 for optimal starts vs 27.5 for nonoptimal starts; relative rate [RR], 0.45; 95% CI, 0.38-0.52) and outpatient visits for specialty care other than nephrology or vascular surgery (12.5 vs 18.3, respectively; RR, 0.62; 95% CI, 0.53-0.74).

CONCLUSIONS: Compared with patients with nonoptimal starts, patients with optimal ESRD starts have lower morbidity and mortality and less use of inpatient and outpatient care. Late-stage chronic kidney disease and ESRD care in an integrated system may be associated with greater benefits than those previously reported in the literature.

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Clinical guidelines call for adequate planning before initiating renal replacement therapy in patients with chronic kidney disease (CKD) at risk for end-stage renal disease (ESRD).[1-4] An important objective is to avoid the use of central venous catheters (CVCs) for hemodialysis access, which constitutes suboptimal initiation of renal replacement therapy.[5] In a systematic review of 62 cohort studies, the relative risk of all-cause mortality for patients starting hemodialysis with a CVC, compared with those starting with an arteriovenous fistula (AVF), was 1.53.[6] Patients starting hemodialysis with a CVC are also at increased risk of fatal infection and major cardiovascular events compared with patients starting dialysis with an AVF or arteriovenous graft (AVG).[6] In addition, the median annual procedure and access costs of hemodialysis via CVC are more than 2.5 times higher than similar costs for either AVFs or AVGs.[7]

Other renal replacement therapy options include pre-emptive kidney transplant, peritoneal dialysis, and hemodialysis via AVF or AVG. In 1997, the National Kidney Foundation Kidney Disease Outcomes Quality Initiative first published practice guidelines recommending the use of an AVF in at least 50% of patients initiating renal replacement therapy.[8] In 2005, the Fistula First (now Fistula First Catheter Last) Breakthrough Initiative established national guidelines based on these recommendations.[9]

However, remarkably little nationwide progress has been made toward achieving this goal. In 2013, among 117,162 individuals in the United States with incident ESRD, 70.9% began renal replacement therapy with hemodialysis via CVC.[10] Under the direction of CMS, a national program of 18 ESRD networks is responsible for each state, territory, and the District of Columbia. No network has met the goal of 50% incident AVF use.[11] Across networks, the proportion of patients with functional AVFs at the start of hemodialysis ranged from 11.1% to 22.2%, and nephrology care was significantly associated with increased odds of incident AVF use.[11] One estimate places the potential annual US cost savings from using AVFs rather than CVCs for first hemodialysis access at $2 billion.[12] Although this estimate is based on the faulty assumption that all those who start renal replacement therapy are both candidates for and

TAKEAWAY POINTS

In an integrated healthcare delivery system, compared with patients with end-stage renal disease with nonoptimal starts of renal replacement therapy by hemodialysis via a central venous catheter, patients with optimal starts by hemodialysis via arteriovenous fistula/graft, peritoneal dialysis, or pre-emptive transplant had:

- Reduced morbidity
- Less inpatient utilization
- Annual event rates for all-cause mortality lower than those reported in the largest systematic review to date
- Fewer primary and specialty care outpatient visits, except for nephrology visits, which did not differ between those with optimal and nonoptimal starts

want AVF placement, it illustrates the magnitude of the impact on healthcare costs of the slow progress toward meeting the Fistula First Catheter Last goals.

Suggestions for ameliorating widespread underperformance in late-stage CKD care include multidisciplinary teams that incorporate all stakeholders: engaged patients, primary care providers, nephrologists, and vascular surgeons.[13] Early referrals from primary care to nephrology and from nephrology to vascular surgery are needed to ensure the timely placement of access.[13] Care for patients with CKD stages 1 through 3 at Kaiser Permanente is managed by primary care providers in collaboration with nephrology specialty care as needed and according to clinical guidelines. In every region, patients are referred for nephrology specialty care by the time they reach CKD stage 4 if they have not been referred earlier for severe proteinuria or hypertension or at their request. Nephrologists refer patients for vascular access surgery. The effectiveness of pre-ESRD care is assessed using the National Quality Forum–endorsed Optimal ESRD Starts measure, which calculates the proportion of new patients with ESRD during the measurement period who avoid the use of a CVC for hemodialysis.[14] Thus, it is an appropriate measure for assessing progress toward Fistula First Catheter Last goals.

Although the mortality and morbidity benefits of optimal starts are well documented, it is unclear whether equivalent benefits accrue within an integrated healthcare delivery system. The purpose of this analysis was to use propensity score–matching techniques to assess the association between optimal ESRD starts and clinical outcomes and utilization in an integrated healthcare delivery system facilitating proactive late-stage CKD care.

METHODS

Design and Setting

We conducted a retrospective propensity score–matched analysis of patients who did and did not have an optimal ESRD start in 6 Kaiser Permanente regions between January 1, 2011, and December 31, 2013. Kaiser Permanente's total membership is more than 12 million. In 2013, across the regions participating in this analysis (Colorado, Georgia, Hawaii, Northwest, Northern California, and Southern California), 20,273 adult members were coded as having incident or prevalent stage 4 or 5 CKD; 13,760 were coded as having incident or prevalent ESRD; and 4421 were coded as having received a kidney transplant.

Approximately 230 Permanente Medical Group nephrologists and several hundred contracting nephrologists and nephrology groups care for patients with late-stage CKD. All renal replacement therapy options (home and in-center hemodialysis, peritoneal dialysis, and kidney transplant) are available to Kaiser Permanente members in all regions.

Participants

Patients were included in the analysis if they began renal replacement therapy during the observation period, were 18 years or older on the date they started renal replacement therapy, and had continuous insurance coverage throughout the previous year. We excluded patients who recovered sufficient kidney function to stop dialysis within 3 months of initiation. Kaiser Permanente regions use nurse care coordinators to transition patients into renal replacement therapy; we compiled the patient lists of care coordinators and dialysis and transplantation authorization lists from the participating regions to identify the included population. The medical record numbers of all patients were verified, and all patients were included in the analysis.

Measures

Dependent variables. Measured outcomes included 12-month rates of sepsis and all-cause mortality. Sepsis was identified by *International Classification of Diseases, Ninth Revision* (*ICD-9*) codes (sepsis, 995.9x; septicemia, 038.x). Deaths were identified by a monthly master file provided by the Social Security Administration and filtered for the Social Security numbers of study participants. Utilization outcomes included inpatient stays, total inpatient days, emergency department (ED) visits, and outpatient visits to primary care and specialty care, which included nephrology and vascular surgery visits and visits to all other specialties. Nephrology visits did not include encounters at dialysis facilities. All data on outcomes were available through the electronic health record (EHR).

Independent variable. The primary independent variable was optimal ESRD starts, which we dichotomously measured as occurring or not occurring. Optimal starts were indicated by initial renal replacement therapy consisting of a pre-emptive kidney transplant, outpatient dialysis with peritoneal dialysis (including on an urgent basis), or outpatient dialysis with hemodialysis via an AVF or AVG, including home hemodialysis. The full measure specification is available online.[14] Initiation of renal replacement therapy with hemodialysis via a CVC indicated a nonoptimal start. Data were available in Kaiser Permanente's integrated EHR.

Covariates. Covariates included demographic and clinical characteristics. Sex, race/ethnicity, and region were measured

categorically. Dichotomous variables were created for income (annual household income less than $100,000 and $100,000 or more) and education (high school degree or less and 1 or more years of college). To control for baseline utilization, we created an ordinal variable for combined hospital and ED use in the year before starting renal replacement therapy of 0 or 1 encounters, 2 to 5 encounters, and 6 or more encounters. We created dichotomous variables for body mass index using the cut point for excess weight of 25 kg/m^2, alcohol use (yes and no), and smoking status (current, former, never, and passive). Comorbidities—coronary artery disease, congestive heart failure (CHF) or fluid overload, CKD, peripheral edema, peripheral artery disease, proteinuria, diabetes, and hypertension—were measured dichotomously as present or not. We included the presence of a CKD code as a covariate because appropriate CKD coding would be expected to associate with optimal starts, and CKD codes were not always present.[15] Charlson Comorbidity Index scores and glomerular filtration rate (GFR) were assessed as continuous variables.[16] All data were available in the EHR; comorbidities were identified by *ICD-9* codes. Data on income and education are not routinely collected during care and were imputed from block-level Census data based on participants' home addresses.[17,18] Negligible missingness of data was disregarded in analyses (**Table 1**).

Statistical Analysis

We calculated baseline characteristics of patients with optimal and nonoptimal starts using *t* tests for continuous variables and χ^2 tests for categorical variables. We then created a matched data set to test for differences in outcomes between patients with optimal and nonoptimal renal replacement therapy starts. We did this by generating a propensity score for the likelihood that patients would have an optimal ESRD start using logistic regression modeling that included all listed covariates; stepwise selection was used to identify covariates significantly associated with an optimal start. The final propensity score model included GFR, education, alcohol use, coronary artery disease, CHF or fluid overload, CKD, hypertension, and peripheral edema. We matched patients with optimal starts to patients with nonoptimal starts using the greedy-5 algorithm and a matching ratio of 1:1.[19,20] All optimal and nonoptimal starts were separately ordered by propensity score, and each optimal start was matched to the nearest unmatched nonoptimal start. Five-digit matches were completed first, followed by 4-digit matches, continuing down to a 1-digit match on propensity scores. Matches were not reconsidered, and unmatched optimal starts were not included in further analyses.

We calculated standardized differences in means for all covariates before and after matching, with 10% or more indicating imbalance.[21] After matching, absolute standardized differences in means were less than 10% for all variables used to calculate propensity scores, except for region. Although the standardized difference in means for education was 8% (Table 1), the χ^2 test for differences was statistically significant at $P = .01$. All subsequent analyses were performed on the propensity score–matched cohort and adjusted for propensity score, region, and education. Healthcare utilization was also adjusted for prior-year utilization.

We estimated relative rates for utilization, adjusting for prior-year utilization, propensity score, region, and education. We used logistic

TABLE 1. Baseline Characteristics for the Whole Cohort and the Propensity Score–Matched Cohort

	Before Matching				After Matching			
	Optimal Start (n = 2930)	Nonoptimal Start (n = 2600)	*P*	SDM	Optimal Start (n = 1826)	Nonoptimal Start (n = 1826)	*P*	SDM
Age, mean, years	63.4	65.1	<.001	0.12	64.7	65.0	.55	0.02
Sex, male, n (%)	1647 (56.2)	1500 (57.7)	.27	0.03	1012 (55.4)	1047 (57.3)	.24	0.04
Race/ethnicity, n (%)[a]			.02	0.09			.67	0.05
Black	357 (12.2)	325 (12.5)			247 (13.5)	237 (13.0)		
Hispanic	810 (27.7)	692 (26.6)			508 (27.8)	521 (28.5)		
Other	416 (14.2)	301 (11.6)			243 (13.3)	216 (11.8)		
White	1316 (44.9)	1244 (47.9)			809 (44.3)	831 (45.5)		
Mean annual household income, n (%)[b]			.08	0.04			.65	0.02
<$100,000	1973 (67.3)	1795 (69.0)			1244 (68.1)	1261 (69.1)		
≥$100,000	922 (31.5)	761 (29.3)			561 (30.7)	540 (29.6)		
Education completed, n (%)[c]			.04	0.05			.04	0.08
High school degree or less	564 (19.3)	444 (17.1)			364 (19.9)	305 (16.7)		
1 year of college or more	2331 (79.6)	2112 (81.2)			1441 (78.9)	1496 (81.9)		
Mean BMI, kg/m^2, n (%)			.29	0.03			.34	0.03
<25	797 (27.2)	682 (26.2)			520 (28.5)	494 (27.1)		
≥25	2133 (72.8)	1918 (73.8)			1306 (71.5)	1332 (73.0)		
GFR, mL/min/1.73m^2, mean	10.4	13.2	<.001	0.32	10.4	10.4	.92	0.00

(continued)

TABLE 1. *(Continued)* Baseline Characteristics for the Whole Cohort and the Propensity Score–Matched Cohort

	Before Matching				After Matching			
	Optimal Start (n = 2930)	Nonoptimal Start (n = 2600)	*P*	SDM	Optimal Start (n = 1826)	Nonoptimal Start (n = 1826)	*P*	SDM
Alcohol use, n (%)	97 (3.3)	160 (6.2)	<.001	0.13	70 (3.8)	60 (3.3)	.37	0.03
Tobacco use, n (%)			.01	0.10			.23	0.08
Current	165 (5.6)	186 (7.2)			106 (5.8)	124 (6.8)		
Never	1489 (50.8)	1218 (46.9)			880 (48.2)	899 (49.2)		
Former	1257 (42.9)	1171 (45.0)			830 (45.5)	790 (43.3)		
Passive	13 (0.4)	16 (0.6)			10 (0.6)	10 (0.6)		
Unknown	6 (0.2)	9 (0.4)			0 (0)	3 (0.2)		
CCI score, mean	4.7	5.0	<.001	0.14	5.1	4.9	.6	0.02
Comorbidities, n (%)								
CAD	893 (30.5)	1031 (39.7)	<.001	0.19	685 (37.5)	694 (38.0)	.8	0.01
CHF/fluid overload	1052 (35.9)	1338 (51.5)	<.001	0.32	855 (46.8)	886 (48.5)	.3	0.03
Peripheral arterial disease	348 (11.9)	384 (14.8)	.002	0.09	272 (14.9)	263 (14.4)	.7	0.01
Peripheral edema	1258 (42.9)	1363 (52.4)	<.001	0.19	910 (49.8)	919 (50.3)	.8	0.01
Coded CKD	2909 (99.3)	2426 (93.3)	<.001	0.32	1810 (99.1)	1813 (99.3)	.6	0.02
Proteinuria	777 (26.5)	681 (26.2)	.8	0.01	513 (28.1)	483 (26.5)	.3	0.04
Diabetes	2112 (72.1)	1957 (75.3)	.01	0.07	1408 (77.1)	1400 (76.7)	.8	0.01
Hypertension	2891 (98.7)	2498 (96.1)	<.001	0.16	1798 (98.5)	1806 (98.9)	.3	0.04
Prior-year inpatient and ED encounters, n (%)			<.001	0.76			.8	0.02
0-1	1518 (51.8)	488 (18.8)			416 (22.8)	406 (22.2)		
2-5	933 (31.8)	1188 (45.7)			931 (51.0)	922 (50.5)		
≥6	479 (16.4)	924 (35.5)			479 (26.2)	498 (27.3)		
Region, n (%)			.08	0.08			.6	0.06
1	33 (1.1)	41 (1.6)			15 (0.8)	15 (0.8)		
2	59 (2.0)	44 (1.7)			40 (2.2)	30 (1.6)		
3	106 (3.6)	128 (4.9)			97 (5.3)	87 (4.8)		
4	1241 (42.4)	1116 (42.9)			704 (38.6)	748 (41.0)		
5	89 (3.0)	71 (2.7)			49 (2.7)	49 (2.7)		
6	1402 (47.9)	1200 (46.2)			921 (50.4)	897 (49.1)		

BMI indicates body mass index; CAD, coronary artery disease; CCI, Charlson Comorbidity Index; CHF, congestive heart failure; CKD, chronic kidney disease; ED, emergency department; GFR, glomerular filtration rate; SDM, standardized difference in means.

[a]Data on race were missing for 1.25% of included patients.

[b]Data on income were missing for 1.43% of included patients.

[c]Data on education were missing for 1.43% of included patients.

regression to calculate odds ratios (ORs) for sepsis and mortality and Cox proportional hazards to estimate a hazard ratio (HR) for 12-month mortality; all were adjusted for propensity score, region, and education. Analyses were performed using SAS version 9.2 (SAS Institute; Cary, North Carolina). This quality improvement analysis did not meet criteria for institutional review board oversight.

RESULTS

We identified 5530 patients meeting inclusion criteria, 90% of whom came from 2 large Kaiser Permanente regions (Northern California and Southern California). The initial renal replacement modality was hemodialysis via CVC for 2600 (47.0%) patients, hemodialysis via AVF for 1534 (27.7%) patients, and hemodialysis via AVG for 183 (3.3%) patients. A total of 1072 (19.4%) patients began renal replacement therapy via peritoneal dialysis and 141 (2.2%) patients received pre-emptive transplants. Of 2930 patients with an optimal start, 1826 patients were successfully matched to 1826 patients with a nonoptimal start.

In unadjusted comparisons of utilization in the year before starting renal replacement therapy, patients with optimal starts had fewer inpatient visits and days than patients with nonoptimal starts. Patients with optimal starts also had more visits to nephrologists, vascular surgeons, and other types of specialty care before starting renal replacement therapy (**Table 2**). Primary care and ED visits did not differ. In the analysis of utilization in the year after starting renal

TABLE 2. Unadjusted Utilization in the Year Before Starting Renal Replacement Therapy for Propensity Score–Matched Cohorts

	Optimal Start (n = 1826)	Nonoptimal Start (n = 1826)	*P*
Inpatient stays	1.3	1.6	<.001
Total inpatient days	6.0	12.6	<.001
ED visits	2.2	2.2	.59
Outpatient office visits			
Primary care	4.3	4.1	.16
Specialty care[a]	9.8	7.4	<.001
Nephrology	5.4	3.1	<.001
Vascular surgery	2.1	0.8	<.001

ED indicates emergency department.

[a]Does not include nephrology or vascular surgery.

TABLE 3. Healthcare Utilization in the Year After Starting Renal Replacement Therapy

	Annual Utilization[a]			
	Optimal Start	Nonoptimal Start	Rate Ratio (95% CI)	*P*
Inpatient stays	1.5	2.7	0.54 (0.50-0.59)	<.001
Total inpatient days	9.4	27.5	0.45 (0.38-0.52)	<.001
ED visits	2.4	3.5	0.68 (0.63-0.74)	<.001
Outpatient office visits				
Primary care	4.0	4.4	0.88 (0.79-0.97)	.02
Specialty care[b]	12.5	18.0	0.62 (0.53-0.74)	<.001
Nephrology	5.1	4.7	0.88 (0.74-1.05)	.15
Vascular surgery	1.3	3.6	0.31 (0.29-0.34)	<.001

ED indicates emergency department.

[a]Adjusted for utilization in the year before renal replacement therapy initiation, propensity score, region, and education.

[b]Does not include nephrology or vascular surgery.

replacement therapy, which was adjusted for prior-year utilization, propensity score, region, and education, patients with optimal starts had lower utilization of all types except nephrology visits, which did not differ between groups (Table 3). The largest absolute between-group differences in annualized rates were observed for total inpatient days, which were 9.4 for patients with optimal starts versus 27.5 for patients with nonoptimal starts (relative rate [RR], 0.45; 95% CI, 0.38-0.52), and specialty care outpatient visits, which were 12.5 for optimal starts versus 18.0 for nonoptimal starts (RR, 0.62; 95% CI, 0.53-0.74). The largest relative differences in annualized rates were for vascular surgery outpatient visits, which were 1.3 for optimal starts versus 3.6 for nonoptimal starts (RR, 0.31; 95% CI, 0.29-0.34). The rate of nephrology visits did not differ between groups.

In analyses adjusted for propensity score, region, and education, optimal starts were associated with lower morbidity and mortality in the first 12 months after starting renal replacement therapy. The sepsis rate per person-year for patients with optimal starts was 0.16 versus 0.44 for patients with nonoptimal starts (OR, 0.35; 95% CI, 0.29-0.42; *P* <.001); the per person-year mortality rate was 0.10 for patients with optimal starts versus 0.30 for patients with nonoptimal starts (OR, 0.37; 95% CI, 0.29-0.46; *P* <.001). The 12-month HR for mortality, adjusted for propensity score, region, and education, among patients with optimal starts was 0.44 (95% CI, 0.29-0.46).

DISCUSSION

In an integrated healthcare delivery system, optimal ESRD starts were associated with improved clinical outcomes and lower utilization in the year after initiating renal replacement therapy. Patients with optimal starts were less likely to die or to develop sepsis than were patients with nonoptimal starts. They had lower inpatient and outpatient utilization, except for nephrology visits.

Comparing our results with the existing literature is challenging due to variations in study methodologies. Previous reports often focus on comparing mortality associated with starting hemodialysis via CVC with mortality for AVG and AVF starts. Using propensity score matching in a national cohort, Malas et al found an HR for mortality among patients starting hemodialysis with an AVF or AVG of 0.68 (95% CI, 0.67-0.69) compared with those starting with a CVC.[12] However, variations in study periods and covariates may account for the differences between observed HRs. Although our optimal start population also included patients whose initial modality was peritoneal dialysis, recent evidence suggests that short-term mortality is equivalent between patients starting renal replacement therapy with hemodialysis via an AVF or AVG and those starting with peritoneal dialysis.[22-24]

A 2013 meta-analysis identified a relative mortality risk of 1.53 (95% CI, 1.41-1.67) over a median follow-up period of 18 months for patients starting hemodialysis via CVC compared with those starting hemodialysis with an AVF.[6] In the same report, catheter use was associated with 80 to 134 additional deaths per 1000 person-years compared with AVF use and 60 to 125 additional deaths per 1000 person-years compared with AVG use. Reference annual event risks for all-cause mortality for AVF and AVG starts, drawn from an annual US Renal Data System report, were 0.20 and 0.24, respectively.[25] In contrast, the annual event rate for all-cause mortality for all optimal start types in our study was 0.10, and CVC use for hemodialysis was associated with 200 additional deaths per 1000 person-years.

Potential explanations for the difference in the annual reference risks include the possibility that starting renal replacement therapy in the integrated healthcare delivery system studied here confers survival benefits beyond those that have been reported in the literature. Although we did not assess mortality risk by type of optimal start, it is unlikely that any mortality benefits for the minority of patients in our population who received a pre-emptive transplant or started renal replacement therapy with peritoneal dialysis accounted for the difference in reference annual event risks. Reviews and meta-analyses comparing outcomes for incident hemodialysis and peritoneal

dialysis and for patients undergoing dialysis and transplantation suggest that mortality benefits are time-dependent and vary across groups of patients defined by age and comorbidities.[26-28] We found no reports comparing outcomes for incident hemodialysis via CVC and the range of optimal start modalities.

Limitations

Our analysis has several limitations. Its retrospective observational design and the use of pre-existing data create the potential for misclassification of measured confounders and outcomes and for selection biases related to unmeasured confounders. Examples of the latter include adherence, self-care ability, and social support; they could have affected outcomes to an unknown degree. Additionally, a predialysis fistula attempt, successful or not, may be associated with lower mortality for patients younger than 65 years because healthier patients are more likely to have the option of fistula placement.[29,30] We did not assess whether any patients included in the nonoptimal start group were ineligible for fistula placement; their inclusion may have led us to overstate the benefits of optimal starts to an unknown degree, although any mortality benefit of predialysis fistula attempts in the older population we studied is unknown.[29,30] We controlled for the presence of CHF and fluid overload, which could have mitigated against a predialysis fistula placement and is independently associated with increased mortality[31] but not CHF severity. Similarly, we assessed only the modality used at the time of initiation, which may have differed from planned renal replacement modalities.[30] We did not directly assess for fistula failure, but it is associated with severe peripheral artery disease, CAD, and diabetes, all of which were included as covariates.[32] Nevertheless, we may have missed an unknown number of failed fistulae. Standard organizational coding audits give us confidence that miscoding of diagnoses did not affect our results to an appreciable extent. We did not assess costs, although the utilization differences we reported strongly suggest that optimal starts reflect value-based healthcare decision making that occurs before the care on which the CMS ESRD Quality Incentive Program focuses.[33] We did not assess patient satisfaction or quality of life.[34,35]

CONCLUSIONS

Our findings underscore the well-established importance of identifying primary care patients at risk for ESRD and initiating timely referrals to nephrology care. In addition, they suggest that late-stage CKD and ESRD care delivered in an integrated healthcare system may confer benefits beyond those reported in the literature. We also note that the Optimal ESRD Starts measure can currently be used to assess performance over time within a single healthcare organization or system; the proportion of optimal renal replacement therapy starts at Kaiser Permanente improved from 46.0% at first use in 2011 to 56.4% in June 2015. With broad use that enables benchmarking, the measure can also be used to compare performance across organizations and systems. ■

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