

General Medical Care among Patients with Chronic Kidney Disease: Opportunities for Improving Outcomes

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Suboptimal health care during advancing chronic kidney disease (CKD) may result in greater morbidity and cost once dialysis is started and may preclude future transplantation. Medicare data were examined for the prevalence of selected general health, diabetes, and CKD interventions in a national cohort of patients in the 2 yr before dialysis initiation and compared with a contemporaneous non-CKD cohort. A total of 24,778 individuals who were aged ≥ 67 yr composed the CKD cohort, and 1,046,136 individuals who were aged ≥ 67 yr did not have CKD. Among patients with diabetes and CKD, fewer than two thirds had claims for eye examinations, 75% for HbA_{1c} testing, and 68% for lipid testing, with similar proportions in the non-CKD cohort. Among those without diabetes, 47 and 54% of the CKD and non-CKD cohorts, respectively, had claims for lipid testing. Fewer than 50 and 15% had claims for influenza and pneumococcal vaccination, respectively, with slightly lower proportions among patients with CKD. Claims for cancer tests were found for 14 to 41% and 29 to 52% of individuals with and without CKD, respectively, depending on the type of cancer. A greater proportion of patients with diabetes tended to have claims for tests in both cohorts. In the CKD cohort, claims for anemia testing and parathyroid hormone levels were available in fewer than 50 and 15%, respectively, and claims for permanent vascular access were found for only 30% of hemodialysis patients. This study provides further evidence that patients with CKD may not be receiving general health and CKD care according to current recommendations.

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Many patients begin dialysis in the United States with low serum albumin and hematocrit levels, and few are treated with erythropoietin before dialysis initiation (1). Late initiation of care for chronic kidney disease (CKD) may contribute to suboptimal health at initiation of dialysis (2–6), which in turn may be associated with poor outcomes (7–9). There is undertreatment of the complications of CKD even among patients who are under medical attention (10,11). The National Kidney Foundation (NKF) has proposed extensive clinical practice guidelines to improve the care of patients with CKD (12).

Individuals with CKD are at risk not only for complications associated with decreased kidney function but also for cardiovascular disease (CVD), cancer, and infections. Suboptimal care during CKD may preclude consideration of older patients for transplantation and result in greater morbidity once they are on dialysis. Treatment of patients with CKD probably should include generally recommended vaccinations, control of diabetes and hypertension, CVD risk reduction, cancer screening in selected patients with reasonable life expectancy, and management of conditions related to CKD. A recent study of patients

with CKD in the New Jersey area reported that cancer screening and diagnostic testing related to diabetes were infrequent (13). Our study examined the prevalence of testing for cancers and CVD and the adherence to recommended management of diabetes and CKD in the 2 yr before dialysis initiation in a national CKD cohort and compared with a contemporaneous non-CKD cohort.

Materials and Methods

Study Population

In the United States, individuals who are ≥ 65 yr of age are eligible for Medicare, a national health care program that covers hospitalizations, outpatient and other care, and selected medications. The Centers for Medicare and Medicaid Services (CMS) maintains databases of health claims on Medicare patients, from which the populations of interest were derived. The CKD cohort consisted of individuals who were aged ≥ 67 yr, identified as starting dialysis in the United States in 2000 from claims data for ESRD services, with 2 yr of both Medicare Part A and Part B claims/eligibility before the first ESRD service date. Individuals who had incomplete reporting to CMS (Medicare not primary payer, without both Part A and Part B coverage, or enrolled in a health maintenance organization during the study period), had received a transplant, or had evidence of previous chronic dialysis (Medicare claims for dialysis $> \$675$ /mo for at least 6 mo) were excluded. Thus, in this study, CKD refers to patients who did not yet require renal replacement therapy.

The non-CKD cohort was selected from the Medicare 5% database, composed of all Part A and Part B claims for Medicare beneficiaries whose health insurance claim number ends with the digits 05, 20, 45, 70,

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or 95. Because this number is assigned randomly, the 5% database represents a random sample of Medicare beneficiaries. Further detail can be found in previous publications (8,14,15) and in the U.S. Renal Data System's Annual Data Report "Researcher's Guide," which can be accessed readily online (<http://www.usrds.org/research.htm>) (16). The non-CKD study population consisted of individuals who were aged ≥ 67 yr and alive and continuously enrolled in Medicare Part A and Part B between July 1, 1998, and June 30, 2000, with neither ESRD nor CKD during this period.

Data Sources and Definitions

CMS data from Medicare Part A contains claims for inpatient, outpatient, home health, hospice, and skilled nursing services and from Part B covers claims from physicians and suppliers. Dialysis modality was determined on the first ESRD service date (day 0) using information from claims at initiation of dialysis and from the CMS Medical Evidence Form 2728. This form is used to submit information on a variety of patient characteristics to CMS and is mandatory for all patients who initiate renal replacement therapy in the United States to establish Medicare eligibility.

For CKD patients, age was determined as of day 0. Claims 1 yr before the first service date were used to define individuals with diabetes. For non-CKD patients, age was calculated on July 1, 2000. Claims from July 1, 1998, to June 30, 2000, were used to define individuals with diabetes, whereas claims from January 1, 1998, to June 30, 2000, were used to define CKD. Designation of diabetes or CKD required (1) one or more International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes from inpatient, home health, or

skilled nursing services claim or (2) two or more codes from outpatient claims. ICD-9-CM codes that are used to define diabetes are 250.xx, 357.2x, 362.xx, and 366.41. Codes that are used to define CKD are 016.0, 095.4, 189.0, 189.9, 223.0, 236.91, 250.4, 271.4, 274.1, 283.11, 403.x1, 404.x2 to x3, 440.1, 442.1, 447.3, 572.4, 580 to 588, 591, 642.1, 646.2, 753.12 to 753.17, 753.19, 753.2, and 794.4.

Table 1 delineates the interventions examined. All claims codes used for this study may be found in Appendix 1, except those listed above. Unless otherwise stated, claims were searched for the 2 yr before day 0 for patients with CKD and from July 1, 1998, to June 30, 2000, for patients without CKD. The test or intervention was considered done when one or more claims were found with the relevant Medicare Part B or Part A Current Procedural Terminology (CPT) or ICD-9 procedure codes. Part B claims were searched for outpatient physician visit codes. Only one type of visit was counted for a given day when there were multiple visits. Provider types were defined using physician specialty codes in Part B claims and included internal medicine, nephrology, other internal medicine specialty (comprising endocrinology, cardiology, and others), and other provider (surgery, family medicine, or primary care). Principal provider was defined on the basis of type of provider with whom the patient had the most visits during the 2 yr, up to 90 d before day 0. Patients were excluded when provider type could not be assigned. MapInfo GIS software and Census Bureau's Urbanized Area/Cluster information from the 2000 Census were used to find patients' zip codes and divide care setting into urban *versus* rural. Geographic region was defined by ESRD network, a grouping of ESRD service providers in the United States and territories into 18 regions (members detailed in Appendix 2).

Table 1. Categories of care and selected elements of care studied^a

Category of Care	Element of Care
Diabetes (individuals with diabetes only)	Eye examination
Cardiovascular	HbA _{1c}
	Echocardiogram
	Cardiac stress test
General medical	Lipid test
	Pneumococcal vaccine
	Influenza vaccine ^b
	Hepatitis B serology and vaccine ^c
Cancer	Bone densitometry
	Colonoscopy or flexible sigmoidoscopy
	Mammography (women only) ^d
	Papanicolaou smear (women only) ^e
CKD (CKD cohort only)	Prostate-specific antigen (men only) ^f
	Calcium-phosphorus metabolism
	Anemia testing
	Dialysis access:
	arteriovenous graft or fistula
dialysis catheter ^g	
PD catheter	

^aRelevant Medicare claims codes are provided in Appendix 1. CKD, chronic kidney disease; PD, peritoneal dialysis.

^bFor influenza vaccination, claims were searched for Part B-eligible patients from September 1, 1999, through December 31, 1999.

^cFor patients with CKD, claims for the 2 yr before day 0 plus 2 mo after day 0 were searched.

^dWomen who had bilateral mastectomies were excluded.

^eWomen who had hysterectomies were excluded.

^fMen who had prostatectomies were excluded.

^gExcluded catheter activity for nonrenal reasons such as chemotherapy and parenteral nutrition.

Analytic Plan

The proportions with claims for the tests at least once during the 2-yr period preceding day 0 were calculated, as were proportions with claims for selected tests with recommended frequency, using the appropriate base population. The proportions of patients who received the tests were calculated separately for those with and without diabetes and for initial dialysis modality (peritoneal dialysis [PD] or hemodialysis [HD]). The significance of the differences in proportions between selected groups was determined using χ^2 tests. For the CKD cohort, other factors that potentially were associated with testing were evaluated by stratifying selected analyses by age group, gender, race, provider type, and location (geographic, and urban *versus* rural).

Results

There were a total of 41,787 patients who were ≥ 67 yr of age and began dialysis in 2000. Excluded were 7135 with health maintenance organization, 1713 with Medicare as secondary payer, 2352 without Medicare during the 2 yr before day 0, 10 with $> \$675$ /mo dialysis claims for at least 6 mo before day 0, 4770 with unknown dialysis type, and 1029 without both Medicare Part A and Part B. The final CKD cohort comprised 24,778 patients who were aged ≥ 67 yr of age, and the non-CKD cohort comprised 1,046,136 individuals who were aged ≥ 67 yr and had neither ESRD nor CKD. Table 2 details the characteristics of the CKD and non-CKD cohorts and, for the CKD cohort, by initial dialysis modality and diabetic status.

Diabetic Care

Fifty-one and 17% of the CKD and non-CKD cohorts had diabetes, respectively (Table 3). Nearly two thirds had at least one eye examination, but only 24 and 30% of patients with CKD and without CKD, respectively, had at least one eye examination in each of the 2 yr. Similarly, three fourths had at least one HbA_{1C} measurement, but only 16 and 23% of patients with CKD and without CKD, respectively, had more than one per year. Among those who started PD, a larger proportion had these tests (Table 4).

Cardiovascular Care

The same proportion of patients with CKD and without CKD had claims for lipid testing at any one time, and 35% in each group had more than one lipid test (Table 3). A larger proportion of patients with diabetes and those who started PD had lipid tests (Table 4). A substantially larger proportion of patients with CKD had an echocardiogram or cardiac stress test. A higher proportion of patients with diabetes had these two tests, but there was no difference by initial dialysis modality.

General Health Care

A smaller proportion of patients with CKD had claims for influenza and pneumococcal vaccination compared with patients without CKD (Table 3). A larger proportion of patients

Table 2. Demographic and clinical characteristics^a of the CKD cohort and the comparison population without CKD

	CKD Cohort					Non-CKD Cohort		
	Entire Cohort (n = 24,778)	PD (n = 819)	HD (n = 23,959)	Diabetic (n = 12,631)	Nondiabetic (n = 12,147)	Entire Cohort (n = 1,046,136)	Diabetic (n = 180,559)	Nondiabetic (n = 865,577)
Age (mean \pm SD)	76 \pm 6	75 \pm 6	76 \pm 6	75 \pm 5	77 \pm 6	77 \pm 7	76 \pm 7	77 \pm 7
Age distribution (%)								
67 to 69	15	20	15	18	12	16	15	16
70 to 72	17	21	17	19	15	17	17	17
73 to 75	18	18	18	20	16	16	17	16
76 to 78	17	17	17	17	17	15	16	15
79+	33	23	33	26	40	36	34	36
Male gender (%)	50	58	49	44	55	39	41	39
Race distribution (%)								
white	67	84	66	62	72	89	83	90
black	21	9	22	23	19	7	11	6
Asian	3	2	3	3	3	1	1	1
Hispanic	8	5	8	10	6	2	3	2
Native American	1 (0.9)	0 (0.5)	1 (0.9)	1 (1.2)	1 (0.6)	0 (0.3)	0 (0.4)	0 (0.2)
other	0 (0.1)	0 (0.1)	0 (0.1)	0 (0.1)	0 (0.1)	1 (0.9)	1 (1.1)	1 (0.9)
Cause of ESRD (%)								
hypertension	35	32	35	18	52	—	—	—
diabetes	42	38	42	72	11	—	—	—
glomerulonephritis	6	11	6	2	10	—	—	—
other	17	18	17	8	27	—	—	—

^aFor patients without CKD, age was calculated on July 1, 2000, and for patients with CKD at initiation of dialysis. HD, hemodialysis.

Table 3. Prevalence (%) of claims for selected general health tests for CKD cohort and the comparison population without CKD, overall and by diabetic status

	CKD Cohort				Non-CKD Cohort				P Value ^c
	Entire Cohort (n = 24,778)	Diabetic ^a (n = 12,631)	Nondiabetic (n = 12,147)	P Value ^b	Entire Cohort (n = 1,046,136)	Diabetic ^a (n = 180,559)	Nondiabetic (n = 865,577)	P Value ^b	
Diabetic care ^a									
eye exams	60	60	—	—	60	60	—	—	NS
HbA _{1c}	75	75	—	—	74	74	—	—	NS
Cardiovascular disease									
echocardiogram	51	61	41	<0.0001	20	29	18	<0.0001	<0.0001
stress tests	24	29	19	<0.0001	15	20	14	<0.0001	<0.0001
lipid monitoring	58	68	47	<0.0001	57	72	54	<0.0001	0.004
General health									
influenza vaccine	46	49	42	<0.0001	49	52	48	<0.0001	<0.0001
pneumococcal vaccine	9	10	8	<0.0001	14	16	14	<0.0001	<0.0001
hepatitis B serology	72	76	67	<0.0001	1.4	2.3	1.2	<0.0001	<0.0001
hepatitis B vaccine	24	26	23	<0.0001	0.1	0.1	0.1	NS	<0.0001
bone densitometry	5	5	4	NS	11	9	12	<0.0001	<0.0001
Cancer screening ^d									
breast	31 (n = 12,437)	32 (n = 6996)	29 (n = 5441)	0.0009	50 (n = 627,410)	47 (n = 104,412)	50 (n = 522,998)	<0.0001	<0.0001
cervical	14 (n = 12,417)	13 (n = 6982)	14 (n = 5435)	NS	29 (n = 621,646)	25 (n = 103,855)	30 (n = 517,791)	<0.0001	<0.0001
prostate	41 (n = 11,787)	44 (n = 5330)	39 (n = 6457)	<0.0001	52 (n = 369,901)	58 (n = 66,145)	50 (n = 303,756)	<0.0001	<0.0001
colon	16	18	14	<0.0001	13	13	13	<0.0001	<0.0001

^aAmong patients with diabetes only.

^bP value for χ^2 test for comparison between diabetic and nondiabetic.

^cP value for χ^2 test for comparison between CKD and non-CKD patients.

^dBreast and cervical cancer screening among women only; prostate cancer screening among men only.

with diabetes and those who started PD received influenza vaccine (Table 4). Claims for hepatitis B serologic testing and vaccination were found for 72 and 24% of the CKD cohort, respectively, with a higher proportion among patients with diabetes and HD patients. Very few had bone densitometry.

Cancer Testing

Compared with women without CKD, fewer women with CKD had claims for breast and cervical cancer testing (Table 3). There was no difference by diabetic status, but a higher proportion of women who started PD received these tests (Table 4). Fewer men with CKD had claims for prostate cancer testing, and the proportion of men who had diabetes and were tested was higher. Colon cancer testing was more prevalent in the CKD cohort.

CKD Care

A larger proportion of patients with diabetes and patients who started PD had anemia testing (Table 4). The proportion with claims did not differ by hematocrit level at initiation of dialysis, but a larger proportion who received erythropoietin before dialysis had anemia testing compared with those who were not treated (data not shown). Claims for calcium, phosphorus, and parathyroid hormone (PTH) tests were found for a

larger proportion of patients with diabetes and patients who started PD. Claims for access placement before day 0 were found for 42% of patients overall. A larger proportion of PD patients had access placed before dialysis initiation, compared with HD patients. Nine percent of PD patients had some other combination of access, such as fistula or graft and PD catheter, or HD catheter alone, etc. The remaining patients had no claims for access placement before day 0.

Outpatient Utilization

Eighty-nine and 91% of patients with CKD and without CKD, respectively, had claims for outpatient visits. The mean number of visits per individual during the 2 yr of analysis was 27 and 16 for patients with CKD and without CKD, respectively. Fifty percent of patients with CKD had a claim for at least one and 41% had at least two visits to a nephrologist. Among those with nephrology visits, visits increased substantially from 1.7 per patient-year during months -13 to -24 before initiation of dialysis to 8.2 per patient-year during the 12 mo before initiation of dialysis. Fifty-nine and 51% of patients with CKD and without CKD, respectively, had visits with internists, and 44 and 52%, respectively, had visits with family practitioners. Nearly 50% of patients with CKD had at least one visit with

Table 4. Prevalence (%) of claims for selected general health tests and elements of care for CKD among patients with CKD, by initial dialysis modality and diabetic status^a

	PD (n = 819)	Diabetic (n = 360)	Nondiabetic (n = 459)	P Value ^b	HD (n = 23,959)	Diabetic (n = 12,271)	Nondiabetic (n = 11,688)	P Value ^b	P Value ^c
Diabetic care ^d	(n = 360)				(n = 12,271)				
eye exams	66	66	—	—	60	60	—	—	0.01
HbA _{1c}	81	81	—	—	75	75	—	—	0.01
Cardiovascular disease									
echocardiogram	48	57	42	<0.0001	51	62	41	<0.0001	NS
stress tests	25	25	25	NS	24	29	19	<0.0001	NS
lipid monitoring	66	76	59	<0.0001	58	68	47	<0.0001	<0.0001
General health									
influenza vaccine	56	61	53	0.03	46	49	42	<0.0001	<0.0001
pneumococcal vaccine	11	11	10	NS	9	10	7	<0.0001	0.04
hepatitis B serology	67	71	63	0.03	72	77	68	<0.0001	0.0004
hepatitis B vaccine	20	24	17	0.009	25	26	23	<0.0001	0.003
bone densitometry	4	3	5	NS	5	5	4	0.04	NS
Cancer screening									
breast ^e	39	37	40	NS	31	32	29	0.0004	0.002
	(n = 345)	(n = 162)	(n = 183)		(n = 12,092)	(n = 6834)	(n = 5258)		
cervical ^e	21	19	22	NS	13	13	14	NS	0.0002
	(n = 346)	(n = 164)	(n = 182)		(n = 12,071)	(n = 6818)	(n = 5253)		
prostate ^f	42	43	40	NS	41	44	39	<0.0001	NS
	(n = 453)	(n = 189)	(n = 264)		(n = 11,334)	(n = 5141)	(n = 6193)		
colon	13	12	14	NS	16	18	14	<0.0001	0.01
CKD care									
anemia ^g	53	56	51	NS	43	48	37	<0.0001	<0.0001
calcium-phosphorus-PTH ^h	88	95	82	<0.0001	82	92	72	<0.0001	<0.0001
calcium	88	95	82	<0.0001	82	92	71	<0.0001	<0.0001
phosphorus	68	72	66	NS	50	56	43	<0.0001	<0.0001
PTH	19	22	17	NS	12	12	11	0.0006	<0.0001
Dialysis access ⁱ	76	82	71	0.0003	40	47	33	<0.0001	<0.0001
	(n = 812)	(n = 357)	(n = 455)		(n = 23,752)	(n = 12,194)	(n = 11,558)		
PD catheter only	53	57	50	0.03	—	—	—	—	—
both PD and HD catheter	14	13	14	NS	—	—	—	—	—
graft or fistula only	—	—	—	—	20	23	16	<0.0001	—
both graft or fistula and HD catheter	—	—	—	—	10	12	8	<0.0001	—
HD catheter only	—	—	—	—	11	12	9	<0.0001	—

^aPTH, parathyroid hormone.

^bP value of χ^2 test for comparison between diabetic and nondiabetic.

^cP value of χ^2 test for comparison between peritoneal dialysis and hemodialysis.

^dAmong patients with diabetes only.

^eAmong women only.

^fAmong men only.

^gIron studies or occult blood in stool.

^hProportion with claims for any combination of calcium, phosphorus, and/or PTH tests.

ⁱAmong PD patients, 9% had some other combination of access, such as fistula or graft and PD catheter, or HD catheter alone, etc.

cardiology compared with only 30% of patients without CKD, and 34 and 20% of patients with CKD and without CKD, respectively, had two or more visits.

Provider and Regional Variations in Care

Patients who had CKD and had a nephrologist as principal provider were more likely to have testing for calcium-phospho-

rus abnormalities (86 *versus* 54 to 63%) and to have dialysis access in place at initiation of dialysis (63 *versus* 40 to 47%), compared with individuals with other providers. Patients with other internal medicine specialists were more likely to have echocardiograms (67 *versus* 41 to 57%), but those with "other provider," mostly composed of primary care, were more likely to have the remaining tests.

There were nonsystematic variations by ESRD network. However, in only five of 18 networks (3, 8, 9, 10, and 13) were more than two elements of care performed in a substantially lower proportion (5% or greater difference) than in the cohort overall. In the two networks with >50% of tests with low proportions of claims, networks 8 (Alabama, Mississippi, and Tennessee) and 13 (Arkansas, Louisiana, and Oklahoma), the patterns were similar, with low proportions of claims for eye examinations, and HbA_{1C}, lipid, prostate, and calcium-phosphorus-PTH tests. In rural compared with urban locales, there were lower proportions with claims for lipid, prostate, and calcium-phosphate-PTH tests (data otherwise not shown).

Variations in Care Related to Age, Gender, and Race

There was no systematic pattern of testing in either age group (<75 *versus* ≥75 yr). Claims for lipid (61 *versus* 56%) and breast cancer (34 *versus* 28%) tests were found with greater frequency in the younger age group, whereas influenza (48 *versus* 43%) and prostate cancer (43 *versus* 38%) claims were found more frequently in the older age group. Differences in other tests were <5%. We found only very slight gender differences but no clear pattern. Fewer women had claims for influenza vaccination and cancer testing except colon cancer, for which the proportions were similar. Women had more frequent claims for iron tests and bone densitometry. There was a trend for a lower prevalence of testing among nonwhite races, with the lowest prevalence of most tests among Native Americans.

Discussion

General medical and CKD-specific care during advancing CKD has not been characterized previously on a national level. Previous studies suggest that complications of CKD are not addressed appropriately (11,17,18) and that preventive health care measures are not implemented broadly (13). The CKD population is estimated to be nearly 10 million (12,19), and their health care incurs large expenditures (15,20). Thus, improvement of comorbid conditions should yield individual and societal benefit (14,21,22). The results of this study suggest that patients with CKD may not be receiving general health and CKD care according to current recommendations. We hypothesized that the reduced life expectancy of patients with CKD would lead providers to decide against testing; however, the differences relative to care provided to patients without CKD were not as great as expected. This suggests a generalized lack of implementation of recommended health care measures, rather than "neglect" of patients with CKD.

The results of this study are consistent with other data. As reported by the US Renal Data System (USRDS), the prevalence of pneumococcal and influenza vaccination in a cohort of dial-

ysis patients in 1999 was 18 and 58% (23), respectively, each approximately 10% higher than in patients with CKD in our study. The prevalence of cancer tests in our study was almost identical to what was reported in a previous study of cancer screening rates and diagnostic testing related to diabetes in a regional cohort (New Jersey) of individuals with CKD in the 1 yr before and 1 yr after initiation of dialysis (13). In USRDS reports, the prevalence for cancer testing among dialysis patients was higher for breast (40%) and cervical cancer (30%) but lower for prostate cancer (35%) (23). The prevalence of diagnostic testing related to diabetes in this study differed from the New Jersey CKD study, in which a higher proportion (81%) had eye examinations and a lower proportion (18%) had HbA_{1C} claims. As reported by the USRDS, somewhat lower proportions of ESRD patients had eye examinations (50%), HbA_{1C} claims (60%), and lipid tests (45%), compared with our study cohort (23). The generally small discrepancies between these studies may relate to differences in study populations and ascertainment periods.

The higher prevalence of claims for echocardiogram and stress tests in the CKD cohort, compared with the non-CKD cohort, was not surprising, given the higher prevalence of CVD in CKD (22). Similarly, the higher rate of testing and immunization for hepatitis B among patients with CKD was expected. This may reflect adherence to the recommendation that all patients with ESRD and advancing CKD should be immunized (24) but more likely reflects aggressive immunization once dialysis is imminent because it is required by dialysis units.

The proportions with diabetes and lipid testing were similar in the CKD and non-CKD cohorts. However, a minority in either cohort had HbA_{1C} twice yearly or an annual eye examination, although these are the minimum testing intervals recommended by the American Diabetes Association (25). In addition, pneumococcal and influenza immunizations and cancer tests were performed less frequently among patients with CKD. This illustrates that the high-risk CKD population is not receiving recommended care.

Some of these elements of care may be of greater benefit than others. Immunizations against influenza have been shown to reduce hospitalizations and death in ESRD patients and in the elderly (26,27), and glycemic control is associated with substantial reductions in adverse outcomes among individuals with diabetes (28). Although not possible to study with these data, control of hypertension has also been demonstrated to result in improved outcomes among patients with CKD (29). Other elements of care, such as cancer screening and aggressive management of dyslipidemias, arguably may not be of sufficient benefit in this elderly cohort (30,31).

Cancer screening may not make clinical or economic sense in most individuals with advanced CKD, because life expectancy is shortened by competing comorbid conditions (30). However, Kiberd *et al.* (32) examined the cost-effectiveness of cancer screening in kidney transplant recipients (KTR) and dialysis patients. Modeling years of life lost to cancer, the cost per life-year saved was nearly double for breast and colorectal cancer in nondiabetic KTR, three- to four-fold for dialysis patients, and intermediate for diabetic KTR, compared with the

general population. The authors concluded that KTR with above-average cancer risk and reasonable life expectancy may benefit from screening. The same, although not established, may be true for individuals with CKD.

The low rates of anemia testing are consistent with previous reports that individuals initiate dialysis in the United States with low hematocrit levels (33), and a minority of patients with CKD and anemia are treated with erythropoietin (33–35). These findings are disconcerting given the availability of guidelines for anemia management for nearly a decade (36). The prevalence of claims for PTH tests in our study is consistent with the 15% prevalence described in a regional CKD cohort (11). Fewer individuals had attempted vascular access placement before initiation of HD in this study than in some previous reports (5,37). In one single-center study, permanent access was placed before initiation of dialysis in 37% of patients (5), and in an analysis of data from the second wave of the Dialysis Morbidity and Mortality Study Wave, 55% had permanent access placed before initiation of dialysis (37). In this study, a larger proportion of PD patients and patients with diabetes had testing for CKD complications and had access placed before initiation of dialysis. This is consistent with previous observations that patients who start on PD tend to be better prepared for dialysis (38,39). Although it remains to be proved that aggressive management of calcium-phosphorus disorders and anemia improves hard outcomes in patients with CKD, it has been demonstrated that calcium-phosphorus disorders and anemia are associated with morbidity (40–43), and in the case of anemia, treatment can improve quality of life (44). In addition, type and timing of dialysis access placement can influence cost and other outcomes (45).

Differential access to health care may be a partial explanation for the slight regional variations in care. The six states in the networks with the lowest prevalence of claims (Alabama, Mississippi, and Tennessee in network 8 and Arkansas, Louisiana, and Oklahoma in network 13) were among the 12 states with the lowest median household income in the country in 1999 (46). These six states were also among the 15 states with the lowest proportion of residents in the labor force that year (47). In addition, with the exception of Oklahoma, a greater proportion of individuals in these states had only a ninth-grade or lower education than the national average (48). Further evaluation of other potentially associated factors was beyond the scope of our study.

The differences in provision of care were not simply related to frequency of physician visits and type of provider, because the CKD cohort had a higher rate of physician visits than the non-CKD cohort. Alternative explanations for the low rates of general testing and immunization include lack of physician knowledge of recommendations for care, patient unwillingness to adhere to recommendations, or fragmentation of care. Indeed, the highest proportion of general health care testing in this study was seen with “other providers,” consisting mostly of primary care practitioners, who generally oversee health care. The low rate of testing for CKD complications and access placement may be related in part to lack of timely nephrology referral. Fewer than half of the patients had two or more visits

with a nephrologist, but among those, there was a higher prevalence of CKD-related interventions. Timely nephrology care is associated with reduced risk for adverse outcomes, which may be due in part to greater attention to CKD-related and other complications and better preparation for dialysis (5,49,50).

The results of this study should be interpreted considering its limitations. It is a retrospective study of administrative data, it included only patients who were 67 yr or older and were on Medicare (and not private insurance), and it included only patients who progressed or survived to dialysis initiation. The nature of administrative data may lead to missing information (*e.g.*, if calcium and phosphorus tests were “bundled” into a panel, or influenza vaccination was not billed to Medicare) and misclassification. However, the rates of interventions were plausible when compared with published studies or national statistics, and the population is of increasing importance as the nation and the dialysis population grow older.

In summary, among elderly individuals with CKD and the same basic access to health care as individuals without CKD, on the basis of all having Medicare eligibility, not all are receiving recommended routine health care. Decisions to test for cancers and aggressively treat dyslipidemias should take into consideration the individual’s comorbid conditions and life expectancy (51). The benefits of these interventions are not established, and they may result in financial, emotional, and physical burdens if a screening test were positive. However, immunizations against influenza and pneumonia, treatment of calcium-phosphorus abnormalities and anemia, proper management of hypertension and diabetes, and timely access for dialysis have evidence of benefit.

Recognition of CKD by the treating physician and timely nephrology referral are essential components for providing adequate care to patients with CKD. Efforts by the NKF to provide guidelines for care (12) and the Kidney Early Evaluation Program (52), a free health screening program offered by the NKF, should facilitate improvements in the care of patients with CKD. Future work is needed to evaluate the elements of care that truly have an impact on outcomes among patients with CKD to allow concentration of efforts in those areas with greatest benefit.

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Appendix 1: Codes Used for Defining Testing Procedures

CMS provides claims data from Medicare Part A, which covers claims for inpatient, outpatient, home health, hospice, and skilled nursing services, and Part B, which covers claims from physicians and other suppliers. Claims in the 2 yr before the first service date were examined for patients with CKD, and claims during July 1, 1998, and June 30, 2000, were searched for patients without CKD for the tests detailed below. The exceptions were influenza vaccination, for which claims

were searched for Part B–eligible patients from September 1, 1999, through December 31, 1999, as the most common time of year offered, and for patients with CKD, claims for the 2 yr before day 0 plus 2 mo after day 0 were searched for hepatitis B serologic testing and vaccination. In general, when one or more claims for the test were found in either Part A or Part B claims, the person was counted as having such testing done unless specified differently, as for diabetic care.

Diabetic Care

Eye examinations: Any Medicare Part B or Part A CPT codes for eye examinations (CPT codes 92002, 92004, 92012, 92014, 92018 to 92019, 92225 to 92226, 92230, 92235, 92240, 92250, 92260, 92287, 67101, 67105, 67107 to 67108, 67110, 67112, 67141, 67145, 67208, 67210, 67218, and 67227 to 67228), ICD-9 procedure codes for eye examinations (14.9, 95.02 to 95.04, 95.11 to 95.12, 95.16, and 14.1 to 14.5), or with the qualifier ICD-9 diagnosis code V80.2.

HbA_{1c}: Part B or Part A CPT code 83036.

Cardiovascular Care

Echocardiogram: CPT codes 93303 to 93304, 93307 to 93308, 93312, 9331415, 93317 to 93318, 93320 to 93321, and 93325.

Cardiac stress test: CPT codes 78459 to 78460, 78461, 78464 to 78465, 78469, 78472 to 78473, 78478, 78480 to 78481, 78483, 78491 to 78492, 93015 to 93018, and 93350.

Lipid testing: CPT codes 80061, 82465, 83715 to 83721, and 84478.

General Health Maintenance

Influenza vaccination: CPT codes 90724, 90657 to 90660, and G0008.

Pneumococcal vaccination: CPT codes 90699, 90732, J6065, and G0009.

Hepatitis B vaccination: CPT codes 90740, 90743 to 90744, 90746 to 90748, and 90636.

Hepatitis B serologic testing: CPT codes 80059 for years 1998 to 1999; code 80074 for year 2000; and codes 86704, 86706 to 86707, 87340 to 87341, and 87350 for years 1998 to 2000.

Bone densitometry: CPT codes 76075 to 76076, 76977, and G0130 to G0132.

Cancer Screening

Breast cancer testing: CPT codes 76090 to 76092; ICD-9 procedure codes 87.36 and 87.37; ICD-9 diagnosis codes V76.11 and V76.12; or Part A revenue codes 0401 and 0403 for mammography.

Cervical cancer testing: CPT codes 88141 to 88145, 88147 to 88148, 88150, 88152 to 88156, 88158, 88164 to 88167; ICD-9 procedure code 91.46; ICD-9 diagnosis code V76.2; or Part A revenue code 0923 for Papanicolaou smear.

Prostate cancer testing: CPT code 84153; revenue codes of 0300 and 0310 associated with ICD-9 diagnosis codes 185 and 233.4; or ICD-9 procedure codes 60.11 to 60.12, 60.18, 87.92, and 91.39 for prostate-specific antigen.

Colon cancer testing: CPT codes 45300, 45303, 45305, 45330, 45331, 45378, and 45380 or ICD-9 procedure codes 45.23 and 45.24 for colonoscopy and/or sigmoidoscopy.

CKD Care

Abnormal calcium-phosphorus metabolism: CPT codes for calcium (82310 and 82330 for years 1998 to 2000; 80054 for years 1998 to 1999; 80048, 80053, and 80069 for year 2000), phosphorus (84100 for years 1998 to 2000 and 80069 for year 2000), or PTH (83970 for years 1998 to 2000).

Anemia testing: CPT codes 83540, 83545–46, 83550, 83555, 83565,

82728, and 84466 for iron tests CPT code 82270 for occult blood loss in the stool.

Dialysis Access Procedures

Arteriovenous graft or fistula: CPT codes 35190, 35460, 35476, 35875 to 35876, 35903, 36800, 36810, 36815, 36819, 36821, 36825, 36830 to 36835, 37607, 75790, 75820, 75962, 75978, 01784, 01844, G0159, and 36870 or ICD-9 procedure codes 39.27 and 39.93.

HD catheter: CPT codes 36011, 36145, 36489, 36491, 36533 to 36535, 36860 to 36861, 37201, 37205 to 37208, 75860, 75896, 75960, and 00532, or ICD-9 procedure code 38.95.

PD catheter: CPT codes 49420 to 49422.

Catheters for nonrenal reasons were eliminated. Chemotherapy: CPT codes 96408, 96410, and 96412; parenteral nutrition: B4164, B4168, B4172, B4176, B4178, B4180, B4184, B4186, B4189, B4193, B4197, B4199, B4216, B4220, B4222, B4224, B5000, B5100, B5200, B9004, B9006, and B9999.

Outpatient Physician Visit and Physician Specialty

Part B physician/supplier claims were searched for service place codes and physician specialty code.

Outpatient visits: Service codes 11 (office), 22 (outpatient hospital).

Nephrology: Specialty code 39.

Internal medicine: Specialty code 11.

Cardiology: Specialty code 06.

Endocrinology: Specialty code 46.

Other medicine specialty: Specialty codes 03 (allergy/immunology), 10 (gastroenterology), 29 (pulmonary disease), 44 (infectious disease), 66 (rheumatology), 70 (multispecialty clinic or group practice), 82/83/90 (hematology/oncology/medical oncology), 92 (radiation oncology), and 98 (gynecologist/oncologist).

Surgery: Specialty codes 02 (general), 04 (otolaryngology), 14 (neurosurgery), 20 (orthopedic surgery), 24 (plastic and reconstructive surgery), 28 (colorectal surgery), 33 (thoracic surgery), 34 (urology), 40 (hand surgery), 77 (vascular surgery), 78 (cardiac surgery), 85 (maxillofacial surgery), and 91 (surgical oncology).

Primary care/family medicine: Specialty codes 01 (general practice), 08 (family practice), 16 (obstetrics/gynecology), 38 (geriatric medicine), 50 (nurse practitioner), and 84 (preventive medicine).

Provider Specialty Categorization

Internal medicine: Specialty codes 01, 08, 11, 16, 38, 50, and 84.

Nephrology: Specialty code 39.

Other internal medicine specialty: Specialty codes 03, 06, 10, 29, 44, 46, 66, 70, 82, 93, 90, 92, and 98.

Other provider: The remaining specialty codes.

Appendix 2: ESRD Networks

Network 1: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

Network 2: New York.

Network 3: New Jersey, Puerto Rico, and Virgin Islands.

Network 4: Delaware and Pennsylvania.

Network 5: Maryland; Virginia; Washington, DC; and West Virginia.

Network 6: Georgia, North Carolina, and South Carolina.

Network 7: Florida.

Network 8: Alabama, Mississippi, and Tennessee.

Network 9: Indiana, Kentucky, and Ohio.

Network 10: Illinois.

Network 11: Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin.

Network 12: Iowa, Kansas, Missouri, and Nebraska.

Network 13: Arkansas, Louisiana, and Oklahoma.

Network 14: Texas.

Network 15: Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming.

Network 16: Alaska, Idaho, Montana, Oregon, and Washington.

Network 17: American Samoa, Northern California, Guam, and Hawaii.

Network 18: Southern California.

References

- Obrador GT, Arora P, Kausz A, Pereira BJC: Pre-ESRD care in the United States: A state of disrepair. *J Am Soc Nephrol* 9: S44-S54, 1998
- Jungers P, Zingraff J, Albouze P, Chauveau P, Page B, Hannedouche T, Man NK: Late referral to maintenance dialysis: Detrimental consequences. *Nephrol Dial Transplant* 8: 1089-1093, 1993
- Ifudu O, Dawood M, Homel P, Friedman EA: Excess morbidity in patients starting uremia therapy without prior care by a nephrologist. *Am J Kidney Dis* 28: 841-845, 1996
- Eadington DW: Delayed referral for dialysis. *Nephrol Dial Transplant* 11: 2124-2126, 1996
- Arora P, Obrador G, Ruthazer R, Kausz A, Meyer K, Jenuleson C, Pereira B: Prevalence, predictors and consequences of late nephrology referral at a tertiary care center. *J Am Soc Nephrol* 6: 1281-1286, 1999
- Sesso R, Belasco AG: Late diagnosis of chronic renal failure and mortality in maintenance dialysis. *Nephrol Dial Transplant* 11: 2417-2420, 1996
- Foley RN, Parfrey PS, Harnett JD, Kent GM, Murray DC, Barre PE: The impact of anemia on cardiomyopathy, morbidity and mortality in end-stage renal disease. *Am J Kidney Dis* 28: 53-61, 1996
- Xue J, Peter WS, Ebben J, Everson S, Collins A: Anemia treatment in the pre-ESRD period and associated mortality in elderly patients. *Am J Kidney Dis* 40: 1153-1161, 2002
- Iseki K, Uehara H, Nishime K, Tokuyama K, Yoshihara K, Kinjo K, Shiohira Y, Fukiyama K: Impact of the initial levels of laboratory variables on survival in chronic dialysis patients. *Am J Kidney Dis* 28: 541-548, 1996
- Nissenson A, Collins A, Hurley J, Petersen H, Pereira B, Steinberg E: Opportunities for improving the care of patients with chronic renal insufficiency: Current practice patterns. *J Am Soc Nephrol* 12: 1713-1720, 2001
- Kausz AT, Khan SS, Abichandani R, Kazmi WH, Obrador GT, Ruthazer R, Pereira BJC: Management of patients with chronic renal insufficiency in the Northeastern United States. *J Am Soc Nephrol* 12: 1501-1507, 2001
- NKF-K/DOQI Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, classification and stratification. *Am J Kidney Dis* 39[Suppl 1]: S1-S246, 2002
- Winkelmayer WC, Owen W, Glynn RJ, Levin R, Avorn J: Preventive health care measures before and after start of renal replacement therapy. *J Gen Intern Med* 17: 588-595, 2002
- Collins AJ, Li S, Gilbertson DT, Liu J, Chen SC, Herzog CA: Chronic kidney disease and cardiovascular disease in the Medicare population. *Kidney Int Suppl* 87: S24-S31, 2003
- Mix TCH, St. Peter WL, Ebben J, Xue JL, Pereira BJ, Kausz AT, Collins AJ: Hospitalization during advancing chronic kidney disease. *Am J Kidney Dis* 42: 972-981, 2003
- US Renal Data System: Researcher's Guide. *USRDS 2004 Annual Data Report: Atlas of End-Stage Renal Disease in the United States, 2004*. Available: <http://www.usrds.org/>. Accessed May 25, 2005.
- Obrador G, Ruthazer R, Arora P, Kausz A, Pereira B: Prevalence of and factors associated with sub-optimal care prior to initiation of dialysis in the United States. *J Am Soc Nephrol* 10: 1793-1800, 1999
- McClellan WM, Knight DF, Karp H, Brown W: Early detection and treatment of renal disease in hospitalized diabetic and hypertensive patients: Important differences between practice and published guidelines. *Am J Kidney Dis* 29: 368-375, 1997
- Jones C, McQuillan G, Kusek J, Eberhardt M, Herman W, Coresh J, Salive M, Jones C, Agodoa L: Serum creatinine levels in the US population: Third National Health and Nutrition Examination Survey. *Am J Kidney Dis* 32: 992-999, 1998 (published erratum appears in *Am J Kidney Dis* 35: 178, 2000)
- Khan SS, Kazmi WH, Abichandani R, Tighiouart H, Pereira BJ, Kausz AT: Health care utilization among patients with chronic kidney disease. *Kidney Int* 62: 29-36, 2002
- Wheeler D: Cardiovascular disease in patients with chronic renal failure. *Lancet* 348: 1673-1674, 1996
- Foley R, Parfrey P, Sarnak M: Epidemiology of cardiovascular disease in chronic renal disease. *J Am Soc Nephrol* 9[Suppl 12]: S16-S23, 1998
- US Renal Data System: *USRDS 2002 Annual Data Report: Atlas of End-Stage Renal Disease in the United States*. Bethesda, MD, National Institute of Diabetes and Digestive Kidney Diseases (NIDDK), 2002
- Rangel MC, Coronado VG, Euler GL, Strikas RA: Vaccine recommendations for patients on chronic dialysis. The Advisory Committee on Immunization Practices and the American Academy of Pediatrics. *Semin Dial* 13: 101-107, 2000
- Standards of medical care in diabetes. *Diabetes Care* 27[Suppl 1]: S15-S35, 2004
- Gilbertson DT, Unruh M, McBean AM, Kausz AT, Snyder JJ, Collins AJ: Influenza vaccine delivery and effectiveness in end-stage renal disease. *Kidney Int* 63: 738-743, 2003
- Nichol K, Margolis K, Wuorenma J, Von Sternberg T: The efficacy and cost-effectiveness of vaccination against influenza among elderly persons living in the community. *N Engl J Med* 331: 778-784, 1994
- Stratton I, Adler A, Neil H, Mathews D, Manley S, Cul C, Hadden D, Turner R, Holman R: Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): Prospective observational study. *BMJ* 321: 405-412, 2000
- Peterson JC, Adler S, Burkart JM, Greene T, Hebert LA, Hunsicker LG, King AJ, Klahr S, Massry SG, Seifter JL: Blood pressure control, proteinuria, and the progression of renal disease. The Modification of Diet in Renal Disease Study. *Ann Intern Med* 123: 754-762, 1995
- Holley J: Preventive medical screening is not appropriate for many chronic dialysis patients. *Semin Dial* 13: 369-371, 2000
- Zappa M, Visioli C, Ciatto S: Mammography screening in

- elderly women: Efficacy and cost-effectiveness. *Crit Rev Oncol Hematol* 46: 235-239, 2003
32. Kiberd B, Keough-Ryan T, Clase C: Screening for prostate, breast and colorectal cancer in renal transplant recipients. *Am J Transplant* 3: 619-625, 2003
 33. Obrador G, Roberts T, Peter WS, Frazier E, Pereira B, Collins A: Trends in anemia at initiation of dialysis in the United States. *Kidney Int* 60: 1875-1884, 2001
 34. Kazmi WH, Kausz AT, Khan S, Abichandani R, Ruthazer R, Obrador GT, Pereira BJC: Anemia—An early complication of chronic renal insufficiency. *Am J Kidney Dis* 38: 803-812, 2001
 35. Kausz AT, Steinberg EP, Nissenson AR, Pereira BJC: Prevalence and management of anemia among patients with chronic kidney disease in a health maintenance organization. *Dis Manag Health Outcomes* 10: 505-513, 2002
 36. NKF-DOQI clinical practice guidelines for the treatment of anemia of chronic renal failure. *Am J Kidney Dis* 30[Suppl 3]: S192-S240, 1997
 37. Stehman-Breen CO, Sherrard DJ, Gillen D, Caps M: Determinants of type and timing of initial permanent hemodialysis vascular access. *Kidney Int* 57: 639-645, 2000
 38. Lameire N, Van Biesen W, Dombros N, Dratwa M, Faller B, Gahl GM, Gokal R, Krediet RT, La Greca G, Maiorca R, Matthys E, Ryckelynck JP, Selgas R, Walls J: The referral pattern of patients with ESRD is a determinant in the choice of dialysis modality. *Perit Dial Int* 17[Suppl 2]: S161-S166, 1997
 39. Schmidt RJ, Domico JR, Sorkin MI, Hobbs G: Early referral and its impact on emergent first dialyses, health care costs, and outcome. *Am J Kidney Dis* 32: 278-283, 1998
 40. Fellner SK, Lang RM, Neumann A, Korcarz C, Borow KM: Cardiovascular consequences of the correction of the anemia of renal failure with erythropoietin. *Kidney Int* 44: 1309-1315, 1993
 41. Budisavijevic M, Cheek D, Ploth D: Calciphylaxis in chronic renal failure. *J Am Soc Nephrol* 7: 978-982, 1996
 42. Foley RN, Parfrey PS: Anemia as a risk factor for cardiac disease in dialysis patients. *Semin Dial* 12: 84-86, 1999
 43. Sarnak M, Tighiouart H, Manjunath G, MacLeod B, Griffith J, Salem D, Levey A: Anemia as a risk factor for cardiovascular disease in the Atherosclerotic Risk in Communities (ARIC) study. *J Am Coll Cardiol* 40: 27-32, 2002
 44. Revicki D, Brown R, Feeny D, Henry D, Teehan B, Rudnick M, Benz R: Health-related quality of life associated with recombinant human erythropoietin therapy for predialysis chronic renal disease patients. *Am J Kidney Dis* 25: 548-554, 1995
 45. Lee H, Manns B, Taub K, Ghali WA, Dean S, Johnson D, Donaldson C: Cost analysis of ongoing care of patients with end-stage renal disease: The impact of dialysis modality and dialysis access. *Am J Kidney Dis* 40: 611-622, 2002
 46. US Census Bureau: Income and Poverty in 1999. United States by State, 2000. Available: <http://www.census.gov/main/www/cen2000.html>. Accessed May 25, 2005
 47. US Census Bureau: Employment Status and Commuting to Work. United States by State, 2000. Available: <http://www.census.gov/main/www/cen2000.html>. Accessed May 25, 2005
 48. US Census Bureau: Language, School Enrollment and Educational Attainment: 2000. United States by State, 2000. Available: <http://www.census.gov/main/www/cen2000.html>. Accessed May 25, 2005
 49. Avorn J, Bohn RL, Levy E, Levin R, Owen WF Jr, Winkelmayr WC, Glynn RJ: Nephrologist care and mortality in patients with chronic renal insufficiency. *Arch Intern Med* 162: 2002-2006, 2002
 50. Kinchen KS, Sadler J, Fink N, Brookmeyer R, Klag MJ, Levey AS, Powe NR: The timing of specialist evaluation in chronic kidney disease and mortality. *Ann Intern Med* 137: 479-486, 2002
 51. US Renal Data System: Expected remaining lifetimes (years) of the general US population and of prevalent dialysis and transplant patients, by race and gender. *USRDS 2004 Annual Data Report: Atlas of End-Stage Renal Disease in the United States, 2004*. Available: http://www.usrds.org/2004/pdf/06_hosp_morte_04.pdf. Accessed May 25, 2005
 52. Ohmit SE, Flack JM, Peters RM, Brown WW, Grimm R: Longitudinal Study of the National Kidney Foundation's (NKF) Kidney Early Evaluation Program (KEEP). *J Am Soc Nephrol* 14[Suppl 2]: S117-S121, 2003