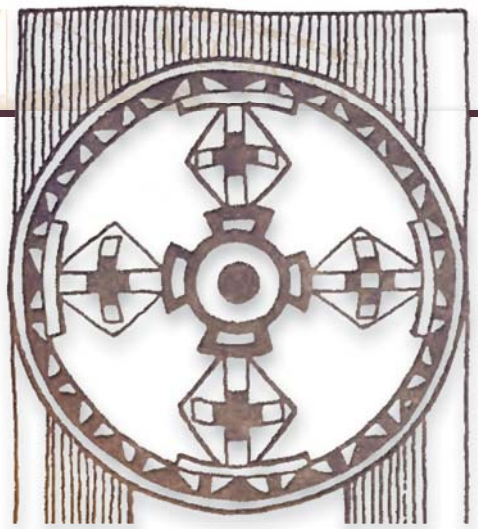
PRÉCIS

an introduction to chronic kidney disease in the united states

I ask you to look both ways. For the road to a knowledge of the stars leads through the atom; and important knowledge of the atom has been reached through the stars.

Arthur Eddington, Stars & Atoms



In this Précis we highlight important data on chronic kidney disease. We begin by showing the overall burden of diabetes, congestive heart failure, and CKD, three interrelated chronic diseases. Diabetes prevalence continues to grow in the U.S., reaching 7.7 percent of the general population in 2003–2006. And the prevalence of congestive heart failure reached 2.5 percent in the same period.

Estimating the size of the CKD population is a challenge. A decline in kidney function is common among older people; they also, however, have the greatest burden of chronic diseases, confounding the question of whether CKD is simply a part of aging or a true disease coexisting with others such as diabetes, hypertension, and vascular disease.

The CKD-EPI equation consistently identifies a greater number of patients with eGFRs above 60 ml/min/1.73 m^2 than does the older MDRD equation. Use of CKD-EPI thus shows a greater burden of comorbidity among patients with eGFRs less than 60, as the placement of healthier patients into the above-60 group leaves behind a denominator of patients with more chronic disease. For the same reason, use of the CKD-EPI equation also shows a greater burden of biochemical abnormalities in patients with lower eGFRs.

Because the limited availability of laboratory data makes it challenging to define the CKD population in the Medicare and employer group health plan (EGHP) cohorts, we also employ a constellation of diagnosis codes. As expected, CKD patients carry 2–5 times the disease burden of non-CKD patients. The degree of biochemical abnormalities among CKD patients in the Ingenix i3 database (with laboratory data on approximately 17 percent of the population) is quite similar to that reported in the general population from the NHANES datasets, with increasing degrees of low serum calcium, elevated PTH, and elevated serum glucose.

We next present data on prescription medication therapy. Among patients with recognized CKD, use of ACEIs/ARBs is 56–57 percent, far below the 71–76 percent seen in those who also have hypertension or diabetes. Interestingly, among CKD patients with recognized cardiovascular disease, 61 percent use a lipid lowering agent.

Adjusted hospitalization rates are 30–50 percent higher for patients with CKD than for those without, and have fallen slightly in both populations, even after adjustments for comorbidity. Hospitalizations for pneumonia have also declined, while those for bacteremia/sepsis have increased.

Mortality has declined over the last 15 years for both CKD and non-CKD patients identified by claims. The rate among CKD patients, however, has decreased to a greater degree, particularly for older ages. By race, adjusted mortality rates among African Americans are lower than those of whites for patients with Stage 1–2 CKD, but higher for those with CKD of Stages 3–5, suggesting that selection bias among those who reach ESRD may have an impact on the mortality rates noted in the dialysis population.

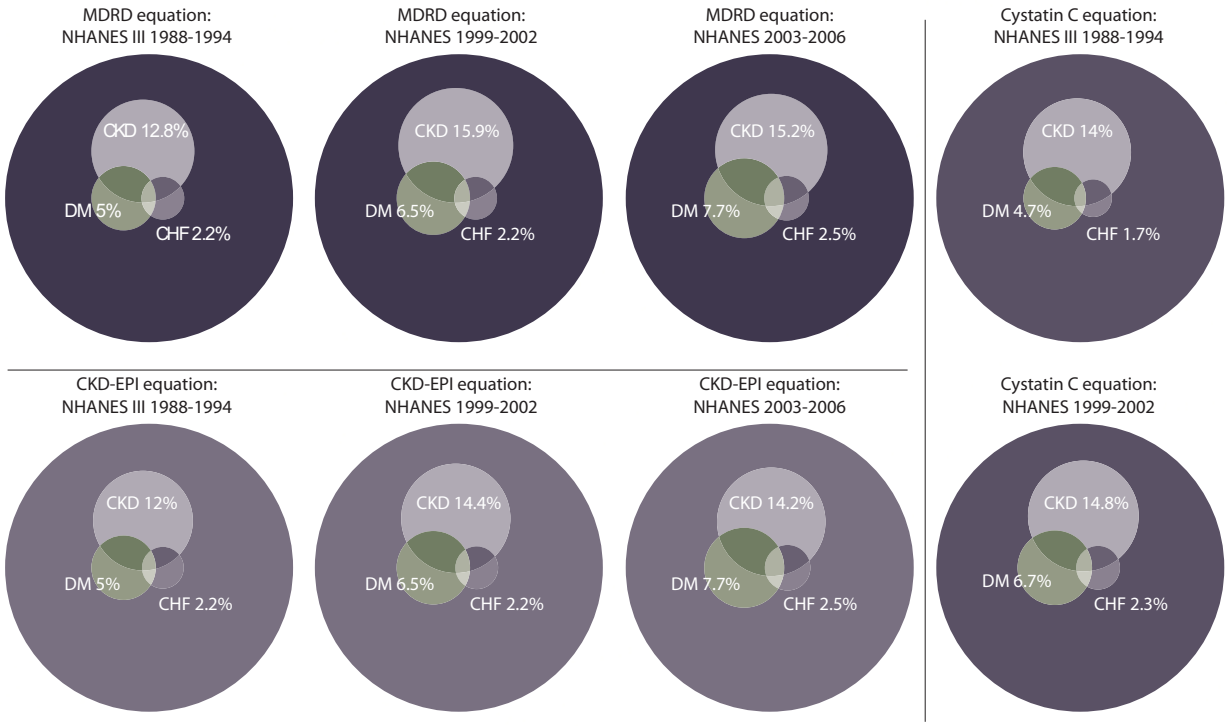
New to the ADR this year is a chapter on the treatment of cardiovascular disease. Use of ACEIs and ARBs among patients with congestive heart failure, and of anticoagulation therapy among those with atrial fibrillation, is similar in the CKD and non-CKD populations; beta blocker use is slightly higher for those with CKD. Also new is a chapter on the transition from CKD to ESRD among patients residing in nursing homes, which includes data on cognitive function.

General data on the transition to ESRD show that nephrology referrals are late when CKD is thought to be less severe or its stage is unspecified. And information on acute kidney injury (AKI) demonstrates that a recurrent AKI hospitalization occurs in about 50 percent of patients surviving a first hospitalization for the condition.

We conclude with figures summarizing costs for CKD patients and for those transitioning to ESRD, and compare costs in the U.S. to those of Taiwan, which has the highest incidence of ESRD in the world. Taiwan uses the same billing system as Medicare, thus allowing for precise comparisons between the two countries. Data here help demonstrate the universal budgetary issues faced by all countries with large CKD and ESRD populations, and show that healthcare systems need to address CKD in a timely manner to reduce its rate of progression to ESRD, its complications, and the risk of premature death.

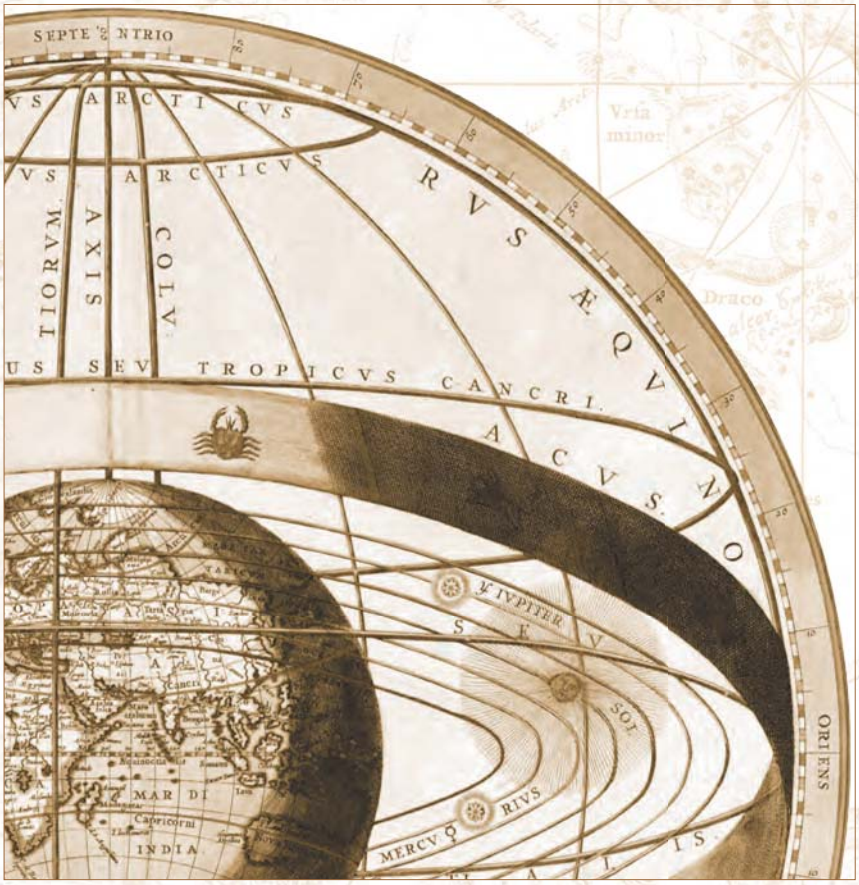
FIGURE 1.1; see page 166 for analytical methods. *NHANES participants age 20 & older.*

1.1 Distribution of NHANES participants with diabetes, congestive heart failure, & markers of CKD, with GFR estimated by MDRD, CKD-EPI, & cystatin C equations



P.a.i **Summary statistics on chronic kidney disease in the United States, by age, gender, race/ethnicity, & risk factor (percent; eGFR determined from CKD-EPI equation)**

	NHANES III 1988–1994				NHANES 1999–2002				NHANES 2003–2006			
	Stg 1	Stg 2	Stg 3	Stg 4–5	Stg 1	Stg 2	Stg 3	Stg 4–5	Stg 1	Stg 2	Stg 3	Stg 4–5
20-39	4.5	0.4*	0.1*	0.0*	4.7	0.7	0.3*	0.2*	4.7	0.8	0.1*	0.0*
40-59	4.5	2.4	1.3	0.0*	5.3	2.4	1.9	0.3*	4.5	2.6	2.2	0.1*
60+	2.7	9.1	18.8	1.3	2.4	9.1	24.2	1.9	2.3	8.1	24.5	2.3
Male	3.1	2.7	3.9	0.3	3.8	3.2	5.0	0.6	3.3	3.5	5.5	0.5
Female	5.0	3.3	5.4	0.4	5.1	3.2	7.3	0.6	4.8	2.8	7.4	0.7
Non-Hispanic white	3.4	3.1	5.3	0.3	3.4	3.5	7.1	0.5	3.1	3.1	7.7	0.6
Non-Hispanic Af Am	7.1	3.0	3.5	0.6	6.4	3.2	5.1	1.4	6.3	3.6	4.7	1.0
Other	5.6	2.4	2.0	0.2*	7.8	2.0	2.9	0.4*	7.2	3.3	2.2	0.4*
Self-reported diabetes	11.2	14.4	14.9	1.8	13.3	9.6	15.1	3.3	10.7	10.7	18.4	2.9
Self-reported hypertension	5.7	6.4	12.0	1.1	5.6	6.2	14.9	2.0	5.3	5.8	14.4	1.6
Self-reported CVD	4.6	5.7	13.6	1.3	2.4	8.1	24.8	4.3	4.0	9.2	26.9	4.2
Current smoker	4.9	2.3	1.9	0.2*	6.5	2.1	2.3	0.5*	5.3	2.4	2.5	0.5
Obese (BMI ≥30)	5.8	4.2	5.9	0.3*	5.9	4.4	6.6	0.6	5.2	4.0	6.6	0.6
COPD	5.8	4.2	6.7	0.3*	4.7	3.3	7.1	0.8	4.2	3.2	7.5	0.8
Hepatitis C	5.5	3.8*	2.9*	0.3*	7.5*	3.8*	6.4*	0*	5.5*	2.3*	1.3*	0.7*
All	4.1	3.0	4.7	0.3	4.4	3.2	6.2	0.6	4.1	3.2	6.5	0.6



Between the 1988–1994 and 2003–2006 NHANES surveys, the percentage of participants with Stage 3 CKD (determined using the CKD-EPI equation) rose from 4.7 to 6.5. A similar increase was seen in many demographic and clinical groups. Among participants with self-reported cardiovascular disease, for example, the percentage with Stage 3 CKD rose from 13.6 to 26.9, while among participants age 60 and older it grew from 18.8 to 24.5. In the latest NHANES survey, 10.7 percent of participants with self-reported diabetes had Stage 2 CKD, and 18.4 percent had CKD of Stage 3. ✣ **Table P.A;** see page 166 for analytical methods. *NHANES participants age 20 & older. *Estimate not reliable.*

Analysis definitions

1. Hypertension defined as blood pressure ≥130/≥80 for those with CKD and diabetes; otherwise ≥140/≥90, or self-reported treatment for hypertension.
2. Awareness and treatment are self-reported. Control defined as <130/<80 for those with CKD and diabetes; otherwise <140/<90.
3. Hypercholesterolemia based on elevated LDL following Adult Treatment Panel III (ATP III) guidelines, with CKD considered a risk equivalent for chronic heart disease, self-reported treatment, or self-reported dieting to lower cholesterol.
4. Awareness and treatment self-reported. Control defined as meeting the National Cholesterol Education Program (NCEP) ATP III LDL target: <100 mg/dl (high risk), <130 mg/dl (moderate risk), or <160 mg/dl (low risk).
5. HDL cholesterol classified according to ATP III guidelines.
6. Total cholesterol classified according to ATP III guidelines.
7. Glycohemoglobin classified according to American Diabetes Association guidelines.

CKD stage markers

1. eGFR ≥90, albumin/creatinine ratio (ACR) ≥30 mg/g
2. eGFR 60–89, ACR ≥30 mg/g
3. eGFR 30–59
4. eGFR 15–29
5. eGFR <15 (dialysis patients excluded from analyses)

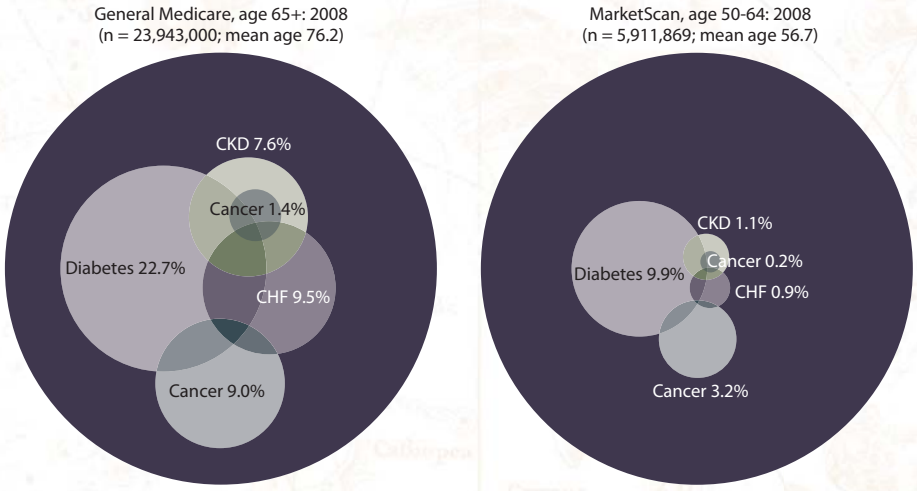
1e **Awareness, treatment, & control of hypertension, hypercholesterolemia, HDL cholesterol, & diabetes, by CKD stage & method used to estimate GFR (percent of NHANES participants)**

	Non–CKD		Stages 1–2		Stages 3–4	
	MDRD	CKD-EPI	MDRD	CKD-EPI	MDRD	CKD-EPI
Hypertension, by current hypertensive status[1]						
Non-hypertensive status	74.4	73.8	36.2	35.6	19.6	15.6
Hypertensive (measured/treated)	25.7	26.2	63.9	64.4	80.5	84.4
Control of hypertension among hypertensive patients[2]						
Unaware	30.9	31.0	36.1	36.2	25.5	23.9
Aware, not treated	11.3	11.1	14.2	13.8	6.1	6.0
Aware, treated, uncontrolled	23.8	24.2	39.1	39.4	48.3	50.5
Aware, treated, controlled	34.0	33.7	10.6	10.5	20.0	19.5
Hypercholesterolemia (LDL): LDL cholesterol[3]						
Within ATP-III target LDL range	66.3	65.6	52.1	51.2	20.2	20.4
Hypercholesterolemic (measured or treated)	33.7	34.4	47.9	48.8	79.8	79.6
Control of hypercholesterolemia (LDL) among participants with hypercholesterolemia (LDL)[4]						
Unaware	34.3	34.6	32.3	32.6	44.1	43.6
Aware, not treated	9.1	9.3	7.7	7.8	8.4	7.2
Aware, treated, uncontrolled	21.6	22.2	29.2	29.2	29.6	27.7
Aware, treated, controlled	35.0	33.9	30.9	30.3	17.9	21.5
HDL cholesterol in ATP III target range[5]						
HDL <40 mg/dl (ATP III target)	19.2	19.1	22.7	22.6	18.5	18.9
HDL 40 mg/dl or higher (at/above ATP III target)	80.8	80.9	77.3	77.4	81.5	81.2
Total cholesterol[6]						
<200 (desirable)	52.1	52.0	47.7	48.0	47.6	48.8
200–239 (borderline high)	31.7	31.8	31.3	30.9	31.8	31.6
240+ (high)	16.1	16.3	21.1	21.2	20.6	19.6
Control of diabetes among diabetic patients[7]						
Glycohemoglobin <7% (controlled)	51.3	51.0	36.1	37.2	53.5	53.4
Glycohemoglobin 7% or higher (uncontrolled)	48.7	49.0	63.9	62.8	46.5	46.6

Here we use NHANES data from 1999–2006 to evaluate awareness, treatment, and control of disease conditions, using CKD stages defined with two creatinine-based methodologies to estimate GFR. With the MDRD method, 80.5 percent of participants with CKD of Stages 3–4 have hypertension; only 20 percent, however, are aware of their condition and on a successful treatment regime. With the CKD-EPI method, 84.4 percent of Stage 3–4 participants have hypertension, while 19.5 percent are aware of their condition and receiving adequate treatment. Among patients with earlier stages of CKD, both MDRD and CKD-EPI show that 64 percent have hypertension, more than one-third are unaware of their condition, 14 percent are not treated, and 11 percent are on a successful treatment regime.

With both MDRD and CKD-EPI, 80 percent of participants with Stage 3–4 CKD have hypercholesterolemia (based on elevated LDL), but only 18–22 percent are treated and brought to levels recommended by clinical practice guidelines. In those with less severe CKD, 48–49 percent have hypercholesterolemia, while less than one-third are aware of their condition and adequately controlled. Approximately 20 percent of CKD patients have high (240+) total cholesterol levels and HDL cholesterol below the recommended levels, while 63 percent of participants with Stage 1–2 CKD and 47 percent of those with Stage 3–4 CKD have glycohemoglobin levels above the recommended 7 percent guideline. ✣ **Table 1.e;** see page 166 for analytical methods. *NHANES 1999–2006 participants age 20 & older; those with Stage 5 CKD excluded.*

2.1i Distribution of period prevalent general Medicare (age 65+) & MarketScan (age 50–64) patients with diagnosed CKD, CHF, cancer, & diabetes, 2008



2.a i Descriptive parameters of CKD datasets, by age, gender, race, ethnicity, comorbidity, & occupation, 2008

	Medicare age (65+)				MarketScan (20–64)				Ingenix i3 (20–64)			
	All (mean age 75.4)		CKD (77.6)		All (mean age 44.4)		CKD (52.3)		All (mean age 42.6)		CKD (50.8)	
	N	%	N	%	N	%	N	%	N	%	N	%
All	1,206,617	100.0	99,735	100.0	14,653,093	100.0	100,093	100.0	5,726,943	100.0	41,327	100.0
20-44					6,855,454	46.8	20,487	20.5	3,069,009	53.6	10,446	25.3
45-54					4,110,725	28.1	26,279	26.3	1,540,226	26.9	11,677	28.3
55-64					3,686,914	25.2	53,327	53.3	1,117,708	19.5	19,204	46.5
65-74	617,098	51.1	37,579	37.7								
75-84	426,669	35.4	42,164	42.3								
85+	162,850	13.5	19,992	20.0								
Male	504,454	41.8	48,362	48.5	6,949,594	47.4	52,662	52.6	2,783,811	48.6	22,281	53.9
Female	702,163	58.2	51,373	51.5	7,703,499	52.6	47,431	47.4	2,942,734	51.4	19,045	46.1
White	1,058,826	87.8	82,545	82.8								
African American	87,363	7.2	11,717	11.7								
Other	15,786	1.3	1,174	1.2								
Hispanic	19,304	1.6	1,928	1.9								
Diabetes	277,426	23.0	48,311	48.4	830,934	5.7	38,026	38.0	299,320	5.2	15,391	37.2
Hypertension	719,773	59.7	91,201	91.4	1,646,943	11.2	53,185	53.1	771,952	13.5	27,274	66.0
Oil & gas extraction, mining					121,239	0.8	739	0.7				
Manufacturing					2,771,319	18.9	20,188	20.2				
Transportation, communications, utilities					1,249,539	8.5	8,587	8.6				
Retail					337,405	2.3	1,703	1.7				
Retail/finance/insurance/real estate					1,527,443	10.4	8,101	8.1				
Missing/unknown					8,646,148	59.0	60,775	60.7				

The disease burden among prevalent Medicare patients age 65 and older is much more severe than that found in the younger employed population. In 2008, 7.6 percent of Medicare patients carried a diagnosis of CKD compared to 1.1 percent in the MarketScan population. Among Medicare patients, 22.7, 9.5, and 10.4 percent, respectively, had a diagnosis of diabetes, CHF, or cancer, compared to 9.9, 0.9, and 3.4 percent in the employed population.

Data on comorbidity in part also reflect the older age of the Medicare population. Ninety-one percent of Medicare CKD patients, for example, have hypertension, compared to 53 and 66 percent, respectively, of those in the MarketScan and Ingenix i3 databases. ✣ **FIGURE 2.1 & TABLE 2.A;** see page 167 for analytical methods. *Point prevalent general (fee-for-service) Medicare patients age 65 & older; point prevalent MarketScan patients age 50–64; CKD, CHF, cancer, & diabetes determined from claims (2.1). Prevalent Medicare (age 65 & older) & MarketScan & Ingenix i3 (age 20–64) patients surviving 2008 & without ESRD (2.a).*

In the population with recognized CKD, the prevalence of comorbidities is similar among those with CKD of Stages 1–2 and those with Stages 3–5. Diabetes, for example, is reported in 48.2 percent of patients in the early stages of CKD, and 49.4 percent of those in the later stages. The primary exception is anemia, reported in 43.1 percent of Stage 1–2 patients, but nearly 57 percent of those in Stages 3–5. ✣ **Table 2.b;** see page 167 for analytical methods. *Medicare patients age 65 & older, surviving all of 2008; ESRD patients excluded.*

2b*i* Comorbidity in the recognized CKD population, by CKD diagnosis code (percent), 2008

	All codes	585.1–2	585.3–5	585.9/other
Diabetes	48.4	48.2	49.4	47.7
Hypertension	91.4	92.0	94.0	89.4
CVD	74.8	69.6	73.4	76.8
ASHD	46.4	43.0	46.3	47.0
PVD	31.7	27.5	29.6	34.0
COPD	25.1	23.0	23.9	26.3
GI	8.7	7.5	8.2	9.3
CVA/TIA	19.9	18.1	18.4	21.4
Dysrhythmia	36.9	32.4	36.1	38.2
Cancer	18.8	16.8	17.2	20.3
Anemia	51.8	43.1	56.8	49.1
Liver disease	2.3	2.2	1.8	2.7
Hospital days (per pt year)	7.2	5.8	6.2	8.1
Hospital admissions (per pt year)	1.1	0.9	1.0	1.3

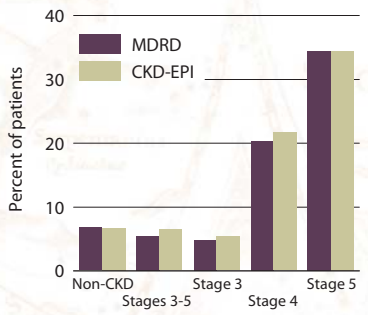
ICD-9-CM codes

585.1	Chronic kidney disease, Stage 1
585.2	Chronic kidney disease, Stage 2 (mild)
585.3	Chronic kidney disease, Stage 3 (moderate)
585.4	Chronic kidney disease, Stage 4 (severe)
585.5	Chronic kidney disease, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis.^)
585.9/oth.	Chronic kidney disease, unspecified

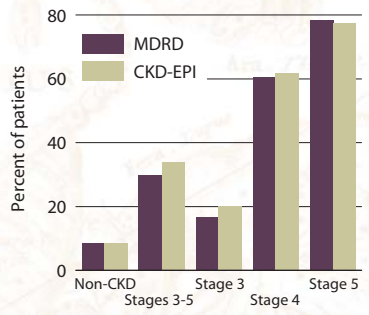
^ *In USRDS analyses, patients with ICD-9-CM code 585.6 are considered to have code 585.5; see Appendix A for details.*

CKD stage estimates are from a single measurement. For clinical case definition, abnormalities should be present ≥ 3 months.

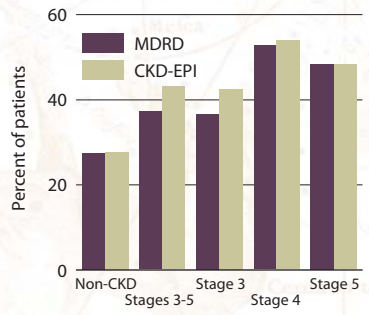
2 22*i* Pts with below-normal calcium levels, by CKD stage & GFR estimation method, 2008



2 23*i* Patients with elevated PTH levels, by CKD stage & GFR estimation method, 2008



2 26*i* Pts with fasting glucose levels > normal, by CKD stage & GFR ID method, 2008

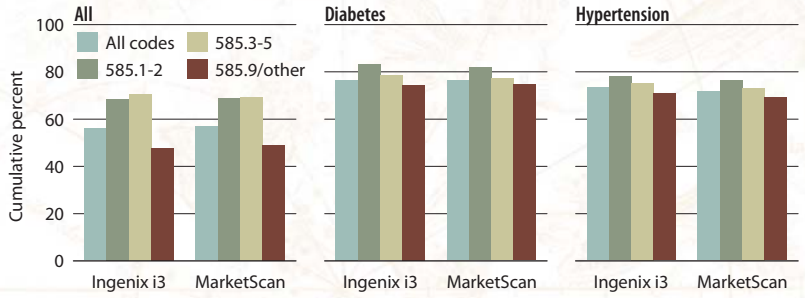


Lower estimated GFRs are often associated with metabolic abnormalities. Here we compare the prevalence of abnormalities in patients with and without CKD while using the MDRD and CKD-EPI equations to define eGFR. For patients with CKD of Stages 3–5, use of the CKD-EPI equation is associated with a higher prevalence of abnormal calcium (6.5 versus 5.5 percent), elevated PTH (33.8 compared to 29.8), and elevated fasting glucose (43.1 compared to 37.2 percent). ✣ **Figures 2.22–23 & 2.26;** see page 167 for analytical methods. *Prevalent Ingenix i3 patients age 20–64, 2008; ESRD patients excluded.*

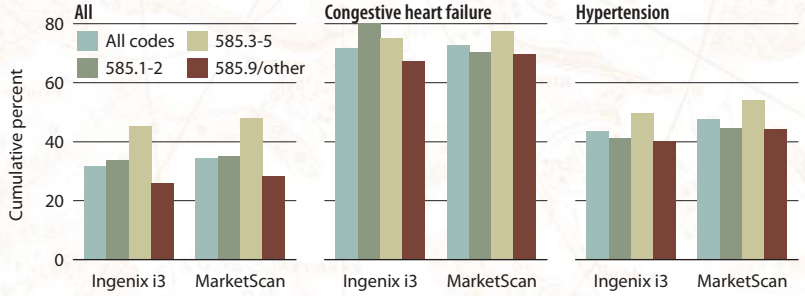
CKD stage markers

1. eGFR ≥90, albumin/creatinine ratio (ACR) ≥30 mg/g
2. eGFR 60–89, ACR ≥30 mg/g
3. eGFR 30–59
4. eGFR 15–29
5. eGFR <15 (dialysis patients excluded from analyses)

3.17i CKD patients with at least one claim for an ACEI/ARB/renin inhibitor in the 12 months following the disease-defining entry period, by dataset & CKD diagnosis code, 2008



3.18i CKD patients with at least one claim for a beta blocker in the 12 months following the disease-defining entry period, by dataset & CKD diagnosis code, 2008



ICD-9-CM codes

585.1	Chronic kidney disease, Stage 1
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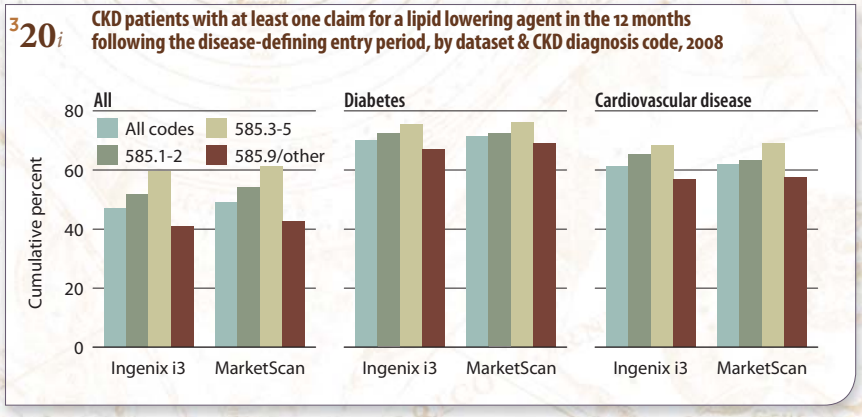
585.9/oth.	Chronic kidney disease, unspecified

^ *In USRDS analyses, patients with ICD-9-CM code 585.6 are considered to have code 585.5; see Appendix A for details.*

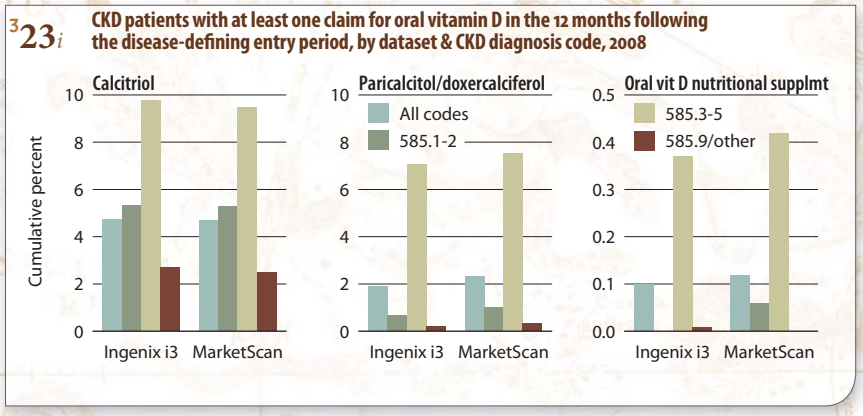
CKD stage estimates are from a single measurement. For clinical case definition, abnormalities should be present ≥ 3 months.

These figures present data on medication use among CKD patients age 20–64 in employer group health plans. Among those with a diagnosis of diabetes or hypertension, 78–83 percent and 73–77 percent, respectively, have evidence of ACEI/ARB/renin inhibitor use; this is about 20 percentage points more than CKD patients without these diagnoses. Data in Chapter Seven, however, suggest that use decreases as CKD progresses towards ESRD.

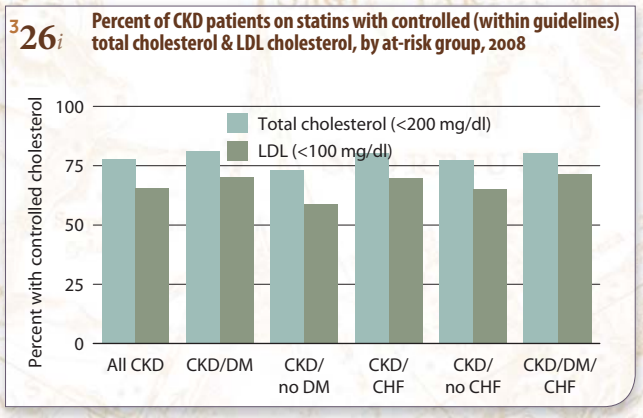
Beta blockers are used by 72 percent of patients with CKD and congestive heart failure, and 45 percent of those with CKD and hypertension. In general, use is higher among Stage 3–5 CKD patients than among those with CKD of Stages 1–2. ✣ **FIGURES 3.17–18;** see page 168 for analytical methods. *Point prevalent MarketScan & Ingenix i3 CKD patients age 20–64.*



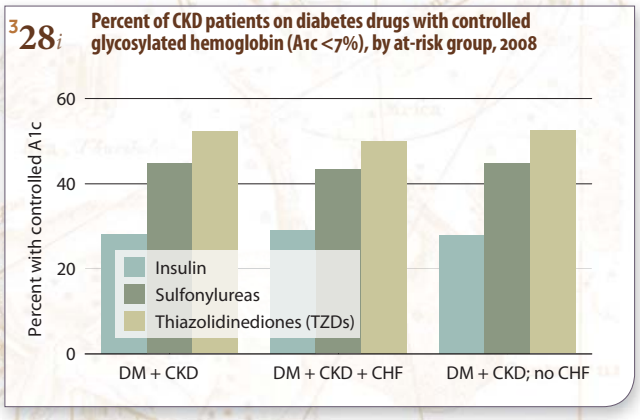
Among patients with CKD and diabetes or cardiovascular disease, 61–72 percent receive a lipid lowering agent. While use rises by CKD stage, data from Chapter Seven show that just over 30 percent of CKD patients are on a lipid lowering agent in the first quarter after ESRD diagnosis, suggesting that some are taken off these medications at dialysis initiation. ✣ **Figure 3.20;** see page 168 for analytical methods. *Point prevalent MarketScan & Ingenix i3 CKD patients age 20–64.*



Fewer than 10 percent of Stage 3–5 CKD patients receive calcitriol, paralleling the use of paricalcitol/doxercalciferol, and less than 0.5 percent receive an oral vitamin D nutritional supplement. ✣ **Figure 3.23;** see page 168 for analytical methods. *Point prevalent MarketScan & Ingenix i3 CKD patients age 20–64. *Ergocalciferol and cholecalciferol.*



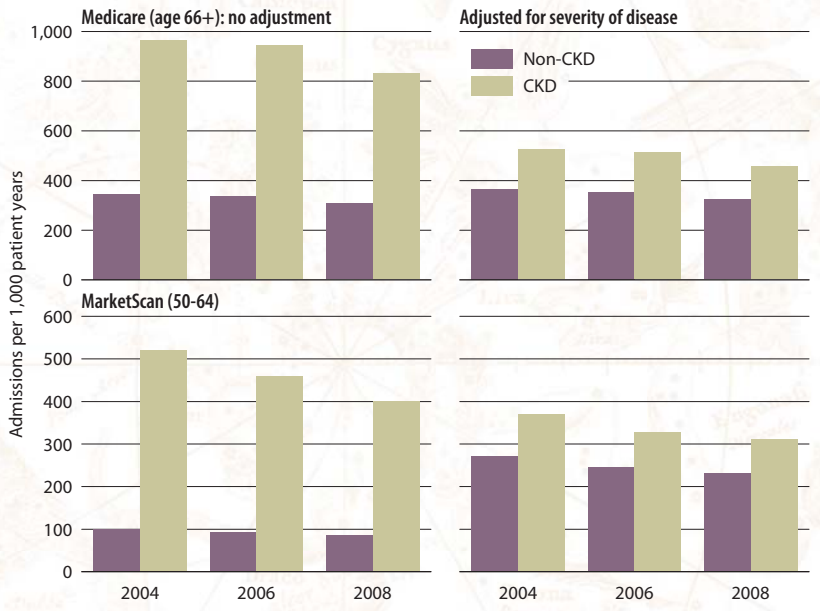
Seventy-eight percent of CKD patients using statins have a controlled total cholesterol (less than 200 mg/dl), while 66 percent have a controlled LDL (less than 100 mg/dl). These numbers rise to 80 and 71 percent among patients with a combined diagnosis of CKD, diabetes, and congestive heart failure. ✣ **Figure 3.26;** see page 168 for analytical methods. *Prevalent Ingenix i3 CKD patients age 50–64, 2008.*



Just 28–29 percent of diabetic CKD patients using insulin have a controlled glycosylated hemoglobin (A1c) of less than 7 percent. This rises to 43–45 percent among patients using sulfonylureas, and to 50–53 percent among those using thiazolidinediones. ✣ **Figure 3.28;** see page 168 for analytical methods. *Prevalent Ingenix i3 CKD patients age 50–64, 2008.*

Here we examine hospitalizations in Medicare and MarketScan patients with and without CKD. Unadjusted rates in the CKD population are 3–5 times those of non-CKD patients, demonstrating the heavy burden of cardiovascular disease (CVD) in CKD patients. Once adjustments have been added for gender, prior hospitalizations, and comorbidity, rates for CKD patients are approximately 1.5 times higher. Unfortunately, adjustments cannot completely address the burden of CVD. Rates are greatest for Medicare patients, and lower for the younger EGHP patients. ✣ **Figure 4.1;** see page 168 for analytical methods. *Medicare: point prevalent patients on January 1 of the year, age 66 & older on December 31 of prior year. MarketScan: point prevalent patients on January 1 of the year, age 50–64 on December 31 of prior year. Adj: gender/comorbidity/prior hospitalization; ref: Medicare patients age 66 & older, 2005.*

4.1i Unadjusted & adjusted all-cause hospitalization rates in the Medicare & MarketScan populations, by CKD status



ICD-9-CM codes

585.1	Chronic kidney disease, Stage 1
585.2	Chronic kidney disease, Stage 2 (mild)
585.3	Chronic kidney disease, Stage 3 (moderate)
585.4	Chronic kidney disease, Stage 4 (severe)
585.5	Chronic kidney disease, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis.^)
585.9/oth.	Chronic kidney disease, unspecified

^ *In USRDS analyses, patients with ICD-9-CM code 585.6 are considered to have code 585.5; see Appendix A for details.*

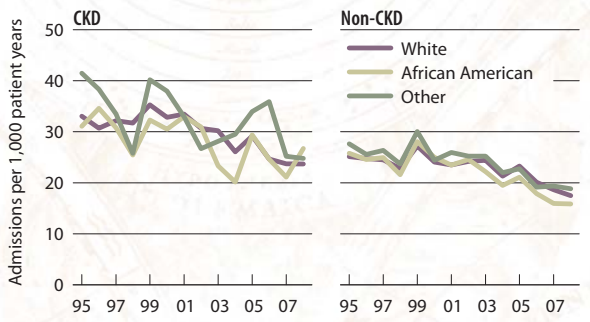
CKD stage estimates are from a single measurement. For clinical case definition, abnormalities should be present ≥ 3 months.

Among Medicare patients age 66 and older, adjusted admission rates are greater for patients with CKD compared to those without, and for patients with Stage 3–5 CKD compared to those with CKD of Stages 1–2. By race, the highest rates for non-CKD patients, all CKD patients, and those with Stage 3–5 CKD occur among African Americans. By gender, rates for those with Stage 3–5 CKD are 5.2 percent higher in women than in men. ✣ **Table 4.a;** see page 168 for analytical methods. *Medicare patients point prevalent on January 1, 2008, age 66 & older on December 31, 2007. Adj: age/gender/race/prior hospitalization/comorbidity; rates presented by one factor are adjusted for the others; ref: Medicare patients age 66 & older, 2008.*

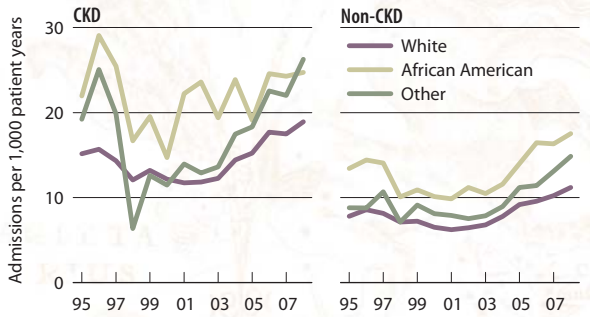
4.a i Adjusted hospitalization rates (per 1,000 patient years at risk) in Medicare patients, by CKD diagnosis code, 2008

	No CKD claim	All CKD	585.1–2	585.3–5	585.9/other
66–69	268	402	311	403	405
70–74	284	398	348	408	401
75–84	349	464	399	487	453
85+	475	578	551	581	586
Male	334	448	397	458	448
Female	333	466	393	481	464
White	331	458	406	472	454
African American	375	497	382	532	494
Other	305	402	288	388	435
All	333	458	397	472	456

4 13i Adjusted rates of hospitalization for pneumonia in Medicare patients, by CKD status & race



4 14i Adjusted rates of hospitalization for bacteremia/septicemia in Medicare patients, by CKD status & race

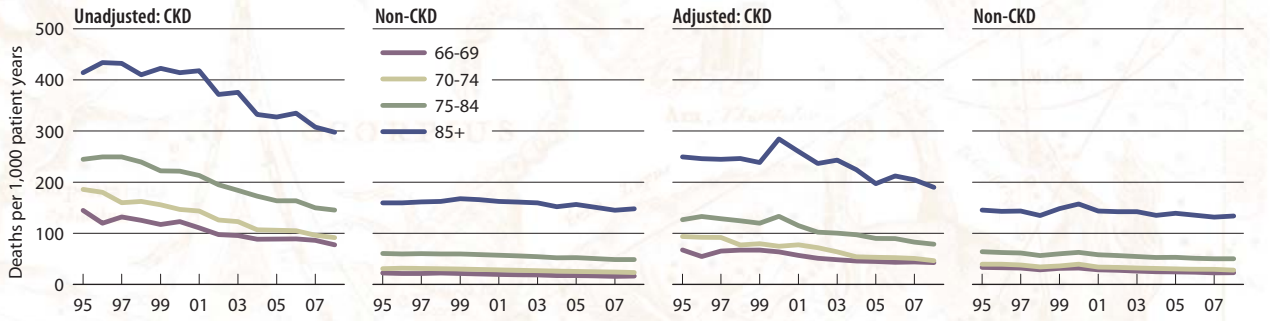


In 2008, adjusted hospitalization rates for pneumonia in Medicare patients varied little by race in both the CKD and non-CKD populations. At 23.7 admissions per 1,000 patient years, the rate among white CKD patients was nearly 36 percent greater than that occurring among their non-CKD counterparts; for African Americans, the rate for CKD patients was more than 68 percent higher.

Rates of hospitalization for bacteremia/septicemia vary more by race. In 2008, for example, the rate among African Americans with CKD reached nearly 25 admissions per 1,000 patient years, 31 percent higher than the rate of 18.9 among whites. While admissions related to pneumonia have generally been declining since 2000, those for bacteremia/septicemia have increased since falling in the beginning of the decade. The rate for white patients with CKD is now almost 25 percent greater than in 1995.

Unadjusted all-cause mortality rates show what seem to be significant declines in mortality in the CKD population. But when rates are adjusted for factors which address patient complexity — such as hospitalization and comorbidity — they begin to flatten out, implying that decreasing comorbidity and severity of disease in the patient population may explain part of the decline in mortality. ✣ **Figures 4.13–14 & 4.16;** see page 169 for analytical methods. *Point prevalent Medicare patients on January 1 of the year, age 66 & older on December 31 of prior year. Adj: age/gender/prior hospitalization/comorbidity; ref: Medicare patients age 66 & older, 2005.*

4 16i Unadjusted & adjusted all-cause mortality rates in Medicare CKD & non-CKD patients, by age



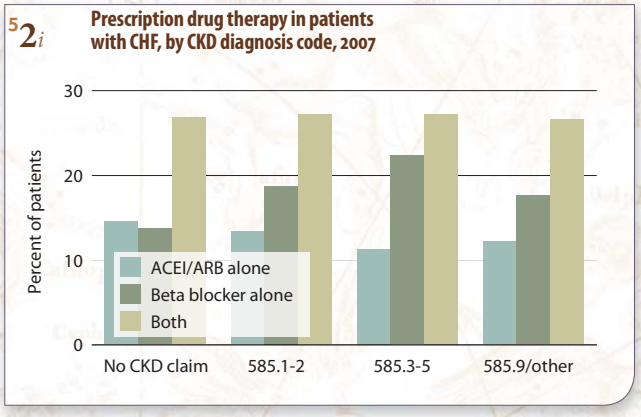
4 b i Adjusted mortality rates (per 1,000 patient years at risk) in Medicare patients, by CKD diagnosis code, 2008

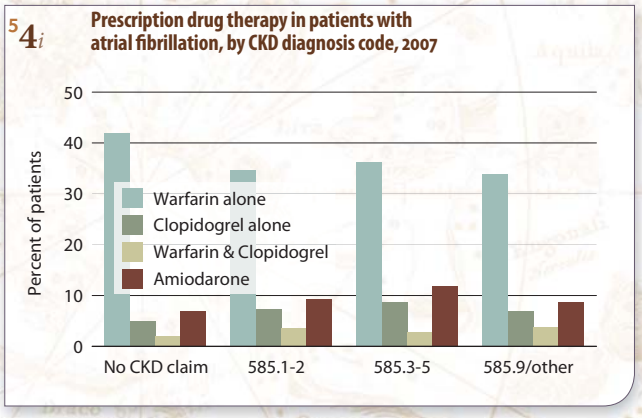
	No CKD claim	All CKD	585.1–2	585.3–5	585.9/oth.
66–69	24.3	45.0	15.9	41.6	51.0
70–74	28.8	49.4	28.6	49.5	52.5
75–84	49.9	80.8	58.5	73.3	89.5
85+	133.9	191.3	161.6	177.0	205.4
Male	59.3	91.8	57.6	86.6	101.3
Female	51.1	85.6	66.0	75.5	94.8
White	54.2	87.6	63.0	80.5	96.0
African American	59.3	87.2	54.0	95.0	90.4
Other	47.7	76.5	33.6	62.8	88.4
All	63.9	96.1	69.1	89.7	104.8

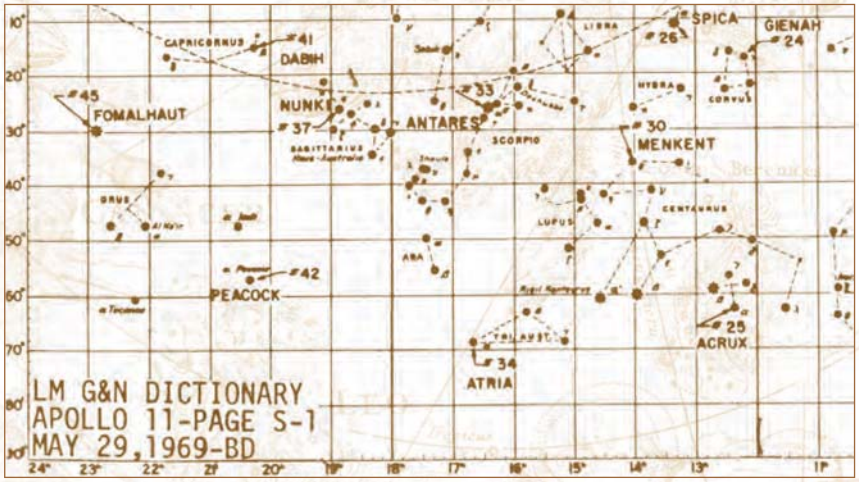
Adjusted rates of mortality in 2008 increased with age, and were highest in patients with advanced stages of CKD: 31–72 percent higher, for example, in patients with Stage 3–5 CKD compared to those with no CKD. By gender, rates in men with CKD were 91.8 per 1,000 patient years at risk compared to 85.6 in women. Rates for CKD patients overall were similar in whites and African Americans, but in patients with Stage 3–5 CKD, rates for African Americans were 18 percent higher than those for whites, at 95.0 and 80.5 per 1,000 patient years, respectively. ✣ **Table 4.b;** see page 169 for analytical methods. *Point prevalent Medicare patients age 66 & older, 2008. Adj: age/gender/comorbidity; ref: 2008 cohort.*

Prior publications have reported that the use of evidence-based therapy in patients with cardiovascular disease generally increases with the severity of CKD. Data here, however, show that use of ACEIs/ARBs in patients with congestive heart failure is consistent across CKD stage, suggesting that therapy titration may not be adequately targeted at the major sources of disease. There is, for example, less CHF in the lower stages of CKD, consistent with data showing higher use of beta blockers in the more advanced stages. The lack of increase in ACEI/ARB use, however, may demonstrate conflicting concerns over declining kidney function.

Warfarin is commonly used in elderly patients with atrial fibrillation. About 44 percent of those without CKD receive warfarin, compared to 38–39 percent of patients with some identified stage of CKD. Interestingly, 12 percent of atrial fibrillation patients with Stage 3–5 CKD are identified as receiving amiodarone. ✣ **FIGURES 5.2 & 5.4;** see page 170 for analytical methods. *January 1 point prevalent Medicare patients age 66 & older, with a first cardiovascular diagnosis or procedure between January 1 & November 30, 2007.*







ICD-9-CM codes

585.1	Chronic kidney disease, Stage 1
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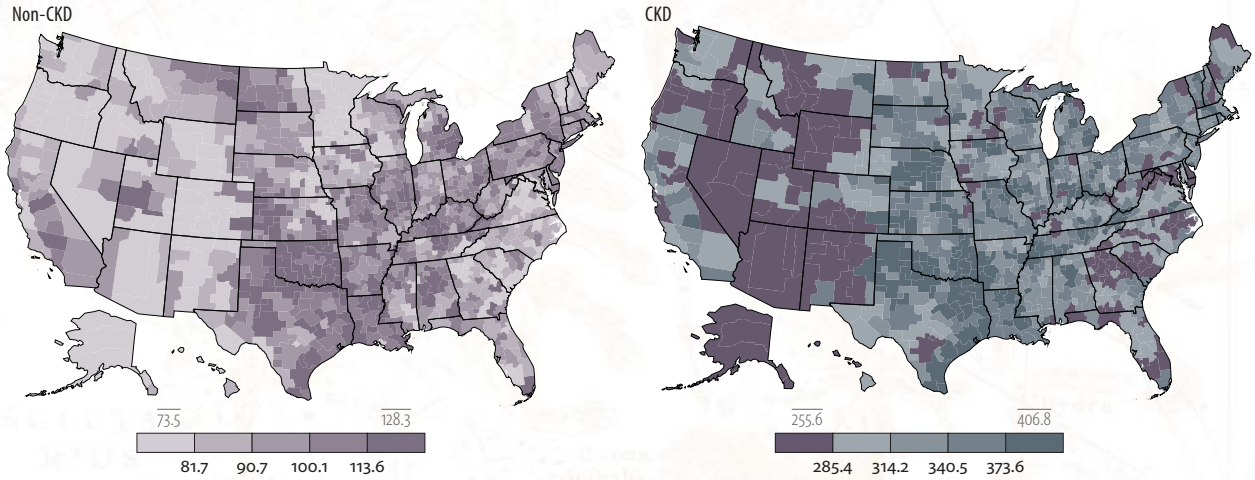
585.9/oth.	Chronic kidney disease, unspecified

^ *In USRDS analyses, patients with ICD-9-CM code 585.6 are considered to have code 585.5; see Appendix A for details.*

CKD stage estimates are from a single measurement. For clinical case definition, abnormalities should be present ≥ 3 months.

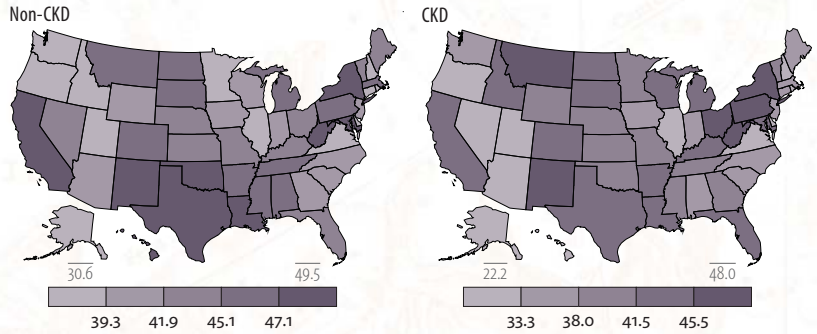
The overall geographic pattern of CHF across the country is similar for elderly patients with and without CKD. Absolute event rates, however, are strikingly different, at 329 per 1,000 patient years for CKD patients, compared to just 97 for those without the disease. Geographic clustering of CHF includes the southern part of the U.S., the Midwest, and Appalachia. ✣ **Figure 5.9;** see page 170 for analytical methods. *December 31, 2007, point prevalent Medicare patients age 66 & older.*

5.9i **Geographic variations in rates of CHF (per 1,000 population), by HSA & CKD status, 2008**

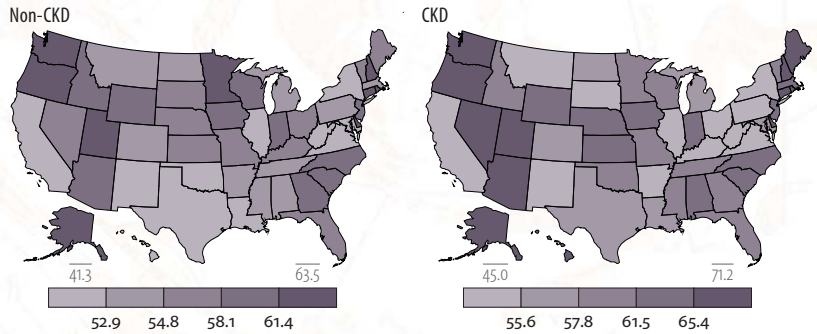


Figures 5.13–14 are "mirror image" maps illustrating variations in the use of medications to treat congestive heart failure, specifically ACEIs/ARBs and beta blockers. Forty-two percent of non-CKD patients with CHF, for example, do not receive medications for their CHF, compared to 45 percent of CKD patients. This lack of treatment may reflect mild disease; it is not likely to demonstrate concern over kidney function, as the non-CKD population is similarly undertreated. ✣ **Figures 5.13–14;** see page 170 for analytical methods. *January 1 point prevalent Medicare patients age 66 & older, with a first cardiovascular diagnosis or procedure between January 1 & November 30, 2007.*

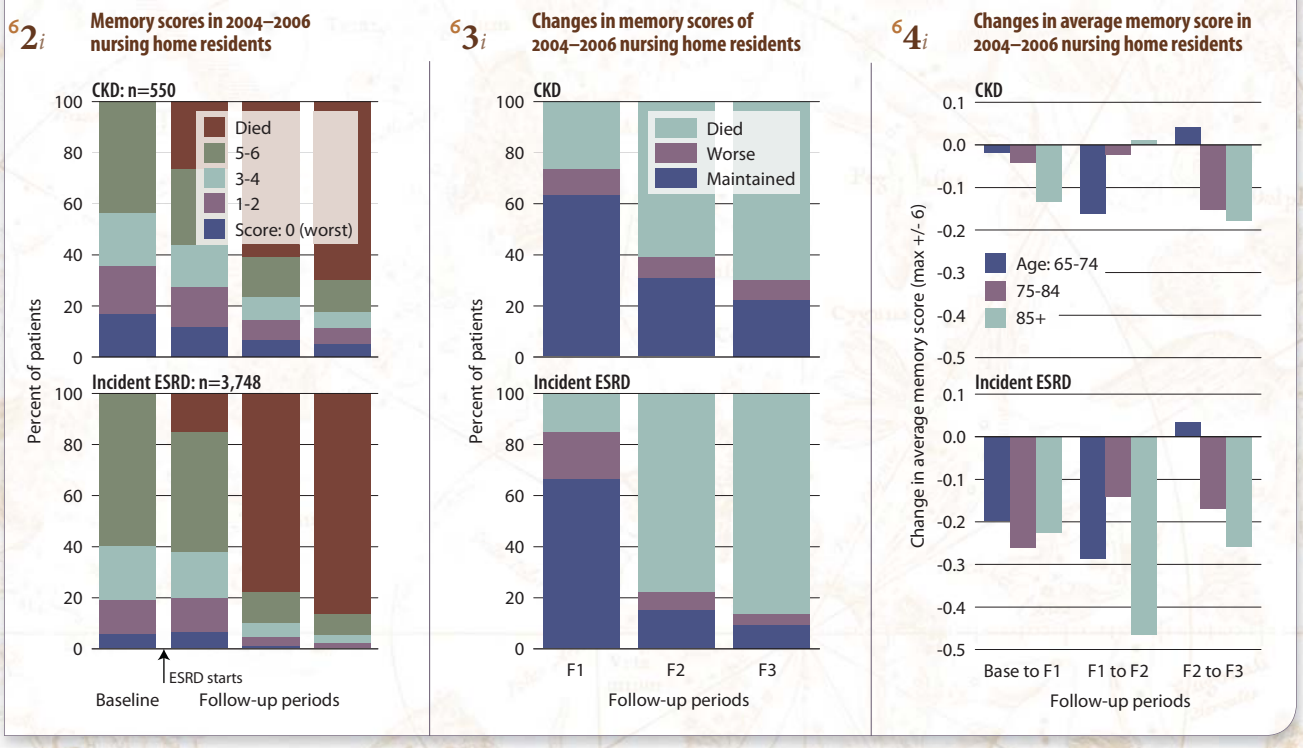
5.13i **Geographic variations in the percent of patients with CHF who do not receive medication for their condition, by state & CKD status, 2008**



5.14i **Geographic variations in the percent of patients with CHF who do receive medication for their condition, by state & CKD status, 2008**



MEMORY SCORES



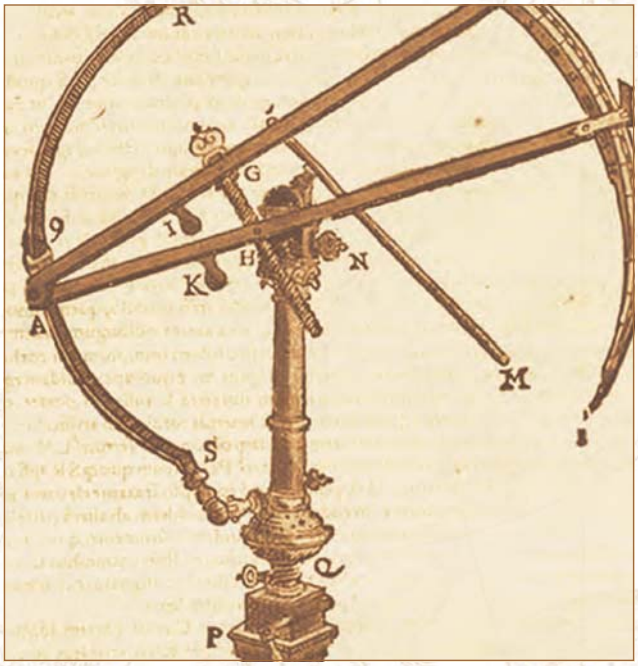
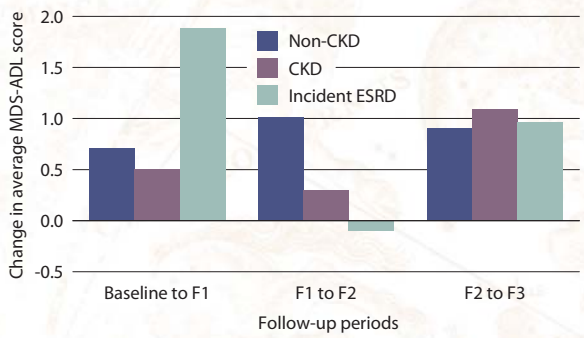


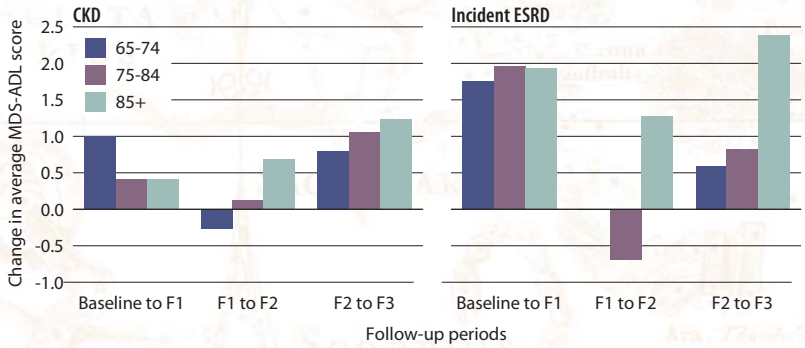
Figure 6.2 describes the percentage of nursing home residents with each memory score at baseline, before dialysis initiation, and at the three follow-up periods of approximately two, six, and twelve months. Baseline scores are somewhat higher in patients who go on to dialysis than in those who do not. The percentage with higher scores then declines most quickly for incident ESRD patients. Figures 6.3–4, depicting changes in scores, are the most telling. Twenty percent of ESRD patients have developed worse memory scores by the first follow-up, compared to 10 percent of those with CKD, and the average memory score declines substantially at each follow-up. ✣ **Figures 6.2–4**; see page 170 for analytical methods.

Nursing home residents with CKD or ESRD, 2004–2006. Follow-up periods: F1 ≈2 mo., F2 ≈6 mo., F3 ≈12 mo.

6 13i Changes in average Activity of Daily Living (ADL) scores in 2004–2006 nursing home residents, by kidney disease status



6 14i Changes in average Activities of Daily Living (ADL) scores in 2004–2006 nursing home residents, by age



6 ai Odds of maintaining physical function in 2004–2006 nursing home residents

	Follow-up 1		Follow-up 2		Follow-up 3	
	Odd ratio	CI	Odds ratio	CI	Odds ratio	CI
No CKD	Reference					
CKD	0.99	0.79-1.24	1.01	0.76-1.35	1.01	0.73-1.40
Incident ESRD	0.53	0.47-0.59	0.69	0.58-0.82	0.95	0.76-1.17
67-74	Reference					
75-84	0.83	0.73-0.95	0.86	0.70-1.05	0.82	0.65-1.04
85+	0.80	0.69-0.93	0.76	0.62-0.94	0.68	0.53-0.87
Male	Reference					
Female	1.03	0.93-1.15	0.89	0.76-1.04	0.91	0.76-1.10
White	Reference					
African American	1.01	0.88-1.16	1.11	0.91-1.36	1.02	0.81-1.29
Other	1.49	1.06-2.09	1.75	1.06-2.87	1.97	1.15-3.39

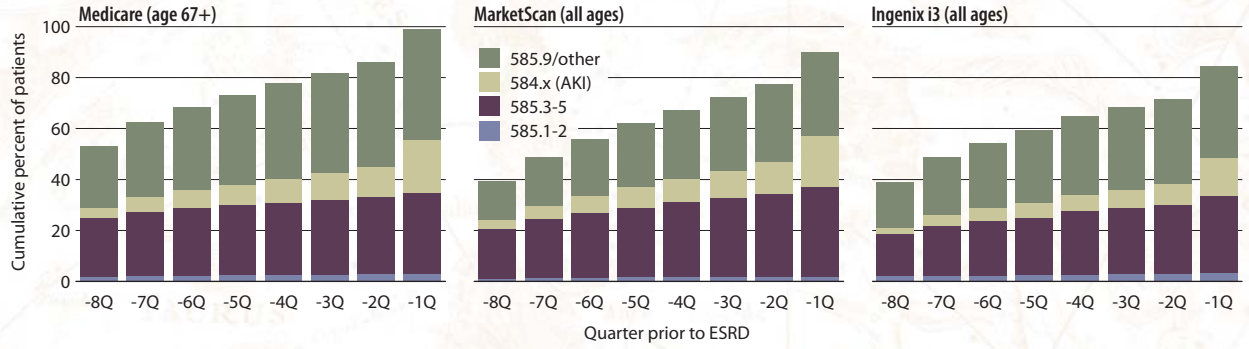
In the first follow-up period the change in mean ADL score, shown in Figure 6.13, is more than three times higher for ESRD patients than for those with CKD, though it stabilizes by the third follow-up period. This is likely due to a survival effect; those surviving the first six months are healthier and may have a greater functional reserve.

Figure 6.14 shows that only at the third follow-up is there a substantial age effect: those age 85 and older in the incident ESRD cohort experience a greater functional decline.

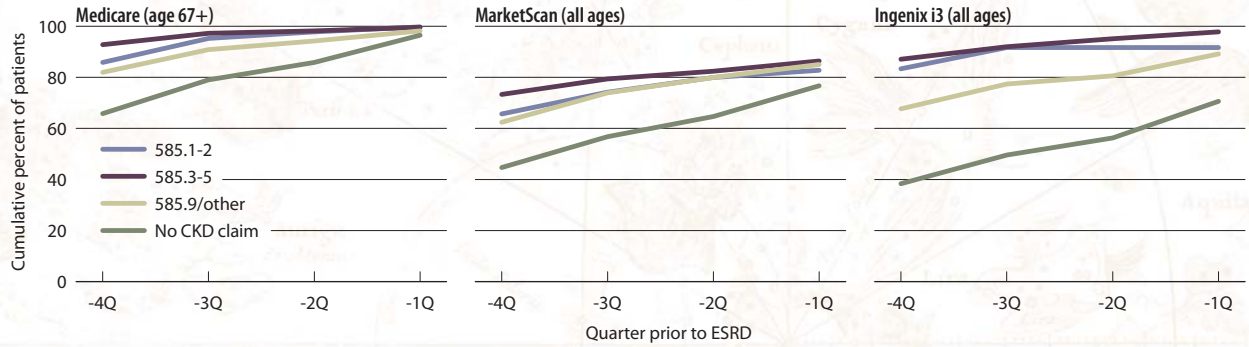
Newly-initiated dialysis patients are half as likely to maintain their physical function status at three months follow-up compared to non-CKD nursing home patients (Table 6.a). Age greater than 75 also increases the risk of functional decline, while race other than white or African American is protective.

✣ **Figures 6.13–14 & Table 6.a;** see page 170 for analytical methods. *Nursing home residents, 2004–2006. For Figures 6.13–14, changes greater than zero in average MDS-ADL scores indicate a worsening condition. Follow-up periods: F1 ≈2 mo., F2 ≈6 mo., F3 ≈12 mo.*

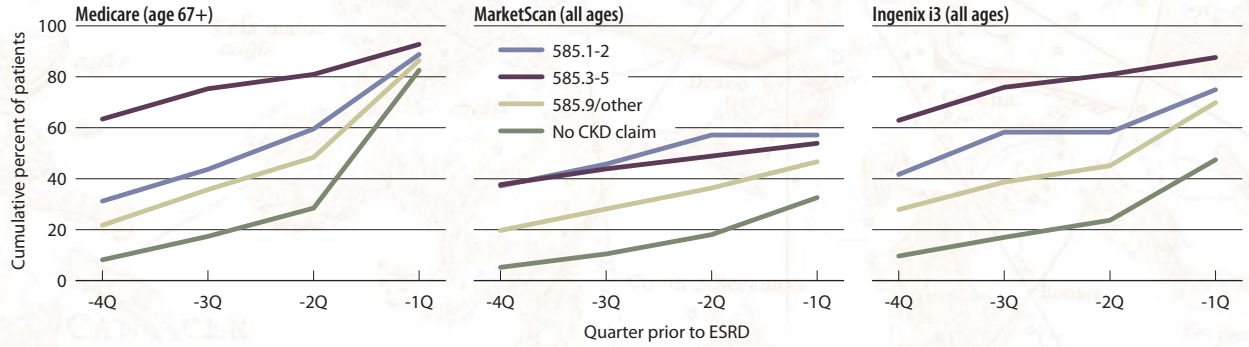
7.2i Cumulative percent of patients with a CKD claim prior to ESRD, by dataset & CKD diagnosis code, 2008



7.3i Cumulative percent of patients with a first physician visit in the year prior to ESRD, by dataset & CKD diagnosis code, 2008



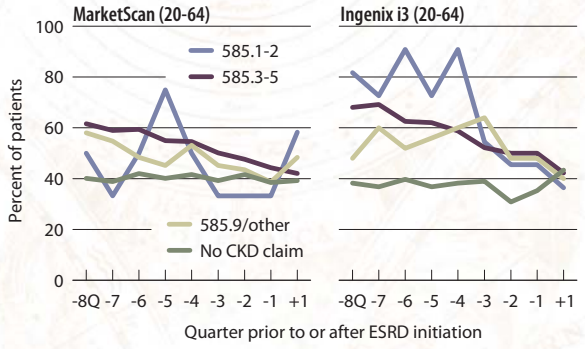
7.4i Cumulative percent of patients with a first nephrologist visit in the year prior to ESRD, by dataset & CKD diagnosis code, 2008



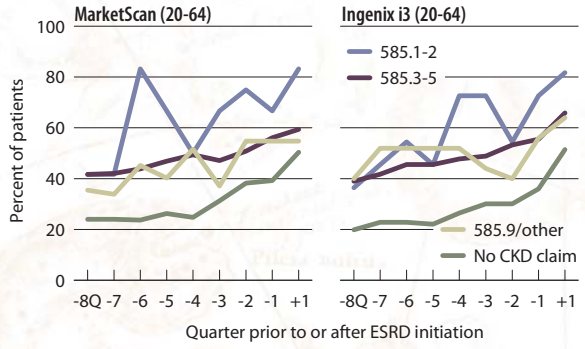
In 2008, the cumulative percentage of ESRD patients with a CKD claim in the quarter just prior to initiation reached 98.9 for Medicare patients age 67 and older, compared to 89.7 and 84.3, respectively, in the MarketScan and Ingenix i3 populations. In the Medicare population, nearly all patients with CKD had seen a physician — a nephrologist, cardiologist, or primary care specialist — by the end of the first quarter prior to ESRD, compared to 83–85 and 89–98 percent, respectively, of MarketScan and Ingenix i3 patients.

Medicare patients were more likely than their MarketScan or Ingenix i3 counterparts to see a nephrologist prior to ESRD. In the quarter just prior to initiation, for example, 93 percent of Stage 3–5 Medicare patients had visited a nephrologist, compared to 54 and 88 percent, respectively, in the MarketScan and Ingenix i3 populations. ✣ **Figures 7.2–4;** see page 171 for analytical methods. *Incident Medicare ESRD patients age 67 & older, & incident MarketScan & Ingenix i3 ESRD patients (all ages), 2008.*

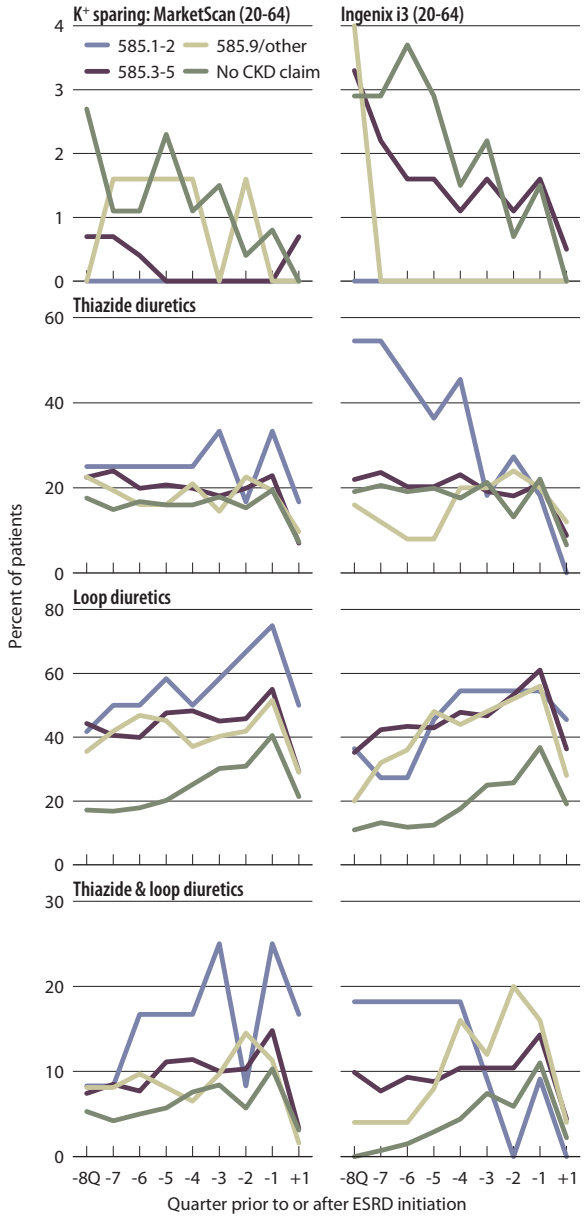
7.13i ACEI/ARB/renin inhibitor use during the transition to ESRD, by dataset & CKD diagnosis code, 2008



7.14i Beta blocker use during the transition to ESRD, by dataset & CKD diagnosis code, 2008



7.17i Use of diuretics during the transition to ESRD, by dataset & CKD diagnosis code, 2008



Among patients with recognized CKD of Stages 3–5 at eight quarters prior to ESRD, ACEI/ARB/renin inhibitor use falls from 62–68 percent to 42 percent in the quarter following ESRD diagnosis. For patients without a CKD code, in contrast, use remains at approximately 40 percent. The opposite pattern is seen with beta blockers, with use in Stage 3–5 CKD patients increasing from 40 to 59–66 percent. Beta blocker use is lower in patients without a CKD code at eight quarters prior to ESRD, rising from 20–24 percent at this point to 50 percent in the quarter after ESRD diagnosis; this may be explained by increasing rates of heart failure.

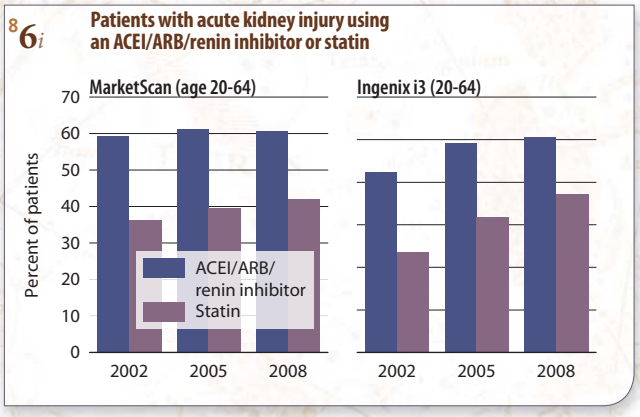
As expected, the use of potassium-sparing diuretics is very low in patients who have Stage 3–5 CKD eight quarters before ESRD, and use of thiazide diuretics falls from 18–23 percent to 7–10 percent by one quarter after diagnosis. Use of loop diuretics increases modestly until a precipitous drop at the initiation of ESRD therapy. While thiazide diuretics are generally ineffective alone at eGFRs less than 30 ml/min/1.73 m^2, they can augment the action of loop diuretics in patients with CKD of Stages 3–5. Among patients with Stage 3–5 CKD eight quarters prior to ESRD, or without a CKD code at this time, simultaneous use of these agents increases slightly as patients near ESRD, but only 10–15 percent are using dual diuretics one quarter prior to initiation. ✣ **Figures 7.13–14 & 7.17;** see page 171 for analytical methods. *Incident MarketScan & Ingenix i3 patients age 20–64.*

ICD-9-CM codes

585.1	Chronic kidney disease, Stage 1
585.2	Chronic kidney disease, Stage 2 (mild)
585.3	Chronic kidney disease, Stage 3 (moderate)
585.4	Chronic kidney disease, Stage 4 (severe)
585.5	Chronic kidney disease, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis.^)
585.9/oth.	Chronic kidney disease, unspecified

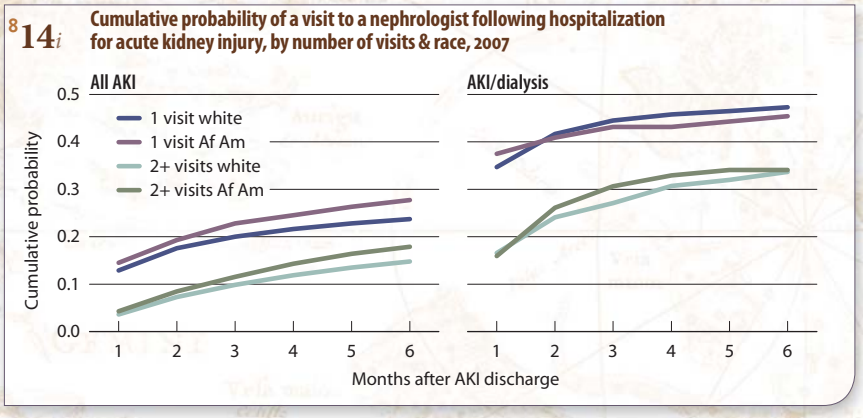
^ *In USRDS analyses, patients with ICD-9-CM code 585.6 are considered to have code 585.5; see Appendix A for details.*

CKD stage estimates are from a single measurement. For clinical case definition, abnormalities should be present ≥ 3 months.

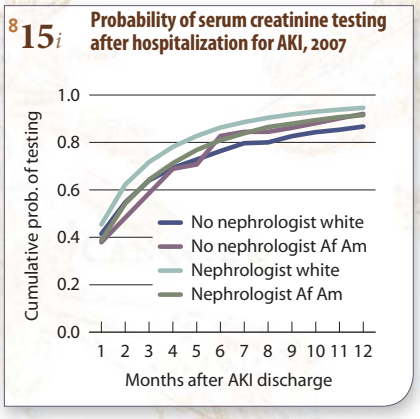


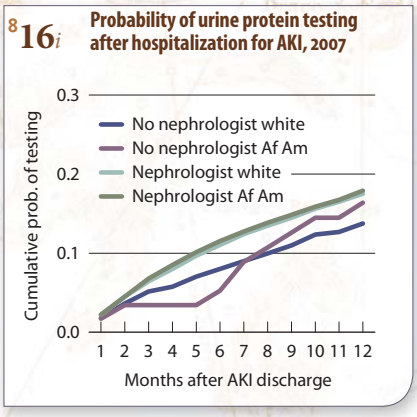
The percentage of MarketScan AKI patients using an ACE inhibitor, angiotensin receptor blocker, or renin inhibitor remained constant between 2002 and 2008, at 59–61 percent. Use of these medications in the Ingenix i3 population is slightly lower, but has increased from 42 to 50 percent.

Statin use has increased from 36.4 to 42.0 percent among MarketScan patients, and from 23.6 to 37.2 percent for those in the Ingenix i3 database. ✣ **Figure 8.6;** see page 172 for analytical methods. *MarketScan & Ingenix i3 AKI patients age 20–64.*



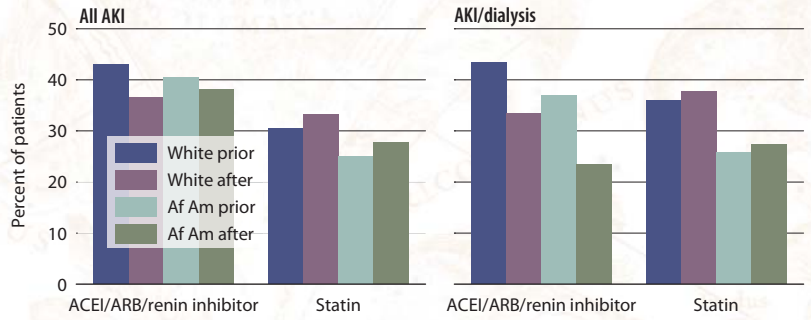
Twenty-eight percent of African Americans hospitalized for AKI visit a nephrologist within six months of discharge, compared to 24 percent of whites. There is a small difference by race for those whose AKI hospitalization requires dialysis, at 45 percent for African Americans and 47 percent for whites. ✣ **Figure 8.14;** see page 172 for analytical methods. *Medicare AKI patients age 66 & older, 2007.*



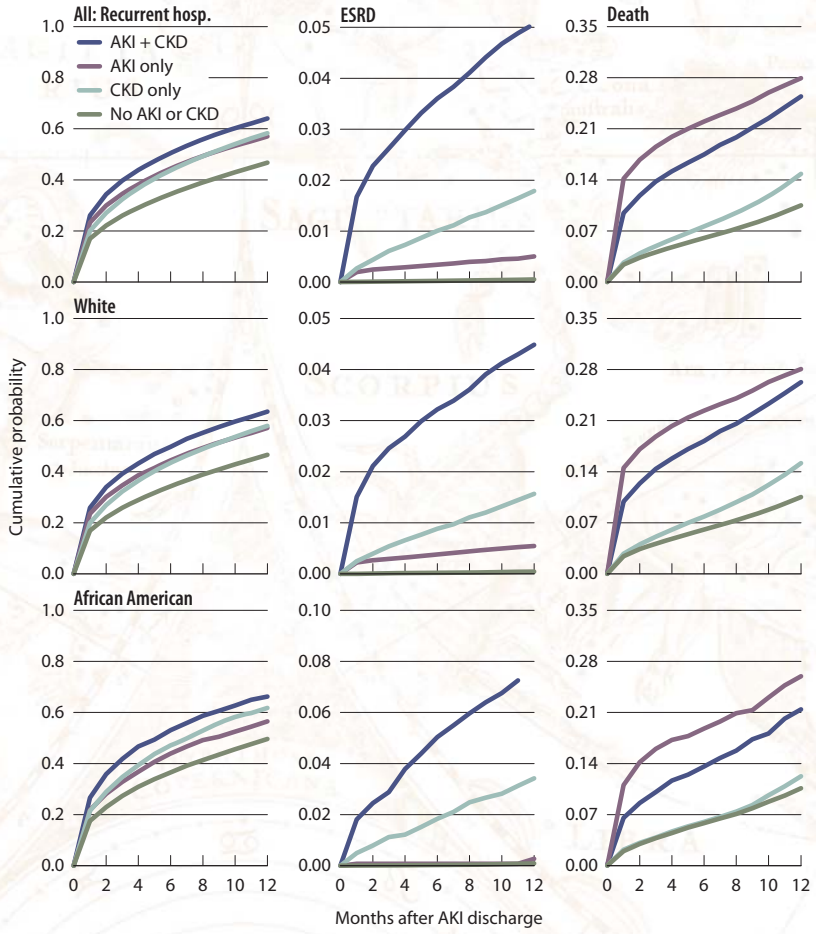


Only 42 percent of white patients who do not see a nephrologist post-AKI, and 38 percent of their African American counterparts, receive serum creatinine testing within the first month after an AKI hospitalization. These rates are only marginally influenced by a nephrologist visit in the same month, rising to 45 and 39 percent. Rates of testing for albuminuria/proteinuria following an AKI episode remain dismal, at less than 20 percent at the end of one year, irrespective of race or nephrologist care. ✣ **Figures 8.15–16;** see page 172 for analytical methods. *Medicare AKI patients age 66 & older, 2007.*

8 17*i* **Drug therapy prior to & after hospitalization for AKI, by race & type of drug, 2008**



8 18*i* **Probability of a recurrent hospitalization, ESRD, or death following hospitalization for AKI, by race, 2007**

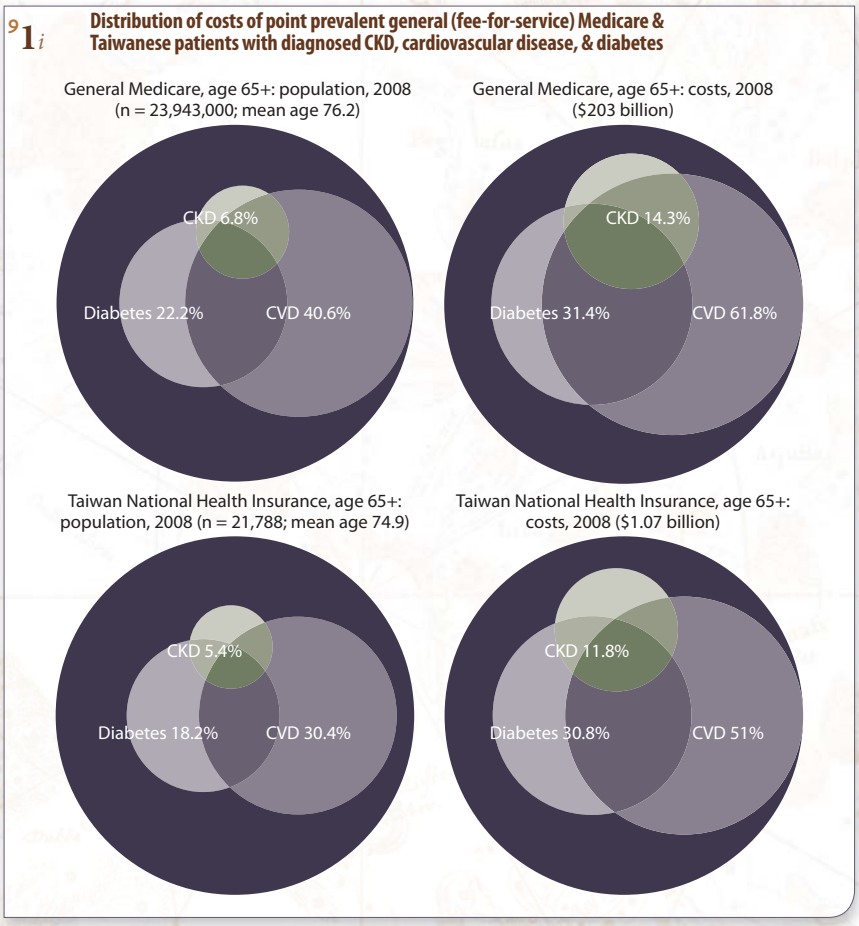


Individuals with an AKI episode, with or without dialysis, are more likely to have their ACEI/ARB/renin inhibitor discontinued during their hospitalization. A new and interesting observation this year is that the percentage of individuals using a statin increases during an AKI hospitalization. ✣ **Figure 8.17;** see page 172 for analytical methods. *Medicare AKI patients age 66 & older with Part D coverage, 2007.*

Individuals who survive an AKI hospitalization have a greater likelihood of a recurrent hospital admission during the next 12 months compared to those with no evidence of kidney disease (AKI or CKD), at 57 versus 47 percent. The presence of CKD in addition to AKI raises this likelihood to 64 percent.

Those surviving an AKI episode are also at risk of developing ESRD in the next year, a risk magnified by the presence of CKD prior to AKI. By race, the probability of ESRD is higher in African Americans than in whites, at 7.3 compared to 4.5 percent among those with a prior diagnosis of CKD.

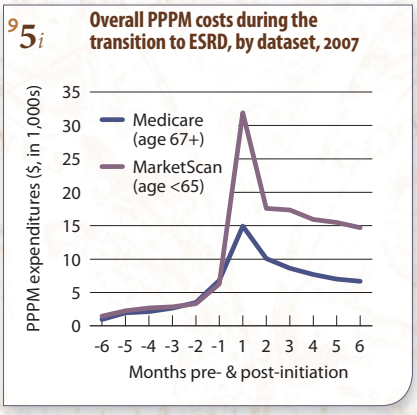
Twenty-eight percent of patients who survive an AKI hospitalization die within one year. The risk of death is elevated regardless of whether or not patients had pre-existing CKD, and is similar in African American and white patients. ✣ **Figure 8.18;** see page 172 for analytical methods. *Medicare AKI patients age 66 & older, 2007.*



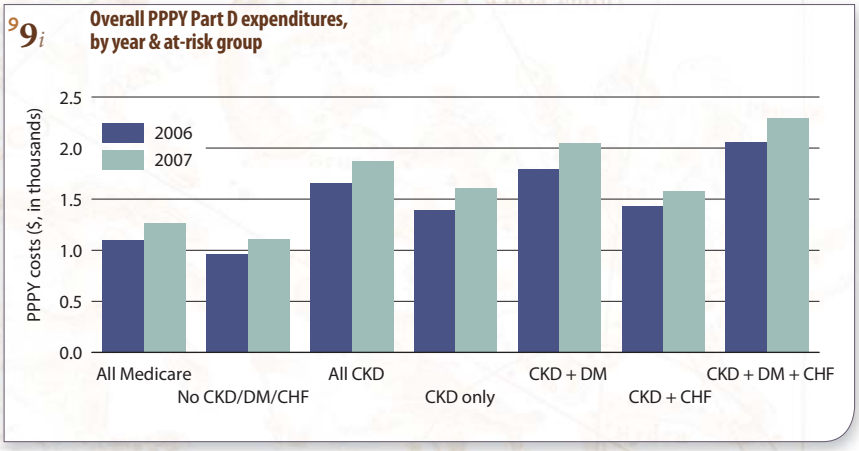
Here we compare data from Medicare and the Taiwan Bureau of National Health Insurance, which both use the Medicare billing format. Taiwan has universal healthcare coverage, which includes prescription medications. Both countries have some of the highest incidence and prevalence of ESRD in the world.

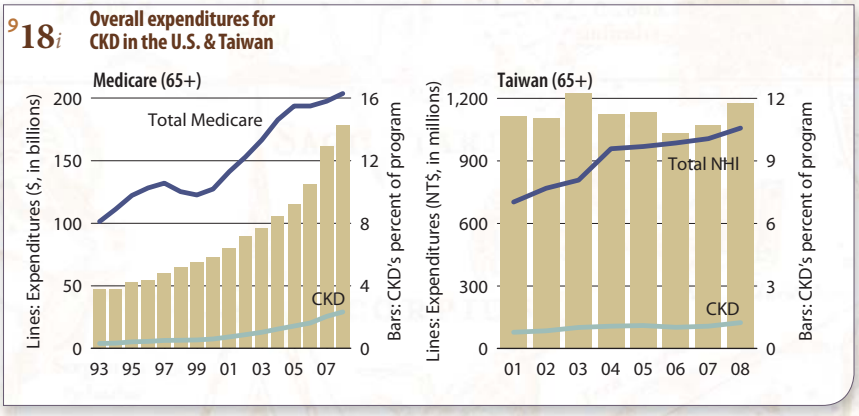
Diabetes is diagnosed in 22 and 18 percent of Medicare and Taiwanese patients, respectively, and CVD in 41 and 30 percent. (It is important to note that CVD in Taiwan is dominated by strokes, rather than the ischemic heart disease and congestive heart failure predominant in the U.S.) The CKD population recognized from diagnosis codes is also similar, at 6.8 and 5.4 percent. As mentioned elsewhere in the ADR, however, these numbers under-represent the total burden of CKD in older patients, suggesting that more advanced disease is being reported. The percentage of healthcare expenditures associated with CKD reaches 14 in the U.S., and 12 in Taiwan, illustrating the significant financial impact of the disease. ✣ **Figure 9.1;** see page 172 for analytical methods. *Point prevalent general (fee-for-service) Medicare patients, & point prevalent patients from the 1 percent Taiwan National Health Insurance sample, age 65 & older, without ESRD. Diabetes, CVD, & CKD determined from claims; costs are for calendar year 2008.*

Total per person per month (PPPM) costs in the month following ESRD initiation reached nearly $15,000 for Medicare patients in 2007, and $31,904 for those in the MarketScan program — 2.1 times greater. ✣ **Figure 9.5;** see page 173 for analytical methods. *Incident Medicare (age 67 & older) & MarketScan (younger than 65) ESRD patients, 2007.*

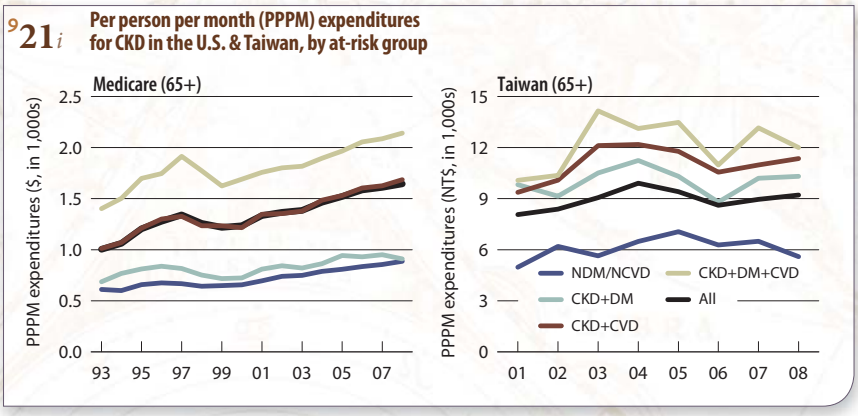


Between 2006 and 2007, average Medicare Part D net prescription drug costs per person per year (PPPY) rose 14.6 percent for general Medicare patients, and 12.9 percent for those with CKD. Costs for CKD patients, however, reached $1,874, compared to just $1,262 in the general Medicare population. Costs rise with patient complexity, reaching $2,049 for those with CKD and diabetes, and $2,294 for those with an additional diagnosis of congestive heart failure (CHF). ✣ **Figure 9.9;** see page 173 for analytical methods. *Point prevalent Medicare patients. Costs are estimated net pay: sum of plan payment & low income subsidy.*

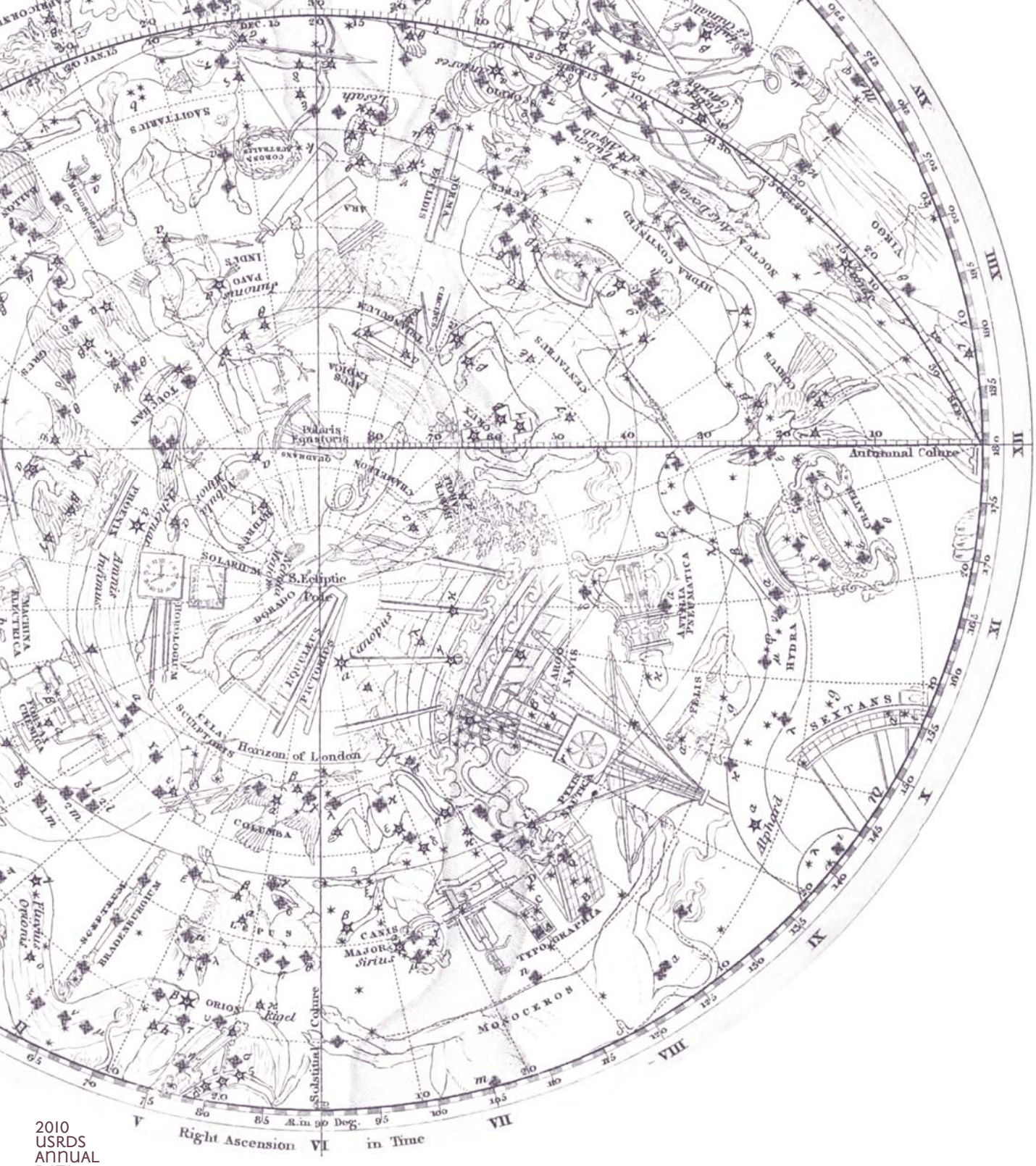




In 1993, costs for Medicare patients with CKD accounted for 3.8 percent of overall Medicare expenditures. By 2008, this had grown to 14.2 percent, in part reflecting growth in the number of recognized CKD patients. Costs for Taiwanese NHI patients with CKD, in contrast, have consistently accounted for 10–12 percent of total NHI expenditures since 2001. ✣ **Figure 9.18;** see page 173 for analytical methods. *Point prevalent Medicare patients age 65 & older, & point prevalent NHI patients age 65 & older.*



Compared to all Medicare patients, those with CKD and CVD have higher PPPM expenditures; costs are lower, in contrast, for those with CKD and diabetes but no CVD. In the Taiwan NHI database, multiplier effects are consistently shown for CKD patients with CVD, diabetes, or both. Uneven trends in the NHI data are due to the small size of the study sample. ✣ **Figure 9.21;** see page 173 for analytical methods. *Point prevalent Medicare & NHI patients age 65 & older.*



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