


The physical landscape is baffling in its ability to transcend whatever we would make of it. It is as subtle in its expression as turns of the mind, and larger than our grasp; and yet it is still knowable. The mind, full of curiosity and analysis, disassembles a landscape and then reassembles the pieces — the nod of a flower, the color of the night sky, the murmur of an animal — trying to fathom its geography. At the same time the mind is trying to find its place within the land, to discover a way to dispel its own sense of estrangement.

**BARRY LOPEZ,**  
*Arctic Dreams*





# 2012

volume one

## **USRDS Annual Data Report**

### Atlas of Chronic Kidney Disease in the United States

national institutes of health  
national institute of diabetes & digestive & kidney diseases  
division of kidney, urologic, & hematologic diseases

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Walk away quietly in any direction and taste the freedom of the mountaineer. Camp out among the grasses and gentians of glacial meadows, in craggy garden nooks full of nature's darlings. Climb the mountains and get their good tidings, Nature's peace will flow into you as sunshine flows into trees. The winds will blow their own freshness into you and the storms their energy, while cares will drop off like autumn leaves. As age comes on, one source of enjoyment after another is closed, but nature's sources never fail.

JOHN MUIR,  
*Our National Parks*

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# volume one highlights

## patients

- 6.7% prevalence of eGFR <60 in NHANES 2005–2010 participants (CKD-EPI formula; Table 1.a)  
*among those with self-reported diabetes: 20.4%*  
*» among those with cardiovascular disease: 27.9%*
- 9.4% prevalence of ACR ≥30 in NHANES 2005–2010 participants (Table 1.a)  
*among those with self-reported diabetes: 30.8%*  
*» among those with cardiovascular disease: 24.3%*
- 9.2% prevalence of recognized CKD in Medicare patients age 65 & older, 2010 (Table 2.b & Figure 2.2)  
*white: 8.8% » black/African American: 13.7%*

## patient care

- 85% hypertension among NHANES 2005–2010 participants with eGFR <60 (CKD-EPI formula; Table 1.b)
- 32% NHANES 2005–2010 participants with eGFR <60 whose hypertension is treated & controlled (CKD-EPI formula; Table 1.b)
- 81% hyperlipidemia among NHANES 2005–2010 participants with eGFR <60 (Table 1.b)
- 27% NHANES 2005–2010 participants with eGFR <60 whose hyperlipidemia is treated & controlled (Table 1.b)
- 42% NHANES 2005–2010 participants with diabetes & eGFR <60 whose diabetes is uncontrolled (Table 1.b)
- 0.6 cumulative probability of a nephrologist visit at month 12 after a CKD diagnosis of 585.3 or higher, 2010: Medicare patients age 65+ (Table 2.h)
- 0.56 cumulative probability of a nephrologist visit at month 12 after a CKD diagnosis of 585.3 or higher, 2010: MarketScan patients age 50–64 (Table 2.h)

## outcomes

- 432 adjusted hospitalization rate in white Medicare CKD patients age 66 & older, 2010 (admissions per 1,000 patient years; Figure 3.3)  
*Stage 1-2: 371 » Stage 3: 430 » Stage 4-5: 596*
- 481 adjusted hospitalization rate in black/African American Medicare CKD patients age 66 & older, 2010 (admissions per 1,000 patient years; Figure 3.3)  
*Stage 1-2: 395 » Stage 3: 470 » Stage 4-5: 598*
- 78 adjusted mortality rate in white Medicare CKD patients age 66 & older, 2010 (deaths per 1,000 patient years; Table 3.c)  
*Stage 1-2: 55 » Stage 3: 70 » Stage 4-5: 121*
- 71 adjusted mortality rate in black/African American Medicare CKD patients age 66 & older, 2010 (deaths per 1,000 patient years; Table 3.c)  
*Stage 1-2: 80 » Stage 3: 67 » Stage 4-5: 91*

## expenditures

- \$4.5 billion total net Part D payment for Medicare enrollees with CKD, 2010 (Figure 5.9)
- \$3,843 per person per year Medicare Part D costs for enrollees with CKD, 2010 (Figure 5.10)
- \$738 per person per year out-of-pocket Part D costs for enrollees with CKD, 2010 (Figure 5.1)
- \$41 billion total Medicare expenditures for CKD, 2010 (Figure 7.5)  
*Non-Part D: \$37.7 billion » Part D: \$3.3 billion*
- \$22.1 billion Medicare expenditures for patients with CKD & diabetes, 2010 (Figure 7.6)  
*Non-Part D: \$20.0 billion » Part D: \$2.1 billion*
- \$19.4 billion Medicare expenditures for patients with CKD & congestive heart failure, 2010 (Figure 7.7)  
*Non-Part D: \$18.1 billion » Part D: \$1.4 billion*
- \$22,323 per person per year expenditures for CKD patients in the general Medicare population, 2010 (includes Part D; Figure 7.8)  
*non-DM/non-CHF: \$15,607  
» CKD + DM + CHF: \$37,490*

# chronic kidney disease (CKD) IN THE UNITED STATES

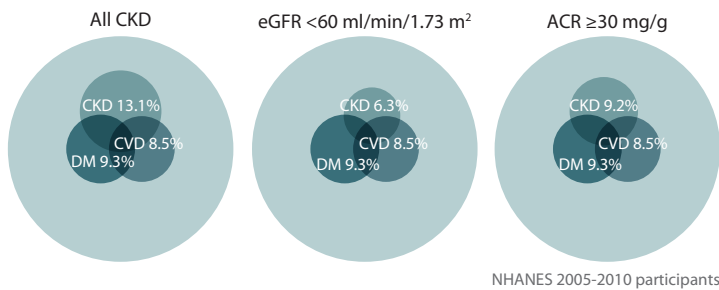
**February 2002:** the National Kidney Foundation introduces a five-stage classification system for chronic kidney disease based on an estimated glomerular filtration rate (eGFR), calculated from serum creatinine levels and levels of proteinuria, and using data from the National Health and Nutrition Examination Survey (NHANES).

## CKD STAGE MARKERS

- 1 eGFR  $\geq 90$  ml/min/1.73 m<sup>2</sup>, albumin/creatinine ratio (ACR)  $\geq 30$  mg/g
- 2 eGFR 60–89, ACR  $\geq 30$
- 3 eGFR 30–59
- 4 eGFR 15–29
- 5 eGFR  $< 15$

Diabetes, congestive heart failure (CHF), and CKD are three interrelated chronic diseases of clear public health relevance.

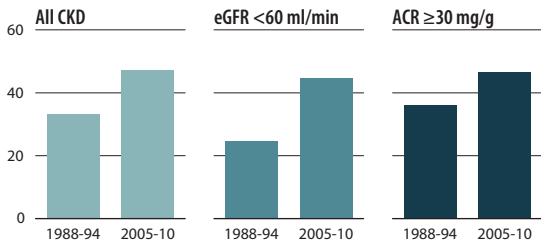
eGFR  $< 60$  ml/min/1.73 m<sup>2</sup> and high ACR are associated with older age, diabetes, hypertension, and cardiovascular disease.



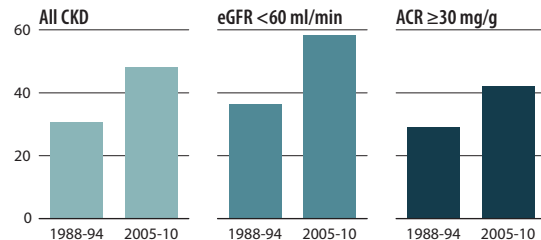
% with CKD	eGFR $< 60$		ACR $\geq 30$ mg/g	
	1988–94	2005–10	1988–94	2005–10
60+	19.5	24.1	18.3	18.4
Diabetes	15.6	19.3	36.3	29.9
Self-reported diabetes	16.4	20.4	35.9	30.8
Hypertension	10.4	12.9	15.4	14.8
Self-reported hypertension	12.9	15.6	17.1	16.7
CVD	14.5	27.9	16.6	24.3
BMI $\geq 30$	6.2	7.4	12.3	11.7

## Control of risk factors for CKD

Percent of NHANES participants at target blood pressure ( $< 130/ < 80$  for those with CKD and diabetes; otherwise  $< 140/ < 90$ )



Percent of NHANES participants with glycohemoglobin (A1c)  $< 7\%$



New ICD-9-CM stage-specific codes for CKD were introduced in the fall of 2005, providing opportunities to use different datasets — like those from employer group health plans (EGHPs) — to track younger populations with reported diagnosis codes over time.

### 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

EGHP patients are much younger than Medicare patients.

### MEAN AGE

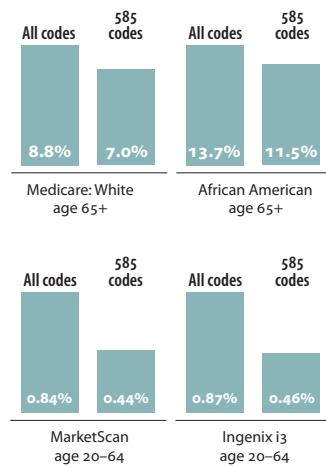
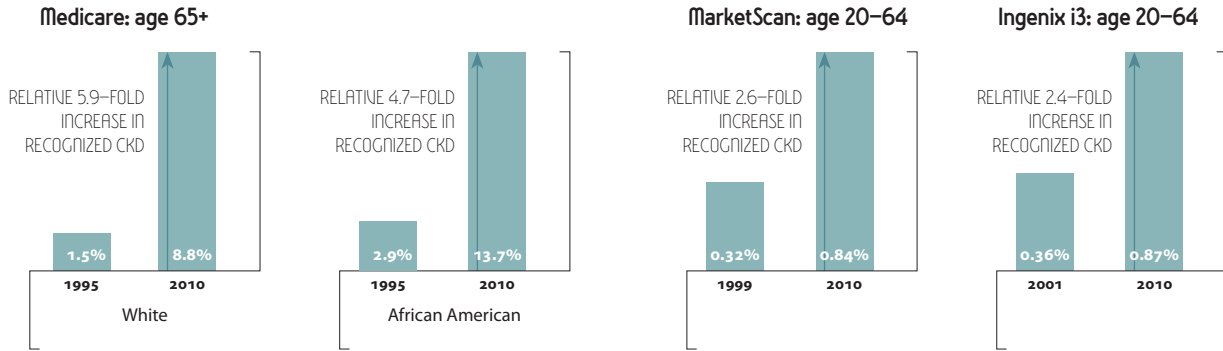
75.0  
MEDICARE  
44.3  
MARKETSCAN  
42.9  
INGENIX I3

CKD is recognized more frequently in Medicare patients age 65 and older than in the Ingenix i3 and MarketScan populations, age 20–64.

### RECOGNIZED CKD

	Medicare	MarketScan	Ingenix i3
20–44		0.4%	0.4%
45–54		0.8%	0.9%
55–64		1.8%	2.0%
65–74	6.5%		
75–84	11.2%		
85+	14.5%		

The prevalence of recognized CKD has increased significantly since 1995.



CKD can be underrecognized when using only stage-specific codes to estimate its prevalence.

**URINE ALBUMIN TESTING** can detect early signs of **KIDNEY DAMAGE** in patients at risk for CKD

**PROBABILITY OF TESTING IN 2010**

- 10%** All patients
- 34%** Patients with diabetes (no hypertension)
- 5%** Patients with hypertension (no diabetes)
- 36%** Patients with both diabetes and hypertension

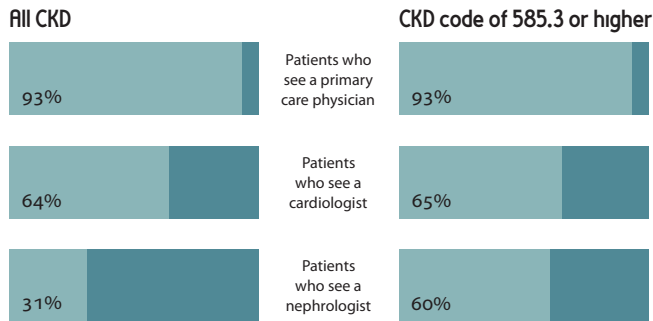
In patients with **DIABETES, HYPERTENSION, OR CARDIOVASCULAR DISEASE**, the odds of a CKD diagnosis code are **2-4 TIMES HIGHER** than in patients without these conditions.

Medicare	Adjusted odds of a CKD diagnosis	MarketScan
2.1	Diabetes	3.2
3.7	Hypertension	3.3
2.4	Cardiovascular disease	2.7

Prevalence of CKD: Figures 2.2-4  
 Recognition of CKD: Figures 2.2-4  
 Urine albumin testing: Figure 2.5  
 Odds of CKD diagnosis: Table 2.f

# chronic kidney disease (CKD) IN THE UNITED STATES

Medicare patients age 65 and older are **twice** as likely to see a **cardiologist** as a **nephrologist** following any diagnosis for **CKD**. Among patients with a CKD diagnosis of **Stage 3** or higher, approximately **two-thirds** see either a **cardiologist** or **nephrologist**.

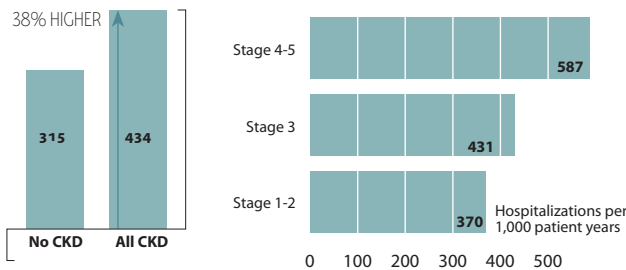


**Acute kidney injury** is highly associated with age, & its reported prevalence (%) has increased significantly

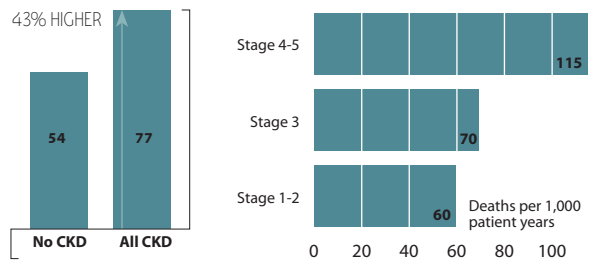
	Medicare 2000	MarketScan 2010	Ingenix i3 2001	Ingenix i3 2010
20-44		0.11	0.6	0.63
45-54		0.36	1.71	1.83
54-64		1.00	4.07	4.19
66-69	3.1	13.6		
70-74	4.1	18.1		
75-79	5.7	24.9		
80-84	6.7	34.2		
85+	8.2	46.9		
White	2.9	6.2		
Black/Af Am	24.3	44.2		

adjusted all-cause **HOSPITALIZATION AND MORTALITY RATES** are **HIGHER IN CKD PATIENTS** than in those without the disease

## Hospitalization rates



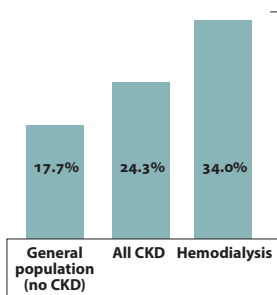
## Mortality rates



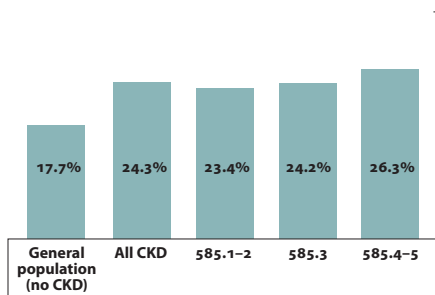
adjusted rates of **REHOSPITALIZATION** are also **HIGHER IN CKD PATIENTS** than in those without the disease

Patients rehospitalized within 30 days of a live hospital discharge (age 66 & older)

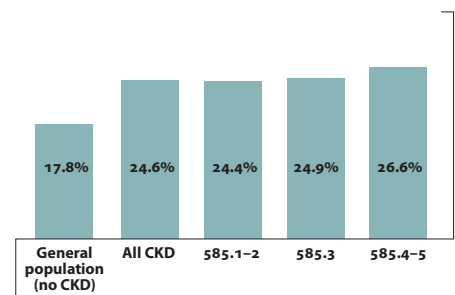
## All-cause rehospitalization



## Rehospitalization after all-cause index hospitalization

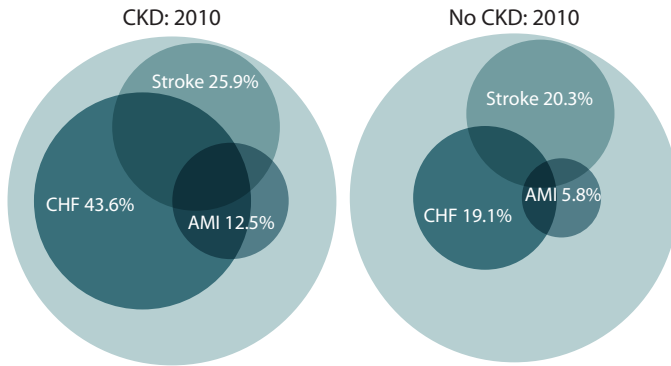


## Rehospitalization after cardiovascular index hospitalization





Patients with CKD carry a larger burden of cardiovascular disease than those without CKD.



52% of CKD patients with CHF receive an **ACEI/ARB**

66% of CKD patients with CHF receive a **BETA BLOCKER**

55% of CKD patients with a stroke receive a **STATIN**

78% of CKD patients with AMI receive a **BETA BLOCKER**

### JANUARY 1, 2006: MEDICARE PART D GOES INTO EFFECT

to help subsidize the costs of prescription drugs in Medicare beneficiaries

**DAYS SUPPLY** top three drug classes used by Part D enrollees with CKD

203 million diuretics (7.7%)  
 192 million statins (7.3%)  
 142 million beta blockers (5.4%)

20.4% of total Medicare Part D drug use in 2010

**COSTS** top three drug classes used by Part D enrollees with CKD

\$360 million insulin (7.9%)  
 \$297 million antipsychotics (6.5%)  
 \$244 million antiplatelet drugs (5.6%)

20.0% of total Medicare Part D drug costs in 2010

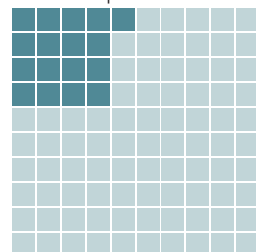
NET PART D COSTS FOR MEDICARE CKD PATIENTS IN 2010

**\$4.53 BILLION**

### Costs of caring for patients with CKD in 2010

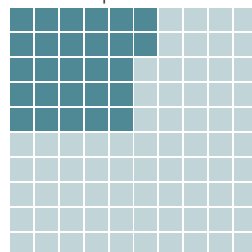
(fee-for-service Medicare patients age 65 & older)

Overall, CKD patients account for 17% of total Medicare expenditures



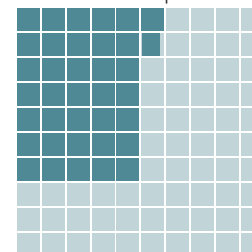
CKD: \$41 billion  
 Medicare total: \$241 billion  
 1%

CKD patients with diabetes account for 27% of Medicare diabetes expenditures



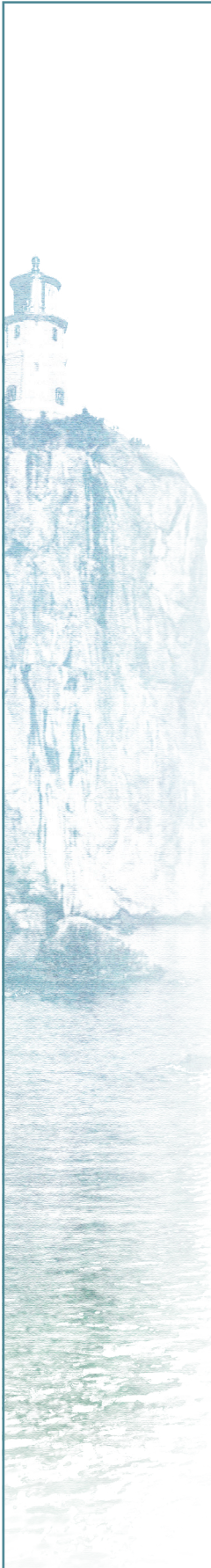
CKD + diabetes: \$22.1 billion  
 Medicare diabetes: \$81.4 billion

CKD patients with congestive heart failure account for 37% of Medicare CHF expenditures



CKD + CHF: \$19.4 billion  
 Medicare CHF: \$52.8 billion

Circle diagram: Figure 4.1  
 Medication use: Table 4.b  
 Medication frequency & costs: Figure 5.16  
 Total Part D costs: Figure 5.9  
 Costs of patient care: Figure 7.5-7



**T**his is the twenty-fourth annual report of the United States Renal Data System, and the thirteenth

in our atlas series. For the fifth year we include a volume on chronic kidney disease (CKD), defining its burden in the general population, and looking at cardiovascular and other comorbidities, adverse events, preventive care, prescription medication therapy, and costs to Medicare and employer group health plans. In Volume Two we provide information on the size and impact of the end-stage renal disease (ESRD) population — the traditional focus of the USRDS — presenting an overview of the ESRD program, along with detailed data on incidence, prevalence, comorbidity of new ESRD patients, severity of disease, clinical care, hospitalization and mortality rates, pediatric patients, renal transplantation, the provider delivery system, the economics of the ESRD program, and international comparisons. In Chapter Ten of Volume Two we also present new data on changes to patient care after the introduction of the bundled payment system in January, 2011.

This year's ADR presents data on the breadth of kidney disease and its impact on both individuals and society as a whole. Increased attention has been given recently to CKD, its progression to more advanced stages, and, most importantly, its high rates of adverse events, including death and end-stage renal disease. From a public health perspective, core issues center on prevention and on the preservation of kidney function over time.

To punctuate these issues, we turn this year to one of the most important preservation initiatives in the United States: the national parks. Yellowstone National Park, considered the first such park in the world, was established by an act signed

by President Ulysses S. Grant on March 1, 1872; on August 25, 1916, President Woodrow Wilson signed an act creating the National Park Service. The parks, which preserve the national history of the United States' most treasured sights and geographic locations, are visited by millions of Americans and foreign visitors each year, and often serves as spiritual places in which people may pause to consider how precious life is and the challenges faced in maintaining it.

In this ADR we reflect on the implications of kidney disease and on how this organ system can have such a widespread impact on health: on the functioning of the heart, brain, and nervous system, on hormonal balance, on bone and mineral metabolism, and on anemia and our ability to resist infections. The replacement of kidney function through a kidney transplant is certainly a new beginning, but it too has its challenges, not the least of which is preserving the function of the transplanted kidney over time.

The emotional implications of life with kidney disease are substantial, and relate not only to the physical elements of the disease but to the enormous stresses of financial issues and the impact on personal relationships. Understanding these broad implications, we hope that the emotional connections realized when viewing the breathtaking landscapes preserved in the national parks help give readers a broader perspective on the disease.

We approach Volume One from the perspective that the implications of CKD were underappreciated prior to February, 2002, when a new CKD classification staging system was proposed. The five-stage system was developed using population-level data from the National Health and

Nutrition Examination Survey (NHANES), a surveillance system coordinated by the National Center for Health Statistics at the Centers for Disease Control and Prevention. The conceptual model of this system was based on similar approaches for populations at risk for diabetes and hypertension, two well-known diseases that damage the kidney as well as other organ systems. The model characterizes progressive stages of CKD, from early evidence of kidney damage — such as albumin in the urine — to overt reductions in the filtering capacity of the kidney, defined by the estimated glomerular filtration rate (eGFR).

There are many issues related to defining the levels of eGFR and urine albumin that indicate “true disease” in the kidney during the early stages of CKD, versus what is considered normal reduction in kidney filtering capacity. This is particularly challenging in the elderly. Improving on the method to define glomerular filtration, a new estimating formula — the CKD-EPI equation — was published in the *Annals of Internal Medicine* in May, 2009. In the past two ADRS we have compared the initial Modification of Diet in Renal Disease (MDRD) formula and the CKD-EPI equation, providing important insight into improvements in defining risk and disease burden. Since the CKD-EPI method has proven to have superior characteristics, we now use only this method in the ADR.

While the USRDS and others will continue to investigate these issues in both the clinical and public health arenas, already there are important data available on the impact of CKD, data based both on biochemical information and on the definition of the disease within the Medicare and health plan datasets. The impact of the CKD staging system as a predictor of morbidity and mortality is now well known on a population level, but its translation into the care of individual patients must continue to evolve to help clinicians provide the best care to their patients affected by kidney disease.

In the Précis we highlight some of the most important data from the chapters, and address the burden of CKD — an area of major public policy and public health concern. In Chapter One we then define the CKD population, using NHANES data to examine how chronic conditions such as diabetes and cardiovascular disease interact with CKD in a random sample of the U.S. population. We show trends in risk groups, assess improvements in the awareness, treatment, and control of hypertension, diabetes, and lipid disorders, and conclude by looking at the impact of reduced kidney function on life expectancy.

Using data from the Medicare claims system and the employer group health plan datasets, we present data on identification and care of CKD patients in Chapter Two. We first summarize basic descriptive and comorbidity information from the major datasets used by the USRDS — the 5 percent Medicare sample, which includes individuals age 65 and older, and

the MarketScan and Ingenix i3 databases, with employed populations that are 20 years younger. We then illustrate that while the identification of CKD is increasing in the health plan datasets, particularly for Stage 3, recognized disease in these datasets remains less than the actual burden shown in the NHANES estimates. Rates of testing for evidence of kidney disease, using serum creatinine and urine albumin tests in high-risk groups, are far lower than needed — a major concern.

We conclude the chapter by looking at the likelihood of receiving nephrologist care after a CKD diagnosis, and at prescription drug therapy among patients with CKD.

In Chapter Three we address morbidity and mortality among patients with CKD. We compare hospitalization and rehospitalization rates in CKD and non-CKD patients, giving particular attention to rehospitalization patterns related to the primary condition of the first event. Interestingly, CKD patients not only have higher overall hospitalization rates than those seen in the general population, but their rehospitalization rates are higher as well. These rates accelerate as patients progress toward ESRD, reflecting increasing complications which are challenging to manage on an outpatient basis. We conclude the chapter with data on mortality rates by CKD stage and across risk groups.

Cardiovascular disease in the CKD population is the focus of Chapter Four, in which we evaluate, by CKD stage, major cardiovascular diagnoses, types of evaluations, adverse events and interventions, and the broad area of medication use. Data on Part D prescription drug therapy address recommended therapies for major cardiovascular diagnoses and for patients receiving certain revascularization procedures.

This year’s chapter on Medicare Part D prescription drug use again defines the populations using the benefit, and looks at various types of coverage, including the low income subsidy (LIS). We begin by showing the top fifteen medications used by CKD patients, reflecting the totality of the disease burden faced by this population. We then look at enrollment patterns in the general Medicare, CKD, and ESRD populations with Part D coverage, and present data on monthly premiums, deductibles, gap coverage, and copayments.

Acute kidney injury is a condition with implications beyond the immediate event. In Chapter Six we bring back our examination of AKI, exploring trends in AKI hospitalization with and without the use of dialysis. We look at racial disparities, an area of major concern, at the medical conditions occurring with the AKI event, and at data on recurrent AKI events. We then focus on physician care after an event, at prescription drug therapy, and on changes in CKD stage.

Chapter Seven addresses the costs associated with CKD. We look at the relative burden of CKD versus other major chronic diseases such as diabetes and congestive heart failure, at per

*continued on page 22*

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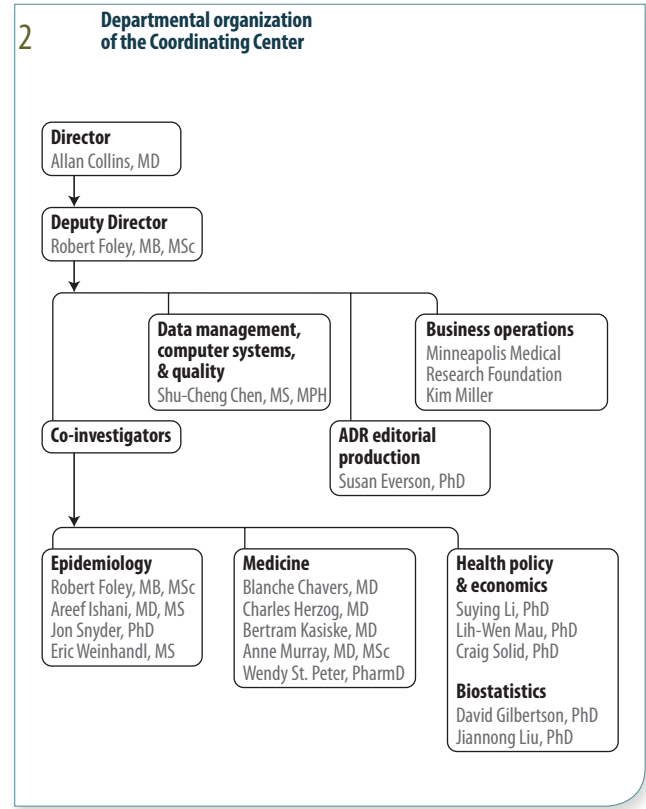
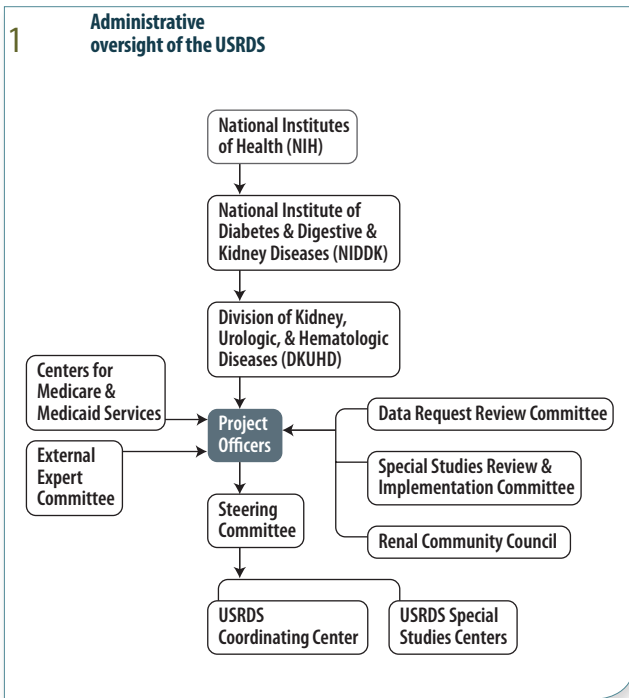
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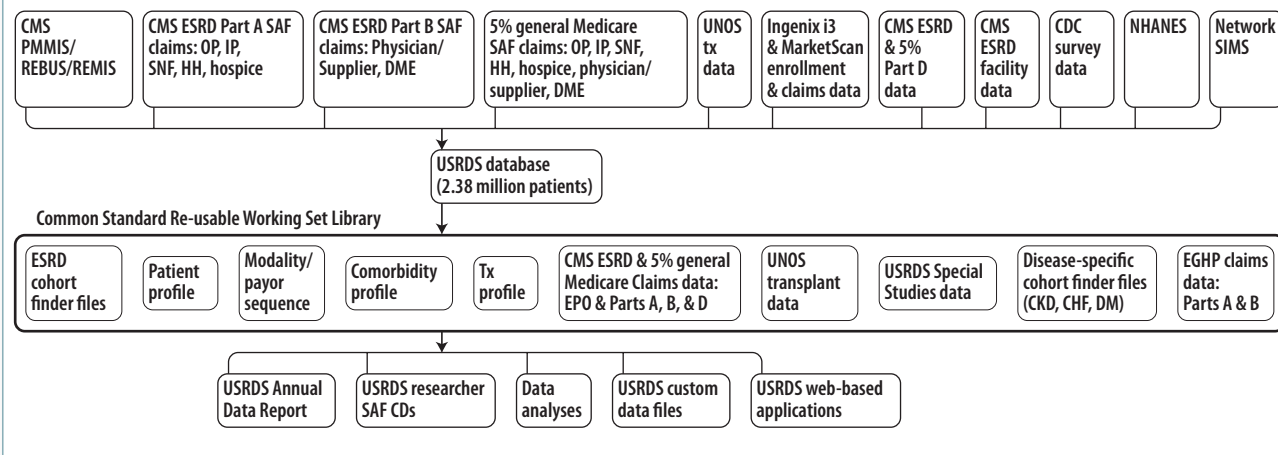
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### 3 Structure of the USRDS database



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person per year costs, at costs by CKD stage and for Part D prescription drugs, and at the impact of the low income subsidy.

Data in this volume illustrate the challenges that CKD, its complications, and its costs pose to the healthcare system, policy makers, and individuals and families facing this condition. Programs to detect CKD — some ongoing since 2000 — have been initiated by the CDC and by non-profit patient organizations. By their nature, detection programs are broad-based approaches to define, through the use of simple tests, populations at risk of a disease or its complications, targeting individuals for detailed evaluation and intervention. The data we present here indicate that the CKD population is under-recognized, and that care of CKD patients is less than expected based on clinical practice guidelines; both issues may contribute to the increased morbidity and mortality of this high-risk population.

Begun in 2010, the CKD education benefit is intended to improve access to care, modality selection, consideration of home therapies, access to preemptive transplant, vascular access planning, management of risk factors, and referral to nephrologists and nutritional counseling for those with Stage 4 CKD. We plan to fully evaluate the implementation of the CKD education benefit in the 2013 ADR, when data are available for its first 18 months (codes for services were implemented in July, 2010).

The *Researcher's Guide*, USRDS database, and USRDS administrative oversight are described in the introduction to Volume Two.

Maps in the ADR present data divided into quintiles. In the sample map here, for example, approximately one-fifth of all data points have a value of 10.8 or above. Ranges include the number at the lower end of the range, and exclude that at the upper end (i.e., the second range here is 8.2–<9.2). To facilitate comparisons of maps for different periods, we commonly apply a single legend to each map in a series. In this case the data in each individual map are not evenly distributed, and a map for a single year may not contain all listed ranges. Numbers in the first and last boxes indicate the mean values of data points in the highest and lowest quintiles.

The Excel page for each map (on our website and CD-ROM) includes additional data. The map-specific mean is calculated using only the population included in the map; this does not usually match other data in the ADR, and should be quoted with caution. The overall mean includes all patients for whom data are available, whether or not their residency is known. We also include the number of patients excluded in the map-specific mean, and the total number of patients used in the calculation.

**Throughout the ADR, with the exception of NHANES data, CKD cohorts exclude ESRD patients.**

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