Chapter Three
Economics of Chronic Kidney Disease

Chronic kidney disease imposes a significant burden of suffering. Modest decreases in quality of life can be identified in even moderate stages of CKD.[1,2] Further, many patients experience marked decreases in their quality of life from the comorbid conditions that can be created or exacerbated from CKD.[3,4] Beyond the effects on personal well-being, CKD imposes significant financial costs on individuals and the overall health care system.

Because CKD patients often have multiple chronic conditions, it is often difficult to identify the cost increases resulting from CKD alone. Indeed, a number of studies have found that the comorbidities have a multiplicative effect; a given comorbidity often leads to larger cost increases among CKD patients than among non-CKD patients.[5] Furthermore, the systematic underdiagnosis of early CKD also is problematic in developing estimates.

Despite these difficulties, researchers have tried to develop cost estimates because they have recognized that understanding the economic costs imposed by chronic kidney disease is critical to developing strategies to decrease the burden of CKD. In order to develop population-based cost estimates, it is necessary to develop prevalence estimates for all stages of CKD. The more accurate prevalence estimates are those based on populations systematically tested for CKD. For example, the National Health and Nutrition Examination Survey (NHANES) is a national survey that performs serum creatinine measurements on all respondents. Because NHANES collects creatinine data, it is possible to calculate estimated GFR to make population-based estimates of the prevalence of CKD.[a] With population prevalence estimates in hand, population cost estimates can be developed by using per-person cost estimates.

Naturally, when describing the costs of medical interventions (such as dialysis), there are ethical concerns since most people are uncomfortable thinking about lives in

a NHANES data are the best source for calculating population-based estimates of CKD. However, ideally, CKD staging would be based on multiple serum creatinine tests. There is no data source which includes multiple samples of creatinine for respondents over time.

dollar terms. Part of the problem is the difference between an *individual* life and a *statistical* life; dialysis saves an individual life, but better traffic signals or safer cars save *statistical* lives (we never know whose life is saved, but we know that on average we saved X lives/year with better traffic signals). Often, when discussing the cost-effectiveness of medical interventions, we use *quality adjusted life years* which measures both the number of years as well as the quality of those years. For example, one study estimated that the quality of life for patients with CKD Stages 2-4 was about 95% of people without CKD (meaning only a modest decrease), but the quality of life for Stage 5 patients was 70% of people without CKD.[2] For context in the following discussion, over a host of medical treatments, those interventions that cost more than $100,000 per quality adjusted life year (QALY) are generally considered not cost-effective,[6] while those that cost less than $50,000 are considered "good bargains," although there is controversy about whether these values are too low.[7]

Costs of CKD and ESKD

The costs associated with CKD and ESKD are largely borne by different payers. People in the non-kidney failure stages of CKD (Stages 1-4) generally have the same insurance coverage as the general population. These individuals may have employer-based coverage, private non-group coverage, public coverage (eg, Medicaid, Medicare, or Veterans), or they may be uninsured. There is no special insurance coverage until a person needs kidney replacement therapy (either dialysis or transplant). Most people who need kidney replacement therapy will qualify for Medicare coverage. In most instances, Medicare coverage begins in the fourth month following initiation of dialysis (however, there are certain instances involving home dialysis or transplantation when coverage can begin earlier). Once Medicare coverage begins, there are special rules for people who have insurance coverage under an employer- or union-based health plan. Employer- or union-based coverage is the primary payer of health bills for the first 30 months (Medicare is the secondary payer and will pay the bills not covered by the employer- or union-based plan). After 30 months, Medicare becomes the primary payer, and the other insurance coverage becomes the secondary payer. Medicare coverage continues for as long as the person receives dialysis or for 36 months following transplantation.[b]

The costs associated with end-stage kidney disease (ESKD) are considerable, although costs vary widely by dialysis modality. One meta-analysis found that the cost per life year saved varies from roughly $55,000-$80,000 per life year for in-center hemodialysis, $33,000-$50,000 for home hemodialysis, and approached $10,000 per life year for transplantation.[8] As noted more fully in

b Centers for Medicare and Medicaid Services. Medicare Coverage of Kidney Dialysis and Kidney Transplant Services. CMS Publication No. 10128. September 2007. http://www.medicare.gov/Publications/Pubs/pdf/10128.pdf.

Chapter 4, transplantation is the most cost-effective treatment for patients with ESKD. Further, peritoneal dialysis is more cost-effective than hemodialysis, although less commonly used. It should be noted that all treatments are cost-effective using commonly used cost-effectiveness standards.[c]

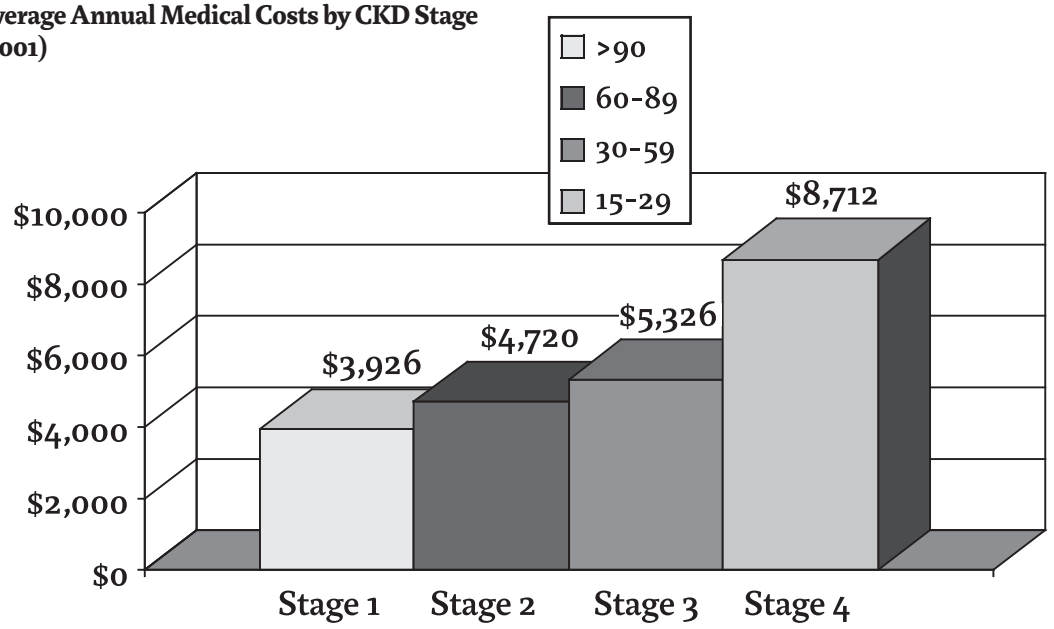
As discussed in Chapter 1, Medicare costs for ESKD have increased considerably over the past few years. ESKD costs represent 6.4% of the Medicare budget, but ESKD patients represent only 1.2% of the Medicare population.[9] The cost of dialysis in the Medicare population was nearly $250,000 per person in 2003. Although Medicare pays for approximately two-thirds of the health care costs for people with ESKD, the state Medicaid program also helps pay for some of the costs. In State Fiscal Year 2006, there were 7,592 North Carolina Medicaid enrollees who received services for ESKD.[10] ESKD patients incurred $839 million in total medical spending—an average annual cost per patient of more than $110,000 (excluding pharmacy costs covered under Part D). Though most Medicaid recipients with ESKD are also covered by Medicare, over half of these costs were incurred by Medicaid patients.

The metaphor of an iceberg is commonly used when describing the epidemiology of the early stages of asymptomatic CKD since the highly visible ESKD population represents but a small fraction of the whole population with CKD. This metaphor is also appropriate when describing the economics of CKD. Total Medicare costs associated with non-ESKD CKD were roughly equal to the Medicare costs of ESKD in 2005. Thus, although ESKD costs are considerable (representing 6.4% of all Medicare costs in 2005), the costs associated with pre-ESKD CKD patients are also considerable. Given that approximately 20% of individuals with Stages 3 and 4 in the 2003-2004 NHANES had private insurance but not Medicare, total costs for CKD will be higher than those incurred by Medicare alone.

Nationally representative data on CKD costs are unavailable, but one study of a large HMO provides some important information on CKD costs. CKD patients experienced an increased cost of as much as $4,676 per person per year, depending on stage of disease.[5] The following chart demonstrates the effect CKD stage has on overall costs. Average annual costs adjusted for age and gender are shown below by stage of CKD. Note that costs for Stage 3 patients were roughly one-third higher than for Stage 1 patients, and costs for Stage 4 were over double. Patients with CKD had 2.5 times as many prescriptions, 1.9 times as many office visits, and were 2.2 times as likely to be hospitalized as non-CKD patients of similar age and gender.

c This is, indeed, by definition as the standard of $50,000-$100,000 commonly used throughout the literature derives from the cost of dialysis.[15]

Figure 3.1.
Average Annual Medical Costs by CKD Stage (2001)



Source: Smith DH, Gullion CM, Nichols G, Keith DS, Brown JB. Cost of medical care for chronic kidney disease and comorbidity among enrollees in a large HMO population. *J Am Soc Nephrol*. 2004;15(5):1300-1306.

The US Renal Data System reports that for CKD patients who never reach ESKD, the average cost in the month prior to death is $12,405.[d] That figure has increased from $4,174 in 1994. Inpatient costs per patient are eight times higher for those with ESKD than for CKD. Often this is a consequence of dialysis beginning when the patient presents in an emergency room setting; this type of dialysis initiation is the most expensive. In 2005, average costs during the first month of dialysis were approximately $15,000 while annual costs were approximately $60,000 (USRDS). As expected, patients with comorbidities cost much more to treat than those with CKD alone; the average costs for inpatient and outpatient services for CKD patients with heart failure were over twice that of a CKD patient with no heart failure. Diabetes increased the costs slightly for a CKD patient without heart failure, but dramatically for patients with heart failure ($1,782 for a CKD patient with diabetes but without congestive heart failure compared to $2,113 for a patient with both diabetes and congestive heart failure).[9]

The costs of CKD have been increasing steadily over the last decade or so. Average costs for people with CKD have increased from approximately $800 per month in 1993 to more than $1,200 in 2005 (adjusted for inflation).[9] Available evidence suggests that one major driver of the cost increases is higher prevalence of comordibity in the CKD population. For example, one study

d United States Renal Data System. USRDS 2006 Annual Data Report: Atlas of End-Stage Renal Disease in the United States. National Institutes of Health. National Institute of Diabetes and Digestive and Kidney Diseases. Bethesda, MD; 2006.

tracked prevalence of selected comorbidities in a sample of new dialysis patients. From 1995 to 1998 the proportion of dialysis patients with heart failure increased significantly from 59.2% to 64.7%, a history of heart attack from 16.0% to 19.4%, diabetes from 54.9% to 58.9%, and hypertension from 73.2% to 81.1%.[11]

Of course, it would be better if we could manage the progression of CKD more effectively and slow the progression of the disease. Early screening in high-risk populations (that is, case-finding), identification, and treatment of CKD can help people prevent ESKD and reduce health care expenditures. For example, as recommended in the KDOQI guidelines, the use of angiotensin-2 receptor blockades and angiotensin-converting enzyme inhibitors in the treatment of CKD can both slow the progression of CKD to more advanced stages as well as inhibit the development of significant comorbidities.[12] Other research has found that proteinuria screening may be appropriate (using conventional levels of cost-effectiveness) but only for certain populations at higher risk for CKD.[13,14,e]

RTI International is currently conducting analyses for the Centers for Disease Control and Prevention on the cost-effectiveness of alternative interventions. *Very few medical interventions are cost-saving*. Cost-effectiveness studies in the health care context evaluate which intervention provides the best health outcomes (ie, extended life or improved quality of life) per cost of the health care intervention. Unfortunately, the research is just beginning, but the types of interventions being considered are similar to those proposed by the Task Force. RTI is also examining whether early intervention and treatment programs lead to sufficient improvements in length and quality of life to warrant the increased health care expenditures. Early results suggest that early CKD intervention and treatment, like many other health care interventions, may not lead to an overall reduction in health care expenditures per patient. Instead, the early intervention and treatment may lead to better health outcomes, improved health status, and functioning and longer lives.

e Proteinuria leads to a larger average annual eGFR decrement for patients with diabetes than without. Thus, it may be more cost effective to screen patients with diabetes for proteinuria than to screen otherwise similar non-diabetics for proteinuria.

REFERENCES

1. Odden MC, Whooley MA, Shlipak MG. Depression, stress, and quality of life in persons with chronic kidney disease: the heart and soul study. *Nephron Clin Pract*. 2006;103(1):c1-7.
2. Tengs TO, Wallace A. One thousand health-related quality-of-life estimates. *Med Care*. 2000;38(6):583-637.
3. Locatelli F, Del Vecchio L, Pozzoni P. Treating anemia at different stages of renal disease. *J Nephrol*. 2007;20(suppl 12):S33-38.
4. Fisher EB, Thorpe CT, DeVellis BM, DeVellis RF. Healthy coping, negative emotions, and diabetes management: a systematic review and appraisal. *Diabetes Educ*. 2007;33(6):1080-1106.
5. Smith DH, Gullion CM, Nichols G, Keith DS, Brown JB. Cost of medical care for chronic kidney disease and comorbidity among enrollees in a large HMO population. *J Am Soc Nephrol*. 2004;15(5):1300-1306.
6. Laupacis A, Feeny D, Detsky AS, Tugwell PX. How attractive does a new technology have to be to warrant adoption and utilization? Tentative guidelines for using clinical and economic evaluations. *CMAJ*. 1992;146(4):473-481.
7. Ubel PA, Hirth RA, Chernew ME, Fendrick AM. What is the price of life and why doesn't it increase at the rate of inflation? *Arch Intern Med*. 2003;163(14):1637-1641.
8. Winkelmayer WC, Weinstein MC, Mittleman MA, Glynn RJ, Pliskin JS. Health economic evaluations: the special case of end-stage renal disease treatment. *Med Decis Making*. 2002;22(5):417-430.
9. US Renal Data System. *USRDS 2007 Annual Data Report: Atlas of End-Stage Renal Disease in the United States*. Bethesda, MD: National Institutes of Health; 2007.
10. DuBard A. Talk presented to: Primary Care Workgroup of Chronic Kidney Disease Task Force; April 23, 2007; Cary, NC.
11. St Peter WL, Khan SS, Ebben JP, Pereira BJ, Collins AJ. Chronic kidney disease: the distribution of health care dollars. *Kidney Int*. 2004;66(1):313-321.
12. Brenner BM, Cooper ME, de Zeeuw D, et al. Effects of losartan on renal and cardiovascular outcomes in patients with type 2 diabetes and nephropathy. *N Engl J Med*. 2001;345(12):861-869.
13. Boulware LE, Jaar BG, Tarver-Carr ME, Brancati FL, Powe NR. Screening for proteinuria in US adults: a cost-effectiveness analysis. *JAMA*. 2003;290(23):3101-3114.
14. Golan L, Birkmeyer JD, Welch HG. The cost-effectiveness of treating all patients with type 2 diabetes with angiotensin-converting enzyme inhibitors. *Ann Intern Med*. 1999;131(9):660-667.
15. Hirth RA, Chernew ME, Miller E, Fendrick AM, Weissert WG. Willingness to pay for a quality-adjusted life year: in search of a standard. *Med Decis Making*. 2000;20(3):332-342.