



Research Brief

Kidney Disease

JUNE 2015

There is no cure for Chronic Kidney Disease (CKD). Characterized by a progressive inability of the kidneys to function properly, CKD, if left untreated, will ultimately result in complete kidney failure and death. Fortunately, the progression of CKD can be slowed with proper disease management and many patients never reach the point where dialysis or kidney transplant are the only treatment options available. Approximately 10% or 20 million adults in the US have CKD. In 2012, Medicare expenditures for patients with kidney failure were about \$29 billion, or 6% of the total Medicare budget (Centers for Disease Control and Prevention [CDC], 2015).

Kidney Function

The kidneys have several important functions in maintaining a healthy body. In addition to the well-known function of filtering waste products from the blood, they also produce hormones that serve to regulate blood pressure, stimulate red blood cell production, and produce an active form of vitamin D necessary for bone health (National Kidney and Urologic Diseases Information Clearinghouse [NKUDIC], 2014).

The primary functional unit of a kidney is called a nephron and there are approximately 900,000 to 1 million in each kidney (Bertam, Douglas-Denton, Diouf, Hughson, and Hoy, 2011). Nephrons contain a network of small blood vessels (capillaries), called glomeruli, which drain waste and water into tubules that drain into ureters, eventually collecting the drainage (as urine) in the bladder.

Cellular waste products are passed to the blood which is then passed through the nephrons. Excess water and chemicals are filtered out in the glomeruli and continue to the tubules. The tubules further filter what was extracted in the glomeruli, either adding or removing the required amounts of water and chemicals such as sodium, phosphorus, and potassium back into the bloodstream to maintain the proper balance for normal function (National Kidney Foundation [NKF], 2015b; NKUDIC, 2014).

Healthy kidneys filter an average of 120 to 150 quarts of blood, removing approximately two quarts of waste products and extra water, per day. A healthy kidney has 100% renal function. Declines in renal function can happen over time as one ages or as a result of disease or injury. A person could have as much as 30% to 40% decline without experiencing symptoms. Blood and urine tests are necessary to discover early declines in renal function (NKUDIC, 2014).

Determining Renal Function

The most common tests used to determine renal function are urine albumin-to-creatinine ratio (ACR) and estimated glomerular filtration rate (eGFR). Albumin is a blood protein that *should not* be filtered out of the blood by the kidney and creatinine is a blood protein that *should* be filtered out. When renal function declines, levels of albumin show up in the urine and levels of creatinine rise in the bloodstream. Elevated levels of albumin and/or other proteins in the urine is called albuminuria or proteinuria and can be measured by a urine protein test. Elevated levels of creatinine in the blood are determined by a

serum creatinine blood test. eGFR is determined by a calculation that combines the measure of creatinine in the blood with values for age, sex, and race (National Kidney Disease Education Program [NKDEP], 2012; NKF, 2015b).

The National Kidney Foundation introduced a five-stage system for classifying CKD based on eGFR (United States Renal Data System [USRDS], 2014):

- Stage 1.** eGFR \geq 90 with ACR \geq 30 mg/g (minimal kidney damage)
- Stage 2.** eGFR 60-89, ACR \geq 30 (mild kidney damage)
- Stage 3.** eGFR 30-59 (moderate kidney damage)
- Stage 4.** eGFR 15-29 (severe kidney damage)
- Stage 5.** eGFR $<$ 15 (kidney failure)

While all five stages represent some level of kidney disease, Stages 1-4 are most commonly referred to as CKD and Stage 5 is identified as end stage renal disease (ESRD) or kidney failure. In 2012, the mortality rate for all CKD patients was approximately 143 per 1,000. The mortality rate for those without CKD was 46 per 1,000 (USRDS, 2014).

Risk Factors for CKD

The two most common causes of kidney disease are diabetes and hypertension (high blood pressure). Other causes include congenital (present at birth) abnormalities such as structural defects that cause urine to back up into the kidney causing infections; and hereditary conditions such as polycystic kidney disease where many fluid-filled sacs grow in the kidney eventually leading to kidney failure (NKF, 2015b). Individuals who have diabetes, hypertension, or cardiovascular disease are 2-4 times more likely to develop CKD than those who do not have those conditions (USRDS, 2014).

Increased risk for kidney disease is associated with:

- Diabetes
 - Approximately 33-36% of adults with diabetes also have CKD (CDC, 2014)
- Hypertension
 - About 20% of adults with hypertension also have CKD (CDC, 2014)

- 85% of patients with Stage 3 CKD have hypertension (USRDS, 2013)
- Among those 65 and older, CKD is 3-7 times more likely in those who have hypertension (USRDS, 2013)
- Cardiovascular disease
 - Approximately 70% of CKD patients over 66 also have a form cardiovascular disease (USRDS, 2014)
 - 41% of CKD patients in stages 4-5 have congestive heart failure (USRDS, 2013)
 - 23% of Stage 3 CKD patients aged 66-69 have cardiovascular disease, while 40% of Stage 4-5 CKD patients aged 85 and older have cardiovascular disease (USRDS, 2013)
- Family history of CKD (NKF, 2015a)
- Age (especially over 60)
 - Rates are highest in those 85 and older
 - 7.2% of Medicare patients between 65-74 have CKD (USRDS, 2014)
 - 12.8% of Medicare patients between 75-84 have CKD (USRDS, 2014)
 - 17% of Medicare patients over 85 have CKD (USRDS, 2014)
- Female
 - 15.8% of women have CKD compared to the 12.1% of men (USRDS, 2013)
 - While women are more likely to develop CKD, men with CKD are 50% more likely than women to progress to kidney failure (CDC, 2014)
- Ethnicity/Population group – of those with CKD (USRDS, 2014)
 - 83.1% are white
 - 11.1% are African-American
 - 2.1% are Asian
 - 0.4% are Native American
 - 3.2% are Other
 - 0.2% are Unknown

Management of Kidney Disease

The first step in managing CKD is diagnosing the existence of decreased renal function. Unfortunately, the probability that a person will be tested for early signs of kidney damage is low. USRDS (2013) reported that in 2005-2010, only 10% of all at-risk patients were tested. Of those, 33% of patients with diabetes but no hypertension; 5% of patients with hypertension

but no diabetes; and 33% of patients with both diabetes and hypertension were tested.

Symptoms of kidney disease are usually not present in its earliest stages. Worsening CKD is often characterized by:

- Fatigue
- Trouble concentrating
- Swelling in hands or feet
- Poor appetite
- Muscle cramps at night
- Dry, itchy skin
- Puffiness around the eyes, especially in the morning
- Trouble sleeping
- Change in urination frequency (NKF, 2015a)

Treatment strategies to slow the progression and reduce the complications of CKD include nutritional and lifestyle interventions along with medical management of co-existing conditions such as high blood pressure and diabetes.

Nutrition

Dietary recommendations for CKD patients are similar to other heart-healthy diets. Salt intake should be limited to 2,300 mg/day to help reduce blood pressure. Also to be avoided is excess protein, phosphorus, and potassium (NKDEP, 2014).

Lifestyle

Cigarette smoking is associated with abnormal urine albumin and therefore smoking cessation is recommended. Physical activity, both aerobic and strength training, is recommended to help prevent cardiovascular disease, improve glucose control, and maintain muscle mass (NKDEP, 2014).

Medicine

ACE inhibitors and ARBs are drugs used to control blood pressure. In CKD patients they have also been shown to reduce albuminuria because they lower glomerular capillary blood pressure as well as systemic blood pressure (NKDEP, 2014). Blood pressure goals of 120/80 have been the norm although a recent study suggested that in CKD patients a blood pressure of 140/90 is adequate to slow the progression towards ESRD (NKF, 2015c). Controlling glucose levels for diabetic patients is essential.

End Stage Renal Disease (ESRD)

Once CKD progresses to Stage 5 (ESRD) the only treatment options are to replace the functions of the kidney through dialysis (using a machine to filter the blood) or a kidney transplant. In 2012, 636,905 patients received treatment for ESRD; 114,813 of whom were new patients. Only 54% of hemodialysis patients and 65% of peritoneal dialysis patient are still alive three years after the start of ESRD therapy. Kidney transplant patients fare better with 84% to 93% surviving the first three years after transplant (USRDS, 2014). In 2013, 6,459 Texans died while receiving dialysis treatment for ESRD (ESRD Network of Texas, 2014).

Hemodialysis (HD)

A dialyzer is a special filter which removes waste, extra salt, and excess water out of the blood in much the same way a functioning kidney does. In hemodialysis, the blood travels through tubes from the patient through the dialyzer and back into the patient. In order to facilitate this blood flow, an access point must be created (usually in the forearm) to attach the tubes. Treatment is usually done three times a week and lasts for 3 to 5 or more hours when done in a treatment facility. In-home hemodialysis is becoming more popular as dialysis machines become smaller and easier to use. When done in-home, hemodialysis is generally done 5 to 7 days per week for 2 to 3 hours at a time (NKUDIC, 2013).

Peritoneal Dialysis (PD)

In this filtration method, the peritoneum (lining of the abdomen) is used to filter waste products from the blood. A dialysis solution, composed of various minerals and sugar dissolved in water, is introduced into the abdominal cavity through a catheter. The solution draws waste products through the peritoneal membrane. After several hours the “dirty” solution is drained and the abdomen is filled with fresh solution. There are two methods of performing peritoneal dialysis (PD): continuous ambulatory PD where the solution is introduced, left 4-6 hours, drained, and new solution introduced at least four times per day, and the patient sleeps with the abdomen filled; and continuous cycler-assisted PD where a machine is used to fill and empty the abdomen 3-5 times per night while the patient is sleeping,

and the abdomen is left filled for the day (NKUDIC, 2013).

Number of Dialysis Patients				
	Home HD	Home PD	In-Center Dialysis	Total
US (2012)	7,987	41,013	400,342	449,342
Texas (2013)	552	3,627	38,153	42,332

(USRDS, 2014; End Stage Renal Disease Network of Texas, 2014)

Kidney Transplant

Kidney transplant involves the surgical placement of a healthy kidney into the body. In successful transplants, the donated kidney functions well enough to keep the patient healthy. Many factors affect whether a person is a good candidate to receive a donated organ to ensure that the organ is not rejected by the body. Kidneys can be transplanted from living or deceased donors. Living donors are generally family members who share compatible blood and tissue types. If no living donor is available the patient will be placed on a waiting list for a deceased organ donation. There are currently (as of May 21, 2015) 101,679 individuals on the waiting list for a kidney transplant. In 2014, 29,532 individuals received kidney transplants (Organ Procurement and Transplantation Network [OPTN], 2015).

Number of Kidney Transplant Recipients, 2014		
Age	U.S.	TX
< 1	280	25
1-5 Years	503	47
6-10 Years	284	32
11-17 Years	728	77
18-34 Years	3,148	286
35-49 Years	6,407	557
50-64 Years	12,791	1,133
65+ Years	5,391	469
Total	29,532	2,626

(OPTN, 2015)

Renal Disease Help in Texas

The Texas Department of State Health Services (DSHS) manages a Kidney Health Care Program (KHC) which provides assistance to Texans with ESRD. Services include providing assistance with obtaining dialysis treatments, access to surgery, prescription drugs, travel to health care visits, and help with Medicare premiums (DSHS, 2014).

The End Stage Renal Disease Network of Texas (ESRDNT), under contract to the Center for Medicare and Medicaid Services (CMS), serves as a liaison between the federal government and providers of ESRD services. It also provides services to patients, such as patient education and facilities locators. It lists 46 dialysis facilities in the San Antonio area (ESRDNT, 2014).

The State of Texas Kidney Foundation (n.d.) provides a variety of education activities and support resources as well as facilitating organ donation.

REFERENCES

- Bertam, J., Douglas-Denton, R., Diouf, B., Hughson, M., and Hoy, W. (2011). Human nephron number: implications for health and disease. *Pediatr Nephrol*. 2011 Sep;26(9):1529-33. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/21604189>
- Centers for Disease Control and Prevention (CDC). (2014). *National chronic kidney disease fact sheet 2014*. Retrieved from http://www.cdc.gov/diabetes/pubs/pdf/kidney_Factsheet.pdf
- Centers for Disease Control and Prevention (CDC). (2015). *Chronic Kidney Disease Initiative*. Retrieved from http://www.cdc.gov/diabetes/projects/pdfs/ckd_summary.pdf
- End Stage Renal Disease Network of Texas (ESRDNT). (2014). *2013 Annual report*. Retrieved from <http://esrdnetwork.org/wp-content/uploads/2013-Annual-Report-FINAL-CORRECTED-06172014.pdf>
- National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). (n.d.). *Kidney disease statistics for the United States*. Retrieved May 21, 2015 from <http://www.niddk.nih.gov/health-information/health-statistics/Pages/kidney-disease-statistics-united-states.aspx#9>
- National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). (2013). *Kidney failure: Choosing a treatment that's right for you*. Retrieved from <http://kidney.niddk.nih.gov/KUDiseases/pubs/choosingtreatment/index.aspx>
- National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). (2014). *The kidneys and how they work*. Retrieved from <http://kidney.niddk.nih.gov/KUDiseases/pubs/yourkidneys/index.aspx>
- National Kidney Disease Education Program (NKDEP). (2012). *Quick Reference on UACR and GFR in evaluating patients with diabetes for kidney disease*. Retrieved from <http://nkdep.nih.gov/resources/quick-reference-uacr-gfr.shtml>
- National Kidney Disease Education Program (NKDEP). (2014) *Slow progression and reduce complications*. Retrieved from <http://nkdep.nih.gov/identify-manage/manage-patients/slow-progression.shtml>
- National Kidney Foundation (NKF). (2015a). *About chronic kidney disease*. Retrieved from <http://www.kidney.org/kidneydisease/aboutckd.cfm>
- National Kidney Foundation (NKF). (2015b). *How your kidneys work*. Retrieved from <http://www.kidney.org/kidneydisease/howkidneyswrk.cfm>
- National Kidney Foundation (NKF). (2015c). *Study shows blood pressure of 140/90 and up increases kidney failure risk*. Retrieved from http://www.kidney.org/news/keep/keephealthy/Winter2012/KH_bp.cfm
- Organ Procurement and Transplantation Network (OPTN). (2015). *Data*. Retrieved from <http://optn.transplant.hrsa.gov/converge/data/default.asp>
- State of Texas Kidney Foundation. (n.d.). *The mission*. Retrieved May 21, 2015, from <http://txkidney.org/>
- Texas Department of State Health Services (DSHS). (2014). *Kidney health care program (KHC)*. Retrieved from <http://www.dshs.state.tx.us/kidney/default.shtml>
- United States Renal Data System (USRDS). (2014) *2014 USRDS annual data report: CKD and ESRD in the United States*. Retrieved from <http://www.usrds.org/2014/view/Default.aspx>