Chapter 1: Incidence, Prevalence, Patient Characteristics, and Treatment Modalities

Incidence

- In 2016, there were 124,675 newly reported cases of ESRD; the unadjusted (crude) incidence rate was 373.4 per million/year (Table 1.1). Since 2011, the crude rate had risen; however, the standardized rate appears to have plateaued (Figure 1.1).
- The age-sex-race standardized incidence rate of ESRD in the United States rose sharply in the 1980s and 1990s, leveled off in early 2006, and has declined slightly since its peak in 2006 (Figure 1.1).
- In 2016, the age-sex-standardized ESRD incidence rate ratio, compared with Whites, was 2.9 for Blacks/African Americans, 1.2 for American Indians/Alaska Natives, and 1.1 for Asians (Figure 1.5). All these represent reductions in the relative rate of ESRD for these minorities compared to Whites over the past 16 years. The incidence rate ratio for Hispanics versus non-Hispanics was 1.3 (Figure 1.6).
- Based on 2013 data, the lifetime risk of being diagnosed with ESRD from birth was 4.0% in males and 2.9% in females. Among males, the lifetime risk ranged from a low of 3.4% in Whites to a high of 8.1% in Blacks/African Americans; in females, it ranged from 2.3% in Whites to 6.8% in Blacks/African Americans. (Figure 1.7 and Table 1.3).

Prevalence

- On December 31, 2016, there were 726,331 prevalent cases of ESRD; the crude prevalence was 2,160.7 per million in the U.S. population (Table 1.4).
- The number of prevalent ESRD cases has continued to rise by about 20,000 cases per year (Table 1.4). In contrast to the standardized incidence rate, the age-sex-race-standardized prevalence of ESRD has continued to increase since 2006 (Tables 1.1 and 1.4).
- Compared to Whites, ESRD prevalence in 2016 was about 9.5 times greater in Native Hawaiians/Pacific Islanders, 3.7 times greater in Blacks, 1.5 times greater in American Indians/Alaska Natives, and 1.3 times greater in Asians (Figure 1.12).

Characteristics of Incident ESRD Cases

- In 2016, 35.4% of incident ESRD patients received little or no pre-ESRD nephrology care (Table 1.8.a).
- Mean eGFR at initiation of dialysis in 2016 was 9.7 ml/min/1.73 m^2 (Table 1.10), down from a peak of 10.4 in 2010. The percentage of incident ESRD cases starting with eGFR ≥10 ml/min/1.73 m^2 rose from 12.9% in 1996 to 42.6% in 2010 but decreased to 38.6% in 2016 (Figure 1.19).

Treatment Modalities

- In 2016, 87.3% of incident individuals began renal replacement therapy with hemodialysis (HD), 9.7% started with peritoneal dialysis (PD), and 2.8% received a preemptive kidney transplant (Figure 1.2).
- On December 31, 2016, 63.1% of all prevalent ESRD patients were receiving HD therapy, 7.0% were treated with PD, and 29.6% had a functioning kidney transplant (Figure 1.9). Among HD cases, 98.0% used in-center HD, and 2.0% used home HD (*Reference Table D.1)*.

Introduction

In this chapter, we describe the population of those individuals living with end-stage renal disease (ESRD) in the United States, the numbers and relative rates of new and existing cases, the sex, age, race, and ethnicity of those most often affected, the clinical precursors of their developing kidney disease, and the therapies used to treat it. This information creates the foundation from which to understand and interpret the current state and trends of ESRD as presented in the 2018 Annual Data Report (ADR).

The foci of this chapter are the incidence and prevalence of ESRD in the U.S. population. We report the absolute numbers of individuals affected, population frequencies, and temporal trends. We examine the distribution of ESRD frequency by age, sex, race, and ethnicity. The population is also described in terms of geographic residence, the primary cause of ESRD as listed in the Centers for Medicare & Medicaid Services (CMS) form 2728, the type of renal replacement therapy (RRT) chosen for treatment, and individual medical characteristics such as receipt of pre-ESRD care, estimated glomerular filtration rate (eGFR), and prevalence and severity of anemia at onset of ESRD.

The definitions of ESRD incidence and prevalence used throughout the ADR are treatment-based, not purely physiological or biological constructs. These terms as used here refer only to treated cases of ESRD, to patients starting or receiving dialysis or transplantation. Although a diagnosis of ESRD is often equated with RRT treatment, and usually commences in Stage 5 CKD (GFR <15 ml/min/1.73 m^2), many do not begin RRT until the eGFR is much lower than 15, and some never receive dialysis or transplantation. Also, there are "ESRD treated" patients on RRT who were initiated on dialysis at an eGFR greater than 15. Thus, although the terms "incident ESRD" and "prevalent ESRD" are used throughout this chapter, they should be interpreted as "treated ESRD."

Incidence refers to the occurrence or detection of new cases of a disease during a given period. In this chapter, ESRD incidence is a count of the number of incident cases in one year or a rate calculated as the number of incident cases in one year divided by person-years at risk. Person-years at risk in each calendar year are approximated by the mid-year census for the population in that year. Incidence rates are expressed per million (population)/year.

Prevalence refers to the presence of existing cases of a disease at a point in time (point prevalence) or during a specific period (period prevalence). In this chapter, ESRD point prevalence is a count of the number of prevalent cases or a proportion of the number of prevalent cases divided by the size of the population from which those cases were identified. ESRD prevalence at the end of each year is expressed per million. ESRD prevalence in a population depends on both the incidence rate of ESRD and the duration of the disease from the start of RRT to death or loss to follow-up.

Risk of ESRD

Disease incidence in a population may be quantified in two ways: as a rate, described above; and as a risk. Disease risk is the probability of persons initially without the disease getting (diagnosed with) the disease during a given period, e.g., between ages 60 and 65, from January 1, 2010, through December 31, 2014, or during the first five years of follow-up in a cohort study or randomized clinical trial. As a probability, risk is a dimensionless quantity; therefore, it can be expressed as a percent (unlike a rate). Note that a risk has a specific period referent. For example, suppose 100 persons without ESRD (e.g., CKD stages 3-4) are followed for five years without loss to follow-up (i.e., no censoring). If 10 of those persons at risk are diagnosed with ESRD during that period, the 5-year risk is 10/100 = 10%. Also note that risk applies to individuals, whereas the rate is strictly a population measure that has no meaning for individuals. Thus, physicians often talk to their patients about risks when discussing the likelihood of developing a disease or other health event during a given period, e.g., the next ten years or their lifetime. Previous editions of the ADR have not included estimates of ESRD risk.

Estimating the risk of disease is straightforward when all individuals in the study population are followed for detection of disease occurrence, as in a cohort study; but that is not the case in a disease surveillance system such as the USRDS because

individuals in the U.S. general population are not followed. Rather, incident cases (numerators) are identified from medical providers and institutions; then they are linked with appropriate census counts (denominators) within categories (strata) of demographic factors such as age, sex, and race or ethnicity. Risk estimation with USRDS data is further complicated by the need to take into account competing events, e.g., deaths from diseases other than kidney disease that occur among persons still at risk for ESRD. Thus, the probability of being diagnosed with ESRD is expected to decline sharply late in life, in part due to increasing frequency of deaths from other causes.

A special life-table method developed by Fay (2004) has been employed to overcome the challenges described above for estimating ESRD risks using USRDS data. In addition to age-specific incidence rates of ESRD for a given period (January 1 through December 31, 2013), the method also requires age-specific mortality rates for ESRD and all other diseases combined, which are estimated with data obtained from the National Center for Health Statistics. Risks—called "cumulative incidences" when using this method—are estimated for a large hypothetical cohort of births followed to age 100+, assuming those age-specific rates in 2013 are constant across calendar time. Thus, for example, we might want to estimate the lifetime cumulative incidence of ESRD or the 10-year cumulative incidence for a 40-year old. Calculations are done with version 6.7 of DevCan software (2005). This method has been applied to males and females separately with further stratification by race or ethnicity.

It is important to recognize that the risks estimated from data in a given year reflect a hypothetical population assumed to be in a steady state, such that all age-specific rates are constant over calendar time. In fact, the U.S. population is not in a steady state with respect to kidney disease; the overall incidence rate of ESRD in the United States rose sharply in the 1980s and 1990s, leveled off in the 2000s, and declined slightly since its peak in 2006. Furthermore, those changes did not occur to the same extent in different age or racial/ethnic groups. Thus, risk estimates presented in this chapter are useful statistics for understanding the frequency of ESRD in demographic groups and potentially guiding doctor-patient communication, but they are not likely to correspond closely to the actual lifetime experience of persons born in 2013. Indeed, that is beyond the reach of any empirical method.

Methods

This chapter uses data from the Centers for Medicare & Medicaid Services (CMS). Findings were primarily drawn from special analyses based on the USRDS ESRD Database. Details of the USRDS database are described in the *Data Sources* section of the *ESRD Analytical Methods* chapter. Trends in overall incidence and prevalence are provided since 1980 when data were first available. Most standardized data are provided since 2000, as race categories in the U.S. Census were changed in that year.

Incidence rates and prevalences in this chapter are presented both without adjustment for other factors (i.e., as crude measures) and with adjustment for sex, age, and race by using a method known as "standardization." Age was stratified into 5 categories, and race was stratified into 5 groups (White, Black/African American, Asian, American Indian/Alaska Native, and Native Hawaiian/Pacific Islander). This method involves stratification of the population by those three variables, and calculation of a weighted average of stratum-specific rates or prevalences. The weights are the numbers of persons in strata of a "standard population," which, since the 2014 ADR, has been the U.S. population in 2011. Each standardized incidence rate or prevalence for a given group or year is interpreted as the expected (crude) rate or prevalence if that group or year had exhibited the age-sex-race distribution of the 2011 U.S. population. (Note: the standard population is different from the reference population to which a given index group is compared.) Because we are standardizing only for age, race, and sex, the trends we see may be due to other variables such as differences in treatment and/or patient case-mix.

For an explanation of the analytical methods used to generate the study cohorts, figures, and tables in this chapter, see the section on *Chapter 1* in the *ESRD Analytical Methods* chapter. Downloadable Microsoft

Excel and PowerPoint files containing the data and graphics for these figures and tables are available on the *USRDS website*. A "special analysis" means that the source of data for a given table or figure was not a Reference Table available in this ADR.

Primary Cause of ESRD: A Cautionary Note

A caution in the interpretation of this chapter is that the reliability of clinician-assigned "primary-cause" of ESRD has not been well established. Because causation for some diagnoses cannot be or are not definitively established through clinical judgment or testing, and because many patients arrive at ESRD without the benefit of prior nephrology care, establishing the validity of these etiologic subtypes of ESRD remains a challenge. For example, in diabetics with CKD (Yuan et al., 2017), confirmatory kidney biopsies are rarely performed, and published data suggest that assigned diagnoses for glomerular disease may be specific, but relatively insensitive (i.e. under-reported; Longenecker et al., 2000).

For diabetes mellitus (DM) and hypertension (HTN), the main problem may be over-reporting of those conditions as the primary cause of ESRD. For HTN in those of Black/African American race, for example, this may especially apply, as the APOL1 high-risk genotype and other emerging risk factors are recognized. For DM, often quoted as the leading "cause" of ESRD, authorities such as KDIGO provide guidance for assigning a diagnosis of diabetic CKD (DM as the primary cause). In reality, it is likely that this judgment is quite variable among nephrologists completing the CMS Medical Evidence form (CMS 2728). Single center studies suggest that DM as a "cause" of ESRD is over-reported on CMS 2728 compared to KDIGO criteria. It is likely that CMS 2728 data indicating the primary cause of ESRD reflect ESRD patients who have DM but not necessarily as the primary cause of their ESRD. This parallels reports of biopsy-confirmed diabetic nephropathy, although there is likely selection bias in patients who undergo biopsy. Also, there may be a need to reclassify etiologies of ESRD that are listed on the form CMS 2728 to improve accuracy and to keep pace with scientific developments (Tucker and Freedman, 2018).

The "primary cause of renal failure," as assessed by individual physicians and reported on the CMS 2728 form, has been used for many years in nephrology to compare populations and assess trends. It may even have played a role in risk-factor assessment for CKD screening, particularly in the primary roles of DM and HTN, in addition to NHANES and other cohorts. In the Annual Data Report (ADR), it allows us to estimate the ESRD incidence rate and prevalence for different purported subtypes of chronic kidney disease: those with the primary cause listed as DM, HTN, glomerulonephritis, or cystic kidney disease. It should be noted, however, that this approach is not the same as stratifying on comorbidity status. For example, in this chapter, we are not estimating standardized incidence rates of ESRD among diabetics and non-diabetics because we do not have laboratory-based data on DM status in the total U.S. population by strata of sex, age, and race. In *Reference Table A.11*, incidence rates of ESRD are estimated for self-reported DM in the U.S. population. As many persons with DM either do not report their condition or are not aware of it, those estimates should be viewed in that context.

Incidence of ESRD: Counts, Rates, and Trends

Overall Incidence Counts and Rate

In 2016, there were 124,675 incident cases of ESRD in the United States; the crude incidence rate was 373.4 per million/year. After a year-by-year rise in the number of incident ESRD cases from 1980 through 2000, the count plateaued between 2007 and 2011 but rose again from 2012 to 2016. Table 1.1 and Figure 1.1 provide the annual counts and crude and age-sex-race standardized incidence rates of ESRD from 1980 through 2016.

It should be noted that the crude and standardized incidence rates of ESRD were the same in 2011; that is not a coincidence but rather reflects the fact that the standard population (the source of stratum-specific weights) was the 2011 U.S. population. The trends in crude and standardized rates are different, however. The crude ESRD incidence rate (and count) increased steadily from 1980 through 2006, remained relatively

stable until 2011, and increased again in recent years. This recent trend implies that the burden of kidney failure in the United States— concerning the expected impact on health-care utilization and costs— continues to increase, due to the aging U.S. population and the rise of obesity and DM.

In contrast, the standardized ESRD incidence rate increased from 1980 through 2001, leveled off through 2006, and has since declined slightly in most years (Table 1.1). The standardized rate of 348.2 per million in 2016 was the lowest rate since 1998. The specific implication of this recent downward trend is more difficult to interpret, but it likely reflects improvements in the prevention or postponement of kidney failure in the United States, possibly due to increases in blood-pressure control and the use of statins in the general population.

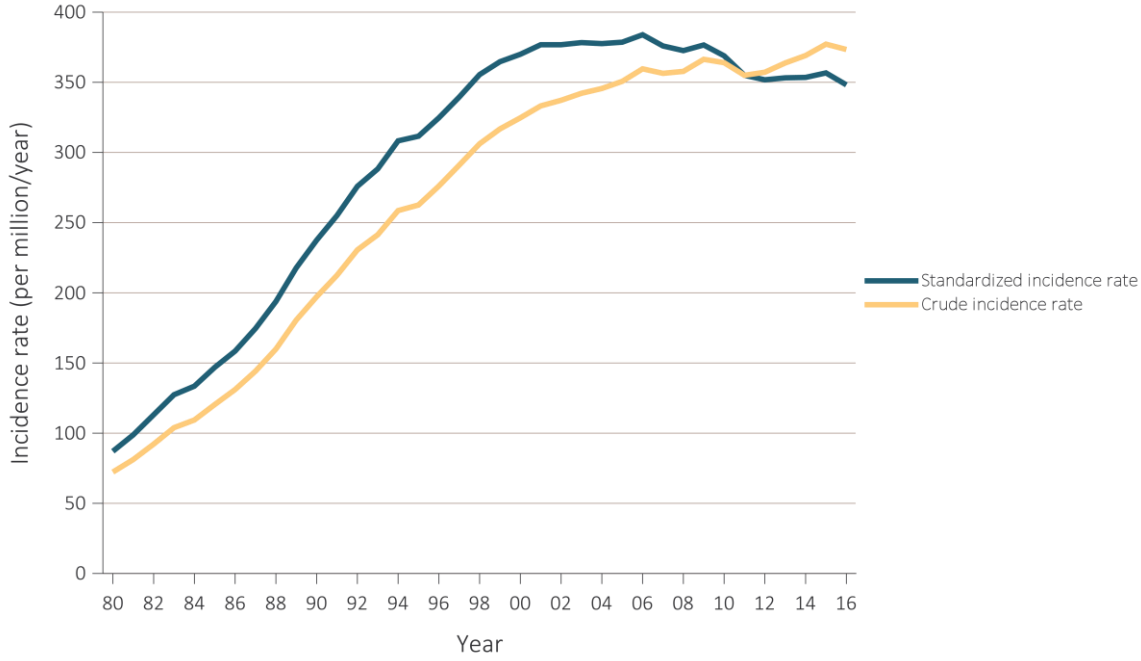
vol 2 Table 1.1 Trends in annual number of ESRD incident cases, crude and standardized incidence rates of ESRD, and annual percentage change in the U.S. population, 1980-2016

Year	Incident count		Crude rate		Standardized rate	
	No. cases	% Change from previous year	Crude rate (per million/yr)	% Change from previous year	Standardized rate (per million/yr)	% Change from previous year
1980	17,903	n/a	72.3	n/a	87.1	n/a
1981	20,039	11.9	81.2	12.3	98.8	13.4
1982	22,568	12.6	92.2	13.5	113.1	14.5
1983	25,775	14.2	103.9	12.7	127.4	12.6
1984	27,324	6.0	109.4	5.3	133.5	4.8
1985	30,214	10.6	120.4	10.1	146.9	10.0
1986	33,112	9.6	131.1	8.9	158.5	7.9
1987	36,605	10.5	144.2	10.0	174.6	10.2
1988	40,991	12.0	159.9	10.9	193.8	11.0
1989	46,303	13.0	180.6	12.9	217.8	12.4
1990	50,830	9.8	197.2	9.2	237.5	9.0
1991	55,387	9.0	212.5	7.8	255.1	7.4
1992	60,886	9.9	230.6	8.5	275.9	8.2
1993	64,485	5.9	241.4	4.7	288.3	4.5
1994	69,958	8.5	258.6	7.1	308.3	6.9
1995	72,202	3.2	262.6	1.5	311.6	1.1
1996	77,003	6.6	276.1	5.1	324.7	4.2
1997	82,119	6.6	291.0	5.4	339.5	4.6
1998	87,327	6.3	306.2	5.2	355.5	4.7
1999	91,405	4.7	316.8	3.5	364.7	2.6
2000	94,704	3.6	324.7	2.5	370.0	1.5
2001	97,964	3.4	333.2	2.6	376.8	1.8
2002	100,180	2.3	337.2	1.2	376.8	0.0
2003	102,607	2.4	342.2	1.5	378.3	0.4
2004	104,480	1.8	345.6	1.0	377.6	-0.2
2005	106,636	2.1	350.7	1.5	378.6	0.3
2006	110,354	3.5	359.6	2.5	383.9	1.4
2007	110,342	0.0	356.4	-0.9	375.9	-2.1
2008	111,908	1.4	357.8	0.4	372.6	-0.9
2009	115,564	3.3	366.4	2.4	376.6	1.1
2010	115,921	0.3	364.0	-0.7	368.9	-2.0
2011	113,809	-1.8	355.0	-2.5	355.0	-3.8
2012	115,549	1.5	357.2	0.6	351.8	-0.9
2013	118,367	2.4	363.8	1.8	353.2	0.4
2014	121,338	2.5	369.1	1.5	353.5	0.1
2015	124,868	2.9	377.2	2.2	356.7	0.9
2016	124,675	-0.2	373.4	-1.0	348.2	-2.4

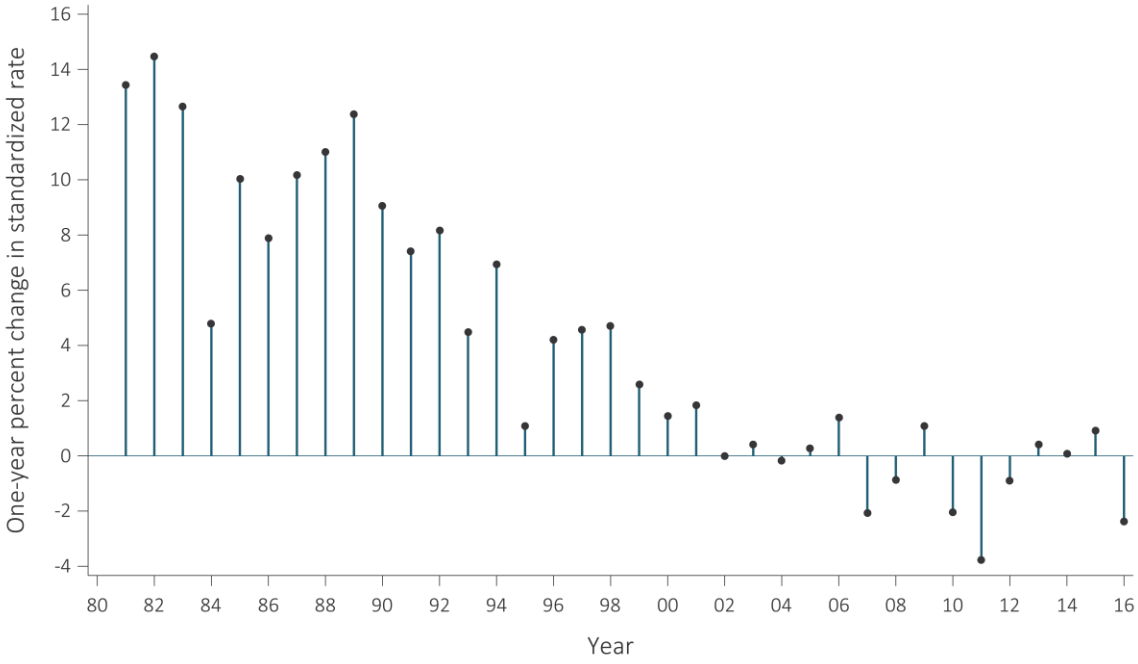
Data Source: Special analyses, USRDS ESRD Database. The special analyses exclude U.S. territories, unknown age, and unknown/other races. Standardized to the age-sex-race distribution of the 2011 U.S. population. Abbreviations: ESRD, end-stage renal disease; n/a, not applicable; yr, year.

vol 2 Figure 1.1 Trends in the (a) crude and standardized incidence rates of ESRD, and (b) the annual percentage change in the standardized incidence rate of ESRD in the U.S. population, 1980-2016

(a) Incidence rate per million/year



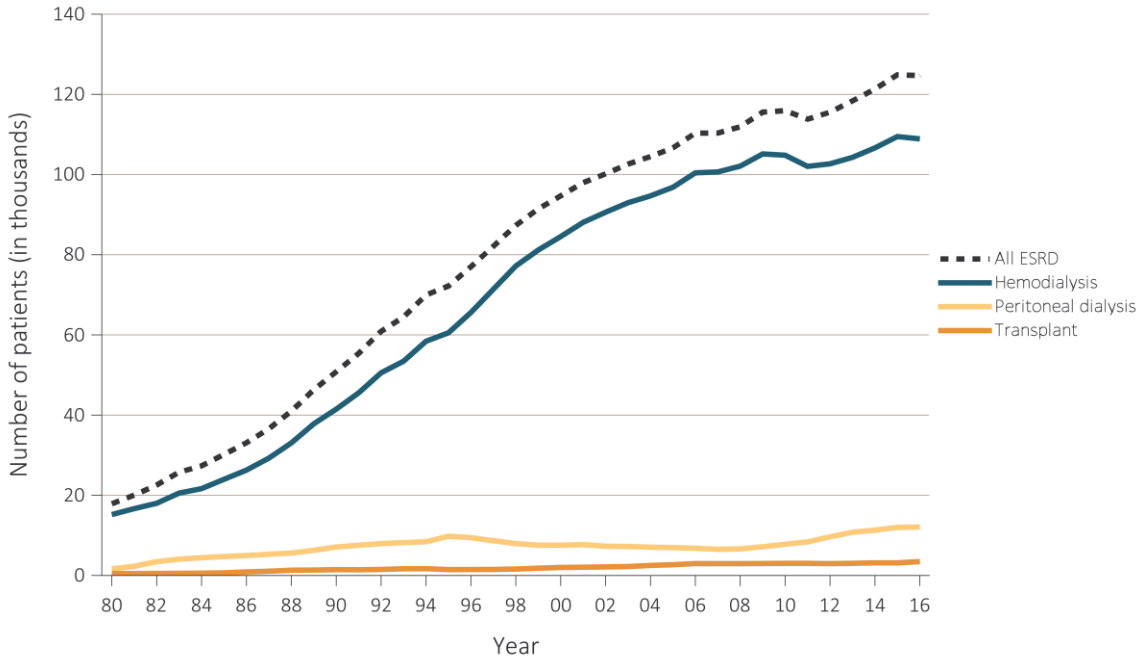
(b) One-year percentage change in standardized incidence rate



Data Source: Special analyses, USRDS ESRD Database. The special analyses exclude U.S. territories, unknown age, and unknown/other races. Standardized to the age-sex-race distribution of the 2011 U.S. population. Abbreviation: ESRD, end-stage renal disease.

In all years since 1980, hemodialysis was the predominant form of initial therapy among incident cases (Figure 1.2). The number of incident peritoneal dialysis patients peaked in the mid-1990s, then declined for more than a decade, and has been increasing again since 2008; the number in 2016 was 12,095.

vol 2 Figure 1.2 Trends in the annual number of ESRD incident cases, by modality, in the U.S. population, 1980-2016



Data Source: Reference Table D.1 and special analysis of USRDS ESRD Database. Persons with "Uncertain Dialysis" were included in the "All ESRD" total, but are not represented separately. Abbreviation: ESRD, end-stage renal disease.

Incidence Rate: By Region

Variation in ESRD incidence rates among the 18 ESRD Networks remained substantial in 2016 (Table 1.2). Standardizing for age, sex and race, the rate (per million/year) was lowest in Network 1 (CT, MA, ME, NH, RI) at 254, and in Network 16 (AK, ID, MT, OR, WA) at 259; the rate was highest in Network 14 (TX) at 442 and Network 18 (S. CA) at 409. The high rates in the latter two networks are partly due to the relatively large proportions of Hispanics (38%) compared with 18% nationwide and to the higher incidence rate in Hispanics than in non-Hispanics. There are some notable differences between the ranking of networks by standardized rate (as ordered in Table 1.2) and crude rates. For example, the shift of Network 8 (AL, MS, TN) from the highest crude incidence rate of ESRD (478 per million/year) to a relatively lower standardized rate (381 per million/year) is due to the much larger proportion of African Americans in AL, MS, and TN (44.9%) than in the total U.S. population (26.0%), and to the higher ESRD incidence rate in African Americans than in other racial groups. That is, race is a strong confounder of the ESRD incidence rate by network. Network incidence rates for renal replacement therapy (RRT) modality are also presented in Table 1.2; these findings are discussed in the section, Modality of Renal Replacement Therapy: Incident ESRD Cases, later in this chapter.

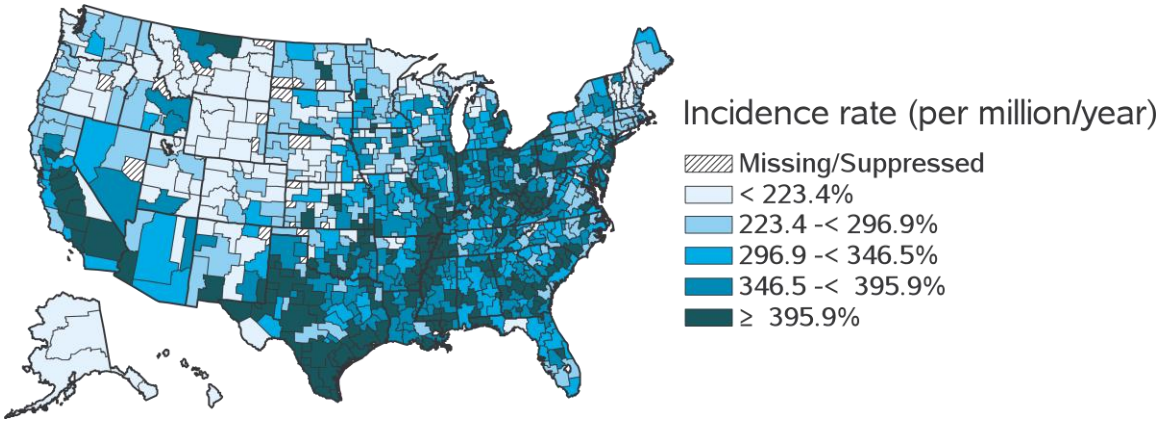
vol 2 Table 1.2 Crude and standardized incidence rates of ESRD and annual number of ESRD incident cases, overall and by modality and ESRD Network (ordered from highest to lowest standardized rate), in the U.S. population, 2016

Network	States* in Network	Total ESRD			Hemodialysis		Peritoneal dialysis		Transplant	
		No. of ** cases	Crude incidence rate (per million/yr)	Standardized incidence rate (per million/yr)	No. of cases	% of network	No. of cases	% of network	No. of cases	% of network
14	TX	11,433	409	442	10,234	89.5	910	8.0	262	2.3
18	S. CA	9,465	384	409	8,330	88.0	948	10.0	179	1.9
13	AR, LA, OK	5,113	439	387	4,481	87.6	540	10.6	89	1.7
9	IN, KY, OH	9,245	407	382	8,145	88.1	865	9.4	196	2.1
10	IL	5,297	412	382	4,496	84.9	616	11.6	154	2.9
8	AL, MS, TN	6,940	478	381	5,944	85.6	884	12.7	108	1.6
3	NJ, PR, VI	5,310	420	378	3,393	90.1	253	6.7	119	3.2
12	IA, KS, MO, NE	4,693	333	346	3,953	84.2	601	12.8	139	3.0
17	N. CA, HI, GU, AS, MP	6,318	369	345	5,083	83.9	830	13.7	138	2.3
6	NC, SC, GA	11,093	435	339	9,659	87.1	1,214	10.9	213	1.9
2	NY	7,600	382	335	6,945	91.4	388	5.1	261	3.4
4	DE, PA	5,285	384	335	4,663	88.2	451	8.5	153	2.9
11	MI, MN, ND, SD, WI	7,625	333	334	6,610	86.7	650	8.5	330	4.3
5	MD, DC, VA, WV	6,986	410	333	6,135	87.8	626	9.0	218	3.1
7	FL	8,342	403	318	7,458	89.4	732	8.8	141	1.7
15	AZ, CO, NV, NM, UT	6,015	282	297	5,145	85.5	649	10.8	215	3.6
16	AK, ID, MT, OR, WA	3,664	245	259	3,088	84.3	465	12.7	111	3.0
1	CT, MA, ME, NH, RI, VT	3,980	269	254	3,463	87.0	343	8.6	167	4.2
	All networks	124,675	388	361	107,225	87.5	11,965	9.8	3,193	2.6

*Data Source: Reference Table A.10 and special analyses, USRDS ESRD Database. *Standardized to the age-sex-race distribution of the 2011 U.S. population. Listed from highest to lowest standardized rate per million/year. The special analyses exclude U.S. territories, unknown age, sex, network, and unknown/other races. ** Includes 50 states, Washington, D.C. (DC), Puerto Rico (PR), Guam (GU), American Samoa (AS), U.S. Virgin Islands (VI), and the Northern Mariana Islands (MP). Northern and Southern California (CA) are split into Networks 17 and 18. Abbreviations: ESRD, end-stage renal disease; yr, year.*

Age-sex-race-standardized incidence rates of ESRD are shown geographically in Figure 1.3 by Health Service Area (HSA) in 2012-2016. Across 784 HSAs in the United States, the average rate during that 5-year period ranged from 59 to 1,152 per million/year (interquartile range: 254 to 392; Figure 1.3). Without further geospatial analyses, specific geographic patterns based on these HSA-level data are difficult to identify. In general, the standardized rates were highest in the South, central Midwest, Atlantic states, and California, and lowest in the mountain areas of Montana, Wyoming, Colorado, Utah, New Mexico, and Alaska.

vol 2 Figure 1.3 Map of the standardized incidence rate of ESRD, by Health Service Area, in the U.S. population, 2012-2016

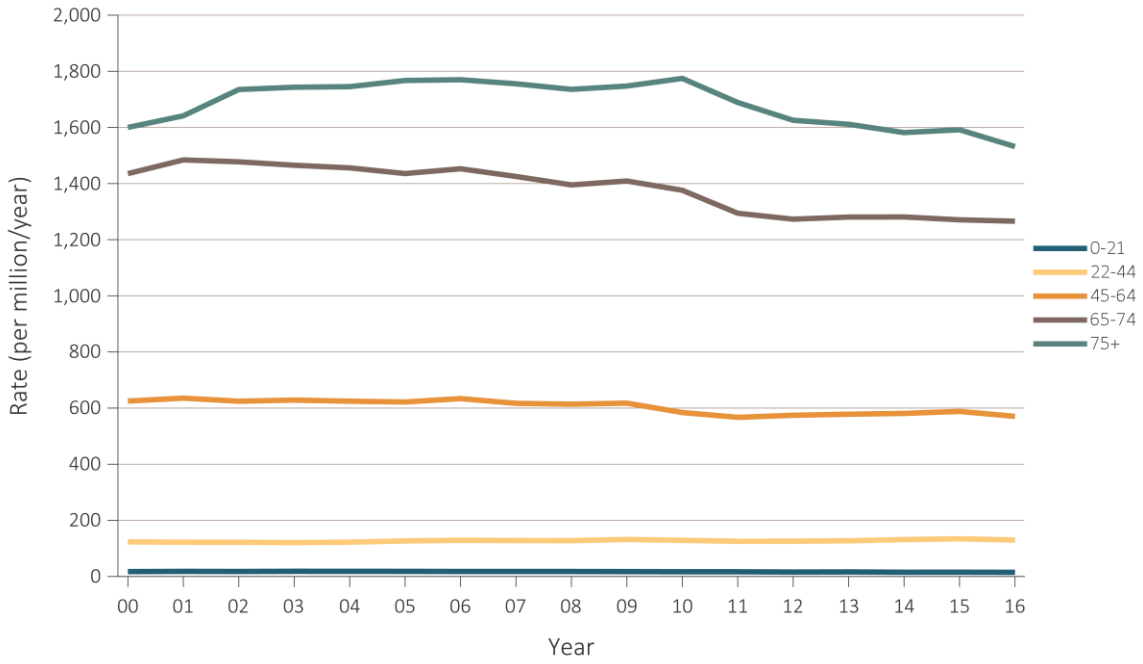


Data Source: Special analyses, USRDS ESRD Database. Standardized to the age-sex-race distribution of the 2011 U.S. population. Special analyses exclude unknown age, sex, HSA, and unknown/other race. Values for cells with 10 or fewer patients are suppressed. Abbreviation: ESRD, end-stage renal disease.

Incidence Rate: By Age

Sex-race-standardized incidence rates of ESRD have been generally stable since 2000 for younger age groups, and they have declined somewhat since 2010 for older persons (Figure 1.4).

vol 2 Figure 1.4 Trends in standardized ESRD incidence rate, by age group, in the U.S. population, 2000-2016



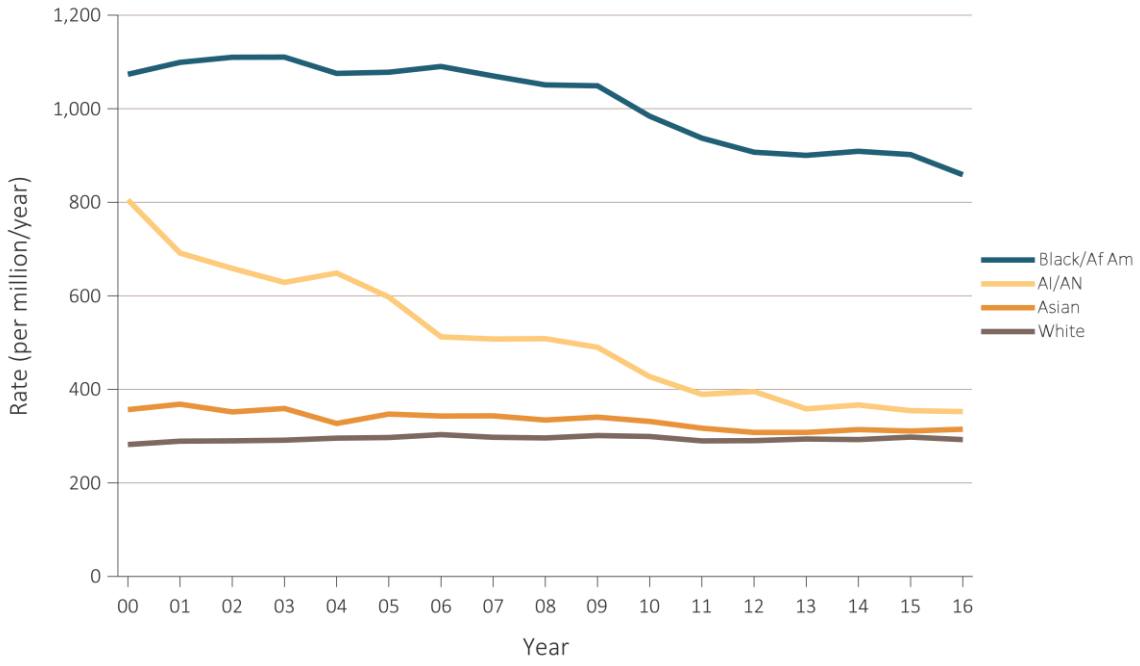
Data Source: Special analyses, USRDS ESRD Database. Standardized to the sex-race distribution of the 2011 U.S. population. Special analyses exclude unknown age, sex, and unknown/other race. Abbreviation: ESRD, end-stage renal disease.

Incidence Rate: By Race and Ethnicity

As shown in Figure 1.5, there were appreciable differences in the age-sex-standardized ESRD incidence rates among racial groups. The standardized incidence rate among Blacks was much higher than the rate among Whites; in 2016, the age-sex-standardized incidence rate ratio (Blacks/Whites) was 2.9. The standardized ESRD incidence rate among Whites has been generally stable since around 2000, but has declined in other race groups, especially among American Indians/Alaska Natives. The net result is that the excess rate of ESRD among minorities compared to Whites has decreased markedly. Between 2000 and 2016, the standardized rate ratio (vs. Whites) declined from 3.8 to 2.9 in African Americans, from 2.9 to 1.2 in American Indians/Alaska Natives, and from 1.3 to 1.1 in Asians, in whom there is no longer a higher rate. These changes may represent a reduction in health inequalities in the population with chronic kidney disease.

Standardized incidence rates for Native Hawaiians and Pacific Islanders (NH/PIs) are not included in Figure 1.5, because our estimates were unexpectedly too high to seem accurate (though similar estimates were included in the 2017 ADR, Figure 1.5). The underlying problem appears to be a difference in how race is classified in the USRDS ESRD database (from which numerators of the incidence rates are obtained) and in the U.S. Census (from which denominators are obtained). In particular, the reporting of multiple races as a category is often used in the Census, but rarely used now in the USRDS database (including the form CMS 2728, required of all newly treated patients with ESRD). This difference in reporting is most relevant for NH/PIs because nearly half of all persons in the 2010 U.S. Census who self-reported their race as NH/PI also reported one or more other races. If the denominators of the incidence rates for NH/PIs include only persons who report that one race—to be comparable with the numerators for which only one race is reported—ESRD incidence rates will be over-estimated by nearly 50%. However, sorting this out to obtain accurate estimates of standardized incidence rates of ESRD in NH/PIs has additional complications; thus, more work is needed before re-introducing these rates into the ADR.

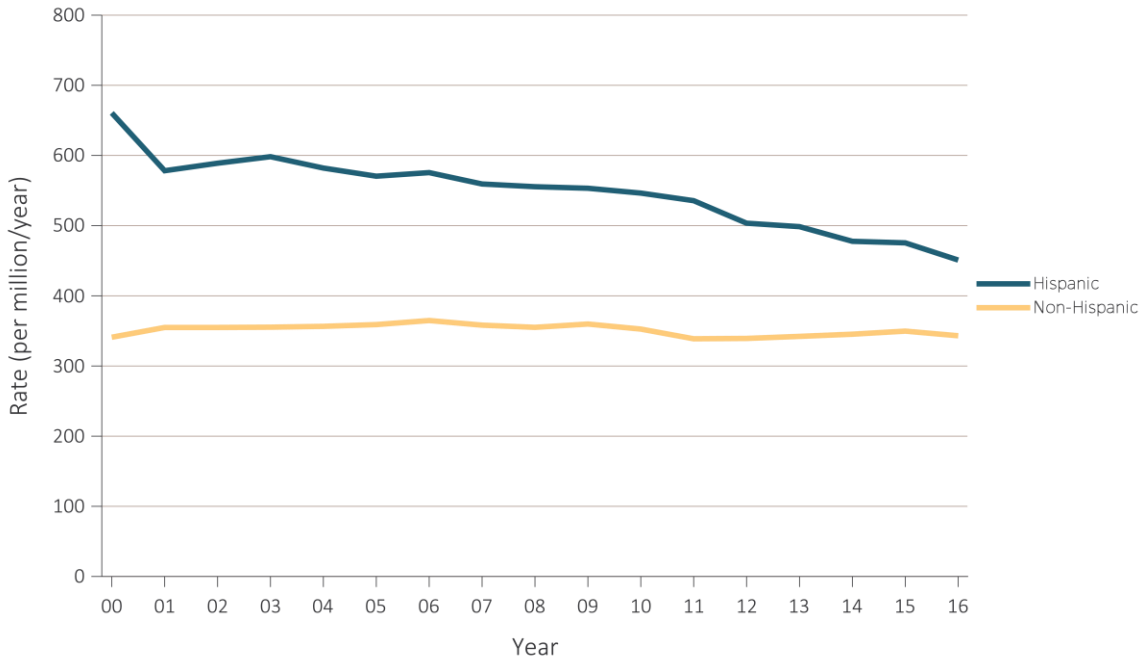
vol 2 Figure 1.5 Trends in standardized ESRD incidence rate, by race, in the U.S. population, 2000-2016



Data Source: Special analyses, USRDS ESRD Database. Standardized to the age-sex distribution of the 2011 U.S. population. Special analyses exclude unknown age, sex, and unknown/other race. Abbreviations: Af Am, African American; AI/AN: American Indian/Alaska Native; ESRD, end-stage renal disease.

While the age-sex-race-standardized incidence rate of ESRD has remained fairly stable in the non-Hispanic population since 2000, it has declined appreciably in Hispanics (Figure 1.6). Thus, the inequality between ethnic groups has also declined, though the rate remained 31.4% higher in Hispanics than non-Hispanics in 2016.

vol 2 Figure 1.6 Trends in standardized ESRD incidence rate, by Hispanic ethnicity, in the U.S. population, 2000-2016



Data Source: Special analysis. Standardized to the age-sex-race distribution of the 2011 U.S. population. Special analyses exclude unknown age, sex, and unknown/other race. Abbreviation: ESRD, end-stage renal disease.

Risk: Cumulative Incidence by Age, Sex, Race, and Duration of Follow-up

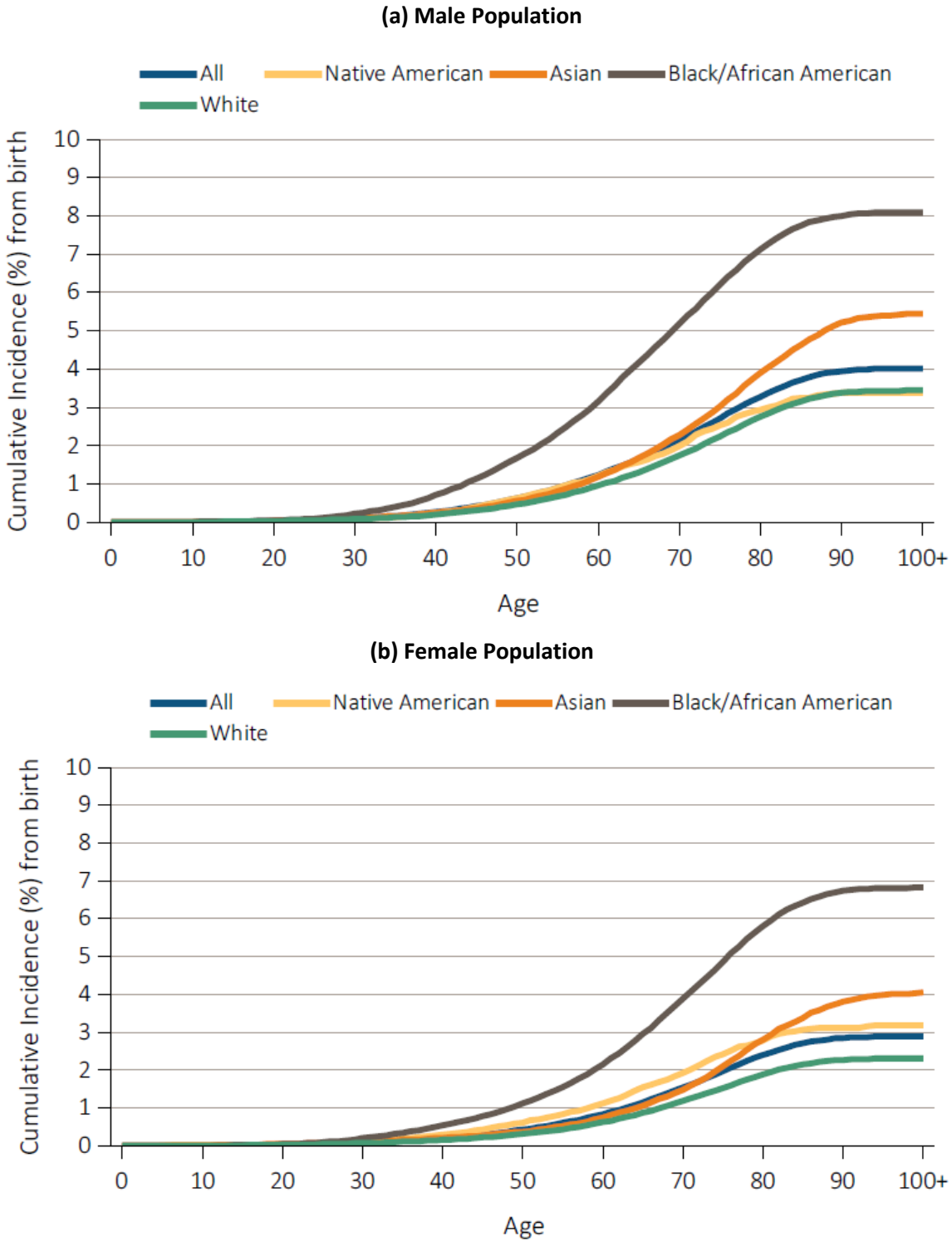
Unlike incidence rates that are strictly population measures, risks are probabilities of disease occurrence (in practice, diagnosis) during a given follow-up period among persons without the disease at the start of that period (baseline). In this section, we introduce the estimation of risks in the ADR, using USRDS data from 2013 to construct a large hypothetical cohort of at-risk persons followed from birth to death (age 100+) (Albertus et al., *AJKD*, 2016). With this method, a risk is referred to as a "cumulative incidence."

The cumulative incidence of ESRD from birth is shown separately for non-Hispanic males and females, by age and race, in Figure 1.7. At each age, starting in the 20s, the cumulative incidence is greater for males than females. Among all races combined, the lifetime cumulative incidence from birth is 4.02% in males and 2.89% in females. Substantial differences in the cumulative incidences of ESRD are observed among racial groups. Among males, the lifetime cumulative incidence from birth ranged from a low of 3.43% in Whites to a high of 8.09% in Blacks/African Americans. Similarly, among females, the lifetime cumulative incidence ranged from a low of 2.32% in Whites to a high of 6.83% in Blacks/African Americans. In both sexes, the elevated risk of ESRD in Blacks/African Americans, relative to all other racial groups, started at a young age—around 30.

Table 1.3 shows the cumulative incidence and 95% confidence interval (CI) of ESRD from a given baseline age (birth to 100), by sex and the duration of follow-up (10 years to lifetime). For example, consider a male who is free of ESRD at age 40 (Table 1.3.a). His 10-year cumulative incidence of ESRD (by age 50) is 0.35% (95% CI: 0.35%, 0.36%); his 30-year cumulative incidence (by age 80) is 3.07% (95% CI: 3.04%, 3.10%); and his lifetime cumulative incidence at age 40 is 3.94% (95% CI: 3.91%, 3.98%). Short-term cumulative incidences are low for both sexes. The 10-year cumulative incidence, which is highest at age 70, is 1.54% (95% CI: 1.52%, 1.57%) for males and 1.05% (95% CI: 1.03%, 1.07%) for females. As expected, the longer someone remains free of ESRD, the less likely that person will be treated for the disease in his or her

lifetime. Note, however, how that lifetime cumulative incidence declines more sharply late in life. That accelerated decline is due to the increasing risk of dying from other diseases (competing causes of death) late in life before being treated for ESRD.

vol 2 Figure 1.7 Cumulative incidence (%) of ESRD from birth to age 100+, by race/ethnicity, in the U.S. (a) male and (b) female populations, 2013



Source: Albertus et al. (Am J Kidney Dis, 2016). Abbreviation: ESRD, end-stage renal disease.

vol 2 Table 1.3 Cumulative incidence (%) of ESRD from baseline age to follow-up age in the U.S. (a) male and (b) female populations, 2013

(a) Male population

Baseline age	Duration of Follow-up										
	10 Years	20 Years	30 Years	40 Years	50 Years	60 Years	70 Years	80 Years	90 Years	100 Years	Lifetime**
Birth	0.01 (0.01-0.01)	0.03 (0.03-0.03)	0.09 (0.09-0.10)	0.25 (0.24-0.25)	0.58 (0.57-0.59)	1.16 (1.15-1.17)	2.05 (2.03-2.06)	3.14 (3.12-3.17)	3.86 (3.83-3.89)	3.96 (3.93-3.99)	3.96 (3.93-3.99)
10 Years	0.02 (0.02-0.02)	0.08 (0.08-0.09)	0.24 (0.23-0.24)	0.58 (0.57-0.59)	1.16 (1.15-1.17)	2.05 (2.03-2.07)	3.16 (3.13-3.18)	3.88 (3.85-3.91)	3.98 (3.95-4.01)		3.98 (3.95-4.02)
20 Years	0.06 (0.06-0.07)	0.22 (0.21-0.23)	0.56 (0.55-0.57)	1.15 (1.13-1.16)	2.04 (2.02-2.06)	3.15 (3.13-3.18)	3.88 (3.85-3.91)	3.98 (3.95-4.01)			3.98 (3.95-4.01)
30 Years	0.16 (0.15-0.16)	0.50 (0.50-0.51)	1.10 (1.08-1.11)	2.01 (1.99-2.02)	3.13 (3.11-3.16)	3.87 (3.84-3.90)	3.97 (3.94-4.00)				3.97 (3.94-4.00)
40 Years	0.35 (0.34-0.36)	0.96 (0.94-0.97)	1.88 (1.86-1.90)	3.03 (3.00-3.05)	3.78 (3.75-3.81)	3.88 (3.85-3.91)					3.88 (3.85-3.91)
50 Years	0.63 (0.62-0.63)	1.58 (1.57-1.60)	2.77 (2.74-2.80)	3.55 (3.51-3.58)	3.65 (3.62-3.69)						3.65 (3.62-3.69)
60 Years	1.04 (1.02-1.05)	2.32 (2.30-2.35)	3.16 (3.13-3.20)	3.28 (3.24-3.31)							3.28 (3.25-3.31)
70 Years	1.51 (1.49-1.53)	2.49 (2.46-2.53)	2.63 (2.60-2.66)								2.63 (2.60-2.67)
80 Years	1.42 (1.39-1.45)	1.61 (1.58-1.64)									1.61 (1.58-1.65)
90 Years	0.51 (0.48-0.54)										0.52 (0.49-0.55)
100 Years											0.07 (0.02-0.17)

Table 1.3 continued on next page.

vol 2 Table 1.3 Cumulative incidence (%) of ESRD from baseline age to follow-up age in the U.S. (a) male and (b) female populations, 2013 (continued)

(b) Female population

Baseline age	Duration of Follow-up										
	10 Years	20 Years	30 Years	40 Years	50 Years	60 Years	70 Years	80 Years	90 Years	100 Years	Lifetime**
Birth	0.01 (0.01-0.01)	0.02 (0.02-0.02)	0.08 (0.08-0.08)	0.19 (0.19-0.20)	0.40 (0.39-0.41)	0.78 (0.77-0.79)	1.45 (1.43-1.46)	2.29 (2.26-2.31)	2.78 (2.76-2.81)	2.84 (2.81-2.87)	2.84 (2.81-2.87)
10 Years	0.02 (0.02-0.02)	0.07 (0.07-0.08)	0.19 (0.18-0.19)	0.39 (0.39-0.40)	0.78 (0.77-0.79)	1.45 (1.43-1.47)	2.29 (2.27-2.32)	2.79 (2.77-2.82)	2.85 (2.83-2.88)		2.85 (2.83-2.88)
20 Years	0.06 (0.05-0.06)	0.17 (0.16-0.17)	0.38 (0.37-0.39)	0.77 (0.75-0.78)	1.44 (1.42-1.45)	2.28 (2.26-2.30)	2.78 (2.76-2.81)	2.84 (2.81-2.87)			2.84 (2.82-2.87)
30 Years	0.11 (0.11-0.12)	0.32 (0.32-0.33)	0.71 (0.70-0.72)	1.39 (1.37-1.40)	2.24 (2.22-2.26)	2.74 (2.72-2.77)	2.80 (2.77-2.83)				2.80 (2.77-2.83)
40 Years	0.21 (0.21-0.22)	0.61 (0.60-0.62)	1.29 (1.27-1.30)	2.15 (2.13-2.17)	2.65 (2.63-2.68)	2.71 (2.69-2.74)					2.71 (2.69-2.74)
50 Years	0.40 (0.40-0.41)	1.10 (1.09-1.11)	1.98 (1.96-2.00)	2.50 (2.47-2.52)	2.56 (2.53-2.58)						2.56 (2.53-2.58)
60 Years	0.73 (0.72-0.74)	1.65 (1.63-1.67)	2.20 (2.17-2.22)	2.26 (2.23-2.29)							2.26 (2.24-2.29)
70 Years	1.02 (1.00-1.04)	1.62 (1.60-1.65)	1.69 (1.67-1.72)								1.69 (1.67-1.72)
80 Years	0.78 (0.76-0.79)	0.87 (0.85-0.89)									0.87 (0.85-0.89)
90 Years	0.19 (0.18-0.21)										0.20 (0.18-0.21)
100 Years											0.02 (0.01-0.05)

*Source: Albertus et al. (Am J Kidney Dis, 2016). Abbreviation: ESRD, end-stage renal disease. **Lifetime corresponds to follow-up of more than 100 years*

Prevalence of ESRD: Counts, Prevalence, and Trends

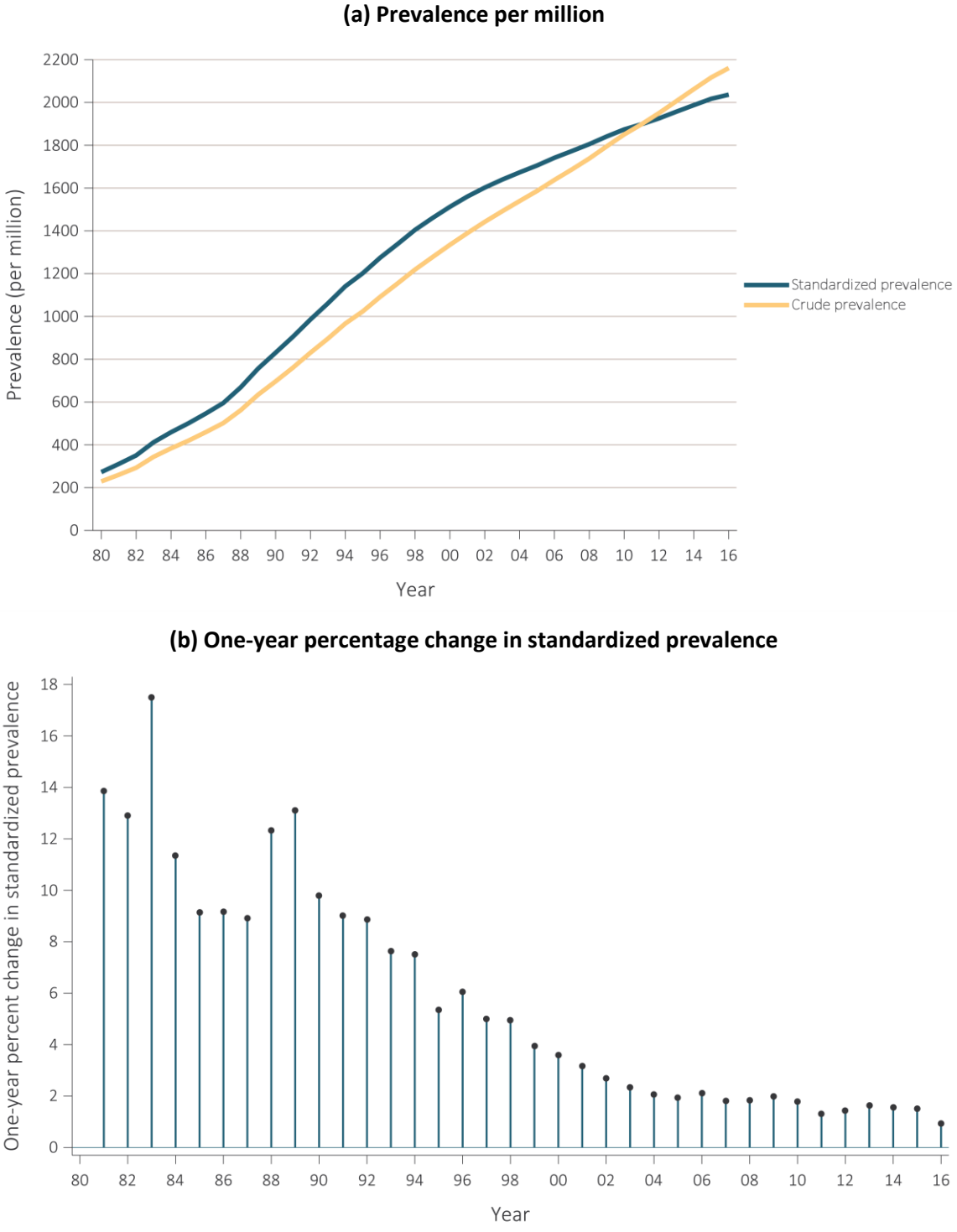
Overall Prevalence

On December 31, 2016, there were 726,331 prevalent cases of ESRD in the United States; this represents an increase of 3.0% since 2015, and of 86.0% since 2000 (Table 1.4 and Figure 1.9). The crude ESRD prevalence reached 2,161 per million, an increase of 2.1% since 2015 and 61.9% since 2000 (Table 1.4).

As shown in Table 1.4 and Figure 1.8, both crude and age-sex-race-standardized prevalence of ESRD increased steadily between 1980 and 2016. In general, however, the absolute and proportional yearly changes were a little greater for the crude prevalence than for the standardized prevalence, particularly after 2000 (Table 1.4). The increasing prevalent count and crude prevalence indicate the need for additional resources to manage ESRD in the U.S. population, as demonstrated in Volume 2, Chapter 9: *Healthcare Expenditures for Persons with ESRD*.

Because prevalence reflects both the incidence and course of the disease, these ESRD prevalence trends result from not only an increasing number of incident cases (Table 1.1) but also longer survival among ESRD patients. This is supported by the mortality data shown in *Volume 2, Chapter 5* and *Reference Table H*. Table H.2 shows that the crude mortality rate among all ESRD patients declined from 185.6 per 1,000/year in 1996 to 136.3 per 1,000/year in 2016, an absolute decrease of 49.3 per 1,000/year. Had the 1996 mortality rate been seen in the 2016 prevalent cohort, there would have been over 30,000 additional deaths. Improving survival in the ESRD population was clearly the primary cause of increasing prevalence in the past two decades.

vol 2 Figure 1.8 Trends in the (a) crude and standardized prevalence of ESRD, and (b) annual percentage change in the standardized prevalence of ESRD, in the U.S. population, 1980-2016



Data Source: Special analyses, USRDS ESRD Database. The special analyses exclude U.S. territories, unknown age, and unknown/other races. Standardized for age, sex, and race. Abbreviation: ESRD, end-stage renal disease.

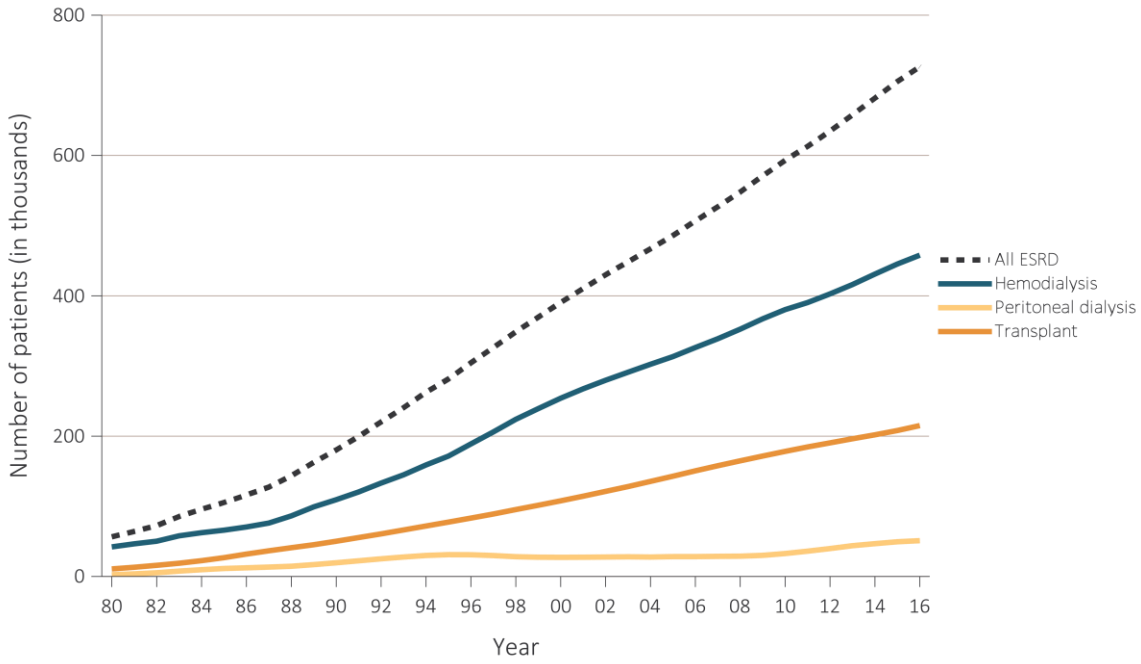
Among prevalent ESRD cases on December 31, 2016, 63.1% used hemodialysis as their renal replacement therapy, 7.0% used peritoneal dialysis, and 29.6% had a functioning kidney transplant (Figure 1.9). The size of the prevalent HD population increased from 2000 to 2016 by 80.2% (Figure 1.9); the prevalent PD population increased by 87.2%, and the transplant population increased by 99.4% during the same period.

vol 2 Table 1.4 Trends in annual number of ESRD prevalent cases, crude and standardized ESRD prevalence, and annual percentage changes, in the U.S. population, 1980-2016

Year	Prevalent count		Crude prevalence		Standardized prevalence	
	No. of cases	% Change from previous year	Prevalence (per million year)	% Change from previous year	Prevalence (per million year)	% Change from previous year
1980	56,435	n/a	59.2	n/a	65.3	n/a
1981	64,258	13.9	74.6	26.0	83.1	27.3
1982	72,499	12.8	90.6	21.4	101.3	21.9
1983	85,581	18.0	109.4	20.8	123.1	21.5
1984	95,897	12.1	131.8	20.5	148.9	21.0
1985	105,432	9.9	157.4	19.4	178.6	19.9
1986	116,119	10.1	190.5	21.0	217.0	21.5
1987	127,476	9.8	226.6	19.0	259.7	19.7
1988	143,526	12.6	284.1	25.4	329.6	26.9
1989	162,708	13.4	349.4	23.0	407.0	23.5
1990	180,526	11.0	395.9	13.3	461.7	13.4
1991	199,554	10.5	442.8	11.8	515.8	11.7
1992	220,345	10.4	500.0	12.9	581.2	12.7
1993	240,552	9.2	549.3	9.9	637.7	9.7
1994	262,627	9.2	607.2	10.5	704.2	10.4
1995	281,564	7.2	729.3	20.1	847.6	20.4
1996	304,420	8.1	865.1	18.6	1,004.3	18.5
1997	326,218	7.2	979.1	13.2	1,132.0	12.7
1998	348,761	6.9	1,080.6	10.4	1,244.1	9.9
1999	369,625	6.0	1,166.3	7.9	1,333.8	7.2
2000	390,566	5.7	1,243.6	6.6	1,410.6	5.8
2001	410,507	5.1	1,311.1	5.4	1,474.2	4.5
2002	429,887	4.7	1,372.7	4.7	1,526.8	3.6
2003	448,543	4.3	1,427.9	4.0	1,571.3	2.9
2004	467,088	4.1	1,480.0	3.6	1,610.2	2.5
2005	485,984	4.0	1,531.1	3.5	1,647.3	2.3
2006	506,764	4.3	1,585.6	3.6	1,686.8	2.4
2007	526,899	4.0	1,637.3	3.3	1,721.5	2.1
2008	548,019	4.0	1,690.7	3.3	1,756.4	2.0
2009	570,790	4.2	1,749.0	3.4	1,794.1	2.1
2010	593,172	3.9	1,805.7	3.2	1,829.0	1.9
2011	613,050	3.4	1,855.1	2.7	1,855.1	1.4
2012	634,728	3.5	1,908.5	2.9	1,884.1	1.6
2013	657,947	3.7	1,965.2	3.0	1,916.7	1.7
2014	681,783	3.6	2,021.7	2.9	1,948.2	1.6
2015	705,492	3.5	2,077.1	2.7	1,979.1	1.6
2016	726,331	3.0	2,120.5	2.1	1,998.3	1.0

Data Source: Special analyses of the USRDS ESRD Database. The special analyses exclude U.S. territories, unknown age, and unknown/other races. Standardized to the age-sex-race distribution of the 2011 U.S. population. Abbreviations: ESRD, end-stage renal disease; n/a, not applicable.

vol 2 Figure 1.9 Trends in the number of ESRD prevalent cases, by modality, in the U.S. population, 1980-2016



Data Source: Reference Table D.1 and special analysis of USRDS ESRD Database. Abbreviation: ESRD, end-stage renal disease. Persons with "Uncertain Dialysis" were included in the "All ESRD" total, but are not represented separately.

Prevalence: By Region

Among the 18 ESRD Networks, the age-sex-race-standardized prevalence of ESRD ranged from 2,870 per million in Network 3 (NJ, PR, VI) to 1,640 per million in Network 1 (CT, MA, ME, NH, RI, VT) (Table 1.5). Renal replacement modality use by region, also presented in Table 1.5, is discussed in the section Modality of Renal Replacement Therapy: Incident ESRD Cases later in this chapter.

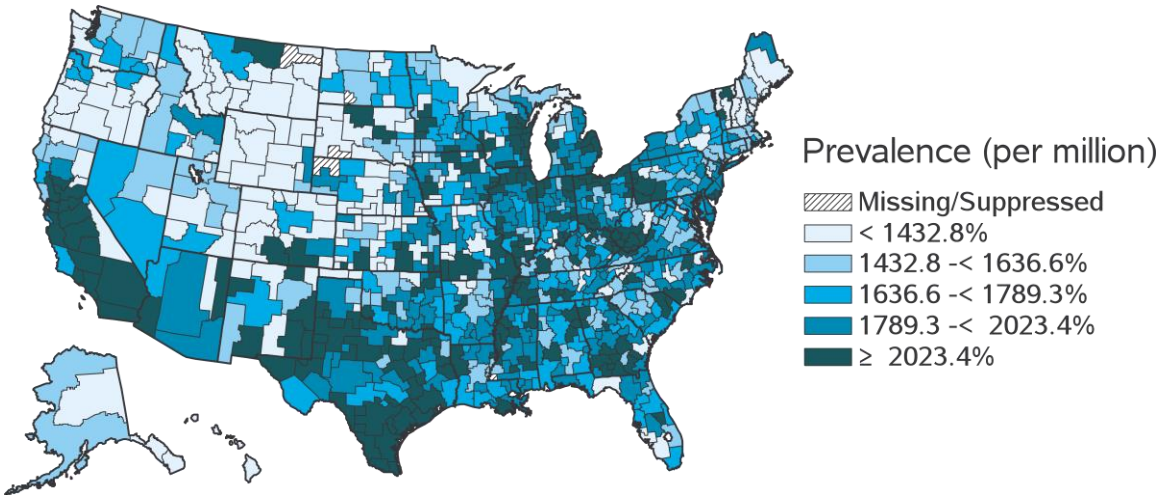
vol 2 Table 1.5 Crude and standardized* prevalence of ESRD (per million) and annual number of ESRD prevalent cases, overall and by modality (hemodialysis, peritoneal dialysis, and transplantation) and ESRD Network (ordered from highest to lowest standardized rate), in the U.S. population, 2016

		Total ESRD			Hemodialysis		Peritoneal dialysis		Transplant	
Network	States in network*	No. of cases**	Crude prevalence (per million)	Standardized prevalence (per million)	No. of cases	% of network	No. of cases	% of network	No. of cases	% of network
3	NJ, PR, VI	28,864	3,141	2,870	13,398	63.7	1,005	4.8	6,572	31.2
18	S. CA	60,362	2,446	2,618	40,597	67.3	4,737	7.8	14,895	24.7
14	TX	65,415	2,321	2,490	45,145	69.0	4,237	6.5	15,837	24.2
10	IL	31,906	2,473	2,293	19,367	60.7	2,274	7.1	10,176	31.9
17	N. CA, HI, GU, AS	39,881	2,417	2,270	23,726	61.2	3,349	8.6	11,541	29.8
11	MI, MN, ND, SD, WI	46,573	2,025	2,094	25,869	55.6	2,682	5.8	17,860	38.4
9	IN, KY, OH	48,366	2,120	2,060	30,458	63.0	3,747	7.7	13,965	28.9
12	IA, KS, MO, NE	26,282	1,860	2,025	14,553	55.4	2,241	8.5	9,403	35.8
4	DE, PA	30,504	2,212	2,010	18,529	60.7	1,929	6.3	9,946	32.6
13	AR, LA, OK	26,851	2,300	1,981	18,078	67.3	2,289	8.5	6,359	23.7
2	NY	45,334	2,258	1,966	29,576	65.2	1,655	3.7	14,008	30.9
8	AL, MS, TN	37,446	2,568	1,948	25,368	67.7	3,063	8.2	8,908	23.8
15	AZ, CO, NV, NM, UT	37,416	1,746	1,877	21,892	58.5	2,800	7.5	12,623	33.7
5	MD, DC, VA, WV	41,439	2,430	1,867	26,224	63.3	2,591	6.3	12,485	30.1
6	NC, SC, GA	64,220	2,501	1,814	43,859	68.3	5,334	8.3	14,849	23.1
7	FL	43,988	2,102	1,738	28,314	64.4	3,170	7.2	12,337	28.1
16	AK, ID, MT, OR, WA	23,081	1,532	1,694	12,555	54.4	1,998	8.7	8,442	36.6
1	CT, MA, ME, NH, RI, VT	24,583	1,653	1,640	13,379	54.4	1,451	5.9	9,648	39.2
	All networks	726,331	2,274	2,138	450,887	63.2	50,552	7.1	209,854	29.4

*Data Source: Reference Table B.10 and special analyses, USRDS ESRD Database. *Standardized to the age-sex-race distribution of the 2011 U.S. population. Listed from highest to lowest standardized rate per million/year. The special analyses exclude U.S. territories, unknown age, sex, network, and unknown/other races. **No. of cases does include 50 states, Washington, D.C. (DC), Puerto Rico (PR), Guam (GU), and American Samoa (AS). Northern and Southern California (CA) split into Networks 17 and 18. Abbreviations: Af Am, African American; ESRD, end-stage renal disease; Hisp, Hispanic; N Am, Native American.*

Across 801 Health Service Areas, the standardized prevalence of ESRD in 2012-2016 ranged from 299 per million to 6,219 per million (interquartile range: 1,481 to 2,023 per million; Figure 1.10). Although specific geographic patterns are difficult to identify without further geospatial analyses, ESRD prevalence in 2016 tended to be relatively high or low in roughly the same areas as observed for ESRD incidence (Figure 1.3).

vol 2 Figure 1.10 Map of the standardized prevalence of ESRD, by Health Service Area, in the U.S. population, 2012-2016*

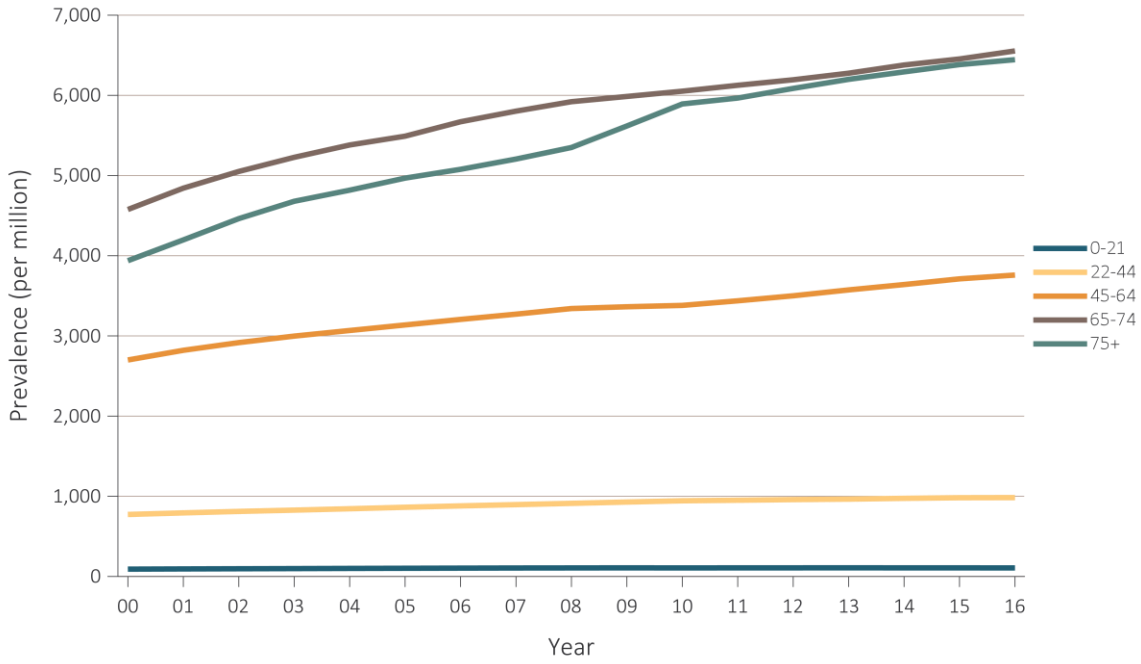


*Data Source: Special analyses, USRDS ESRD Database. Standardized to the age-sex-race distribution of the 2011 U.S. population. Special analyses exclude unknown age, sex, HSA, and unknown/other race. *Four Health Service Areas were suppressed because the ratio of crude rate to standardized rate or standardized rate to crude rate was greater than 3. Values for cells with 10 or fewer patients are suppressed. Abbreviation: ESRD, end-stage renal disease.*

Prevalence: By Age

The sex-race-standardized ESRD prevalence has risen over time, with steeper increases among the older age groups (Figure 1.11). These increases contrast with the ongoing declines in standardized ESRD incidence rates across age groups (Figure 1.4). The pattern of this discrepancy likely results from improvement in survival over calendar time among ESRD patients and the transition of surviving incident ESRD patients in each age group to older groups. ESRD prevalence was highest for persons 65-74 years of age until 2010 when the gap with persons 75 years of age and older started to narrow. Although the incidence rate was highest in the oldest group (≥75), ESRD prevalence was a little lower, due to greater mortality among the oldest ESRD patients.

vol 2 Figure 1.11 Trends in the standardized prevalence of ESRD, by age group, in the U.S. population, 2000-2016



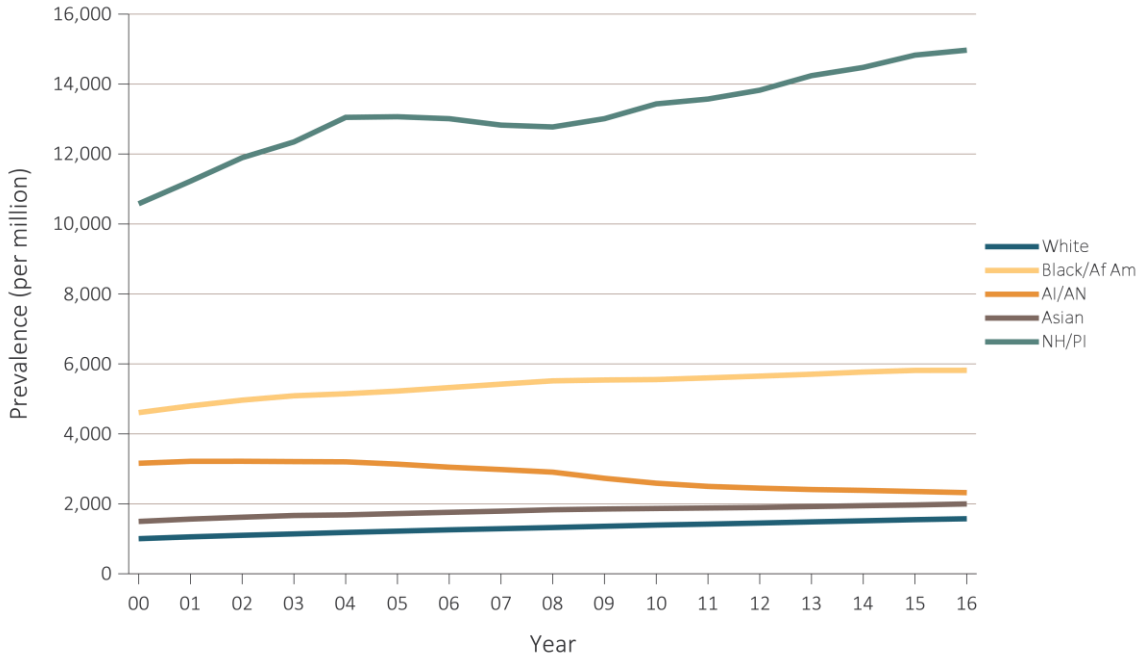
Data Source: Special analyses, USRDS ESRD Database. Point prevalence on December 31 of each year. Standardized to the sex-race distribution of the 2011 U.S. population. Special analyses exclude unknown age, sex, and unknown/other race. Abbreviation: ESRD, end-stage renal disease.

Prevalence: By Race and Ethnicity

In 2016, the age-sex-standardized prevalence of ESRD (per million) was 14,969 among Native Hawaiians/Pacific Islanders, 5,816 among Blacks/African Americans, 2,319 among American Indians/Alaska Natives, 1,997 among Asians, and 1,573 among Whites (Figure 1.12). The prevalence of ESRD for Native Hawaiians/Pacific Islanders was much higher than in other racial groups, by more than 9.5-fold as compared to Whites, nearly 7.5-fold higher than Asians, 6.5-fold higher than American Indians/Alaska Natives, and nearly 2.6-fold higher than Blacks/African Americans.

The standardized prevalence of ESRD has continued to rise, especially since 2008, in all racial groups except American Indians/Alaska Natives (Figure 1.5). The remarkable decline in the incidence rate among this latter group has resulted in a 36% reduction in the prevalence of ESRD, from 3,159 per million in 2000 to 2,319 per million in 2016 (Figure 1.12).

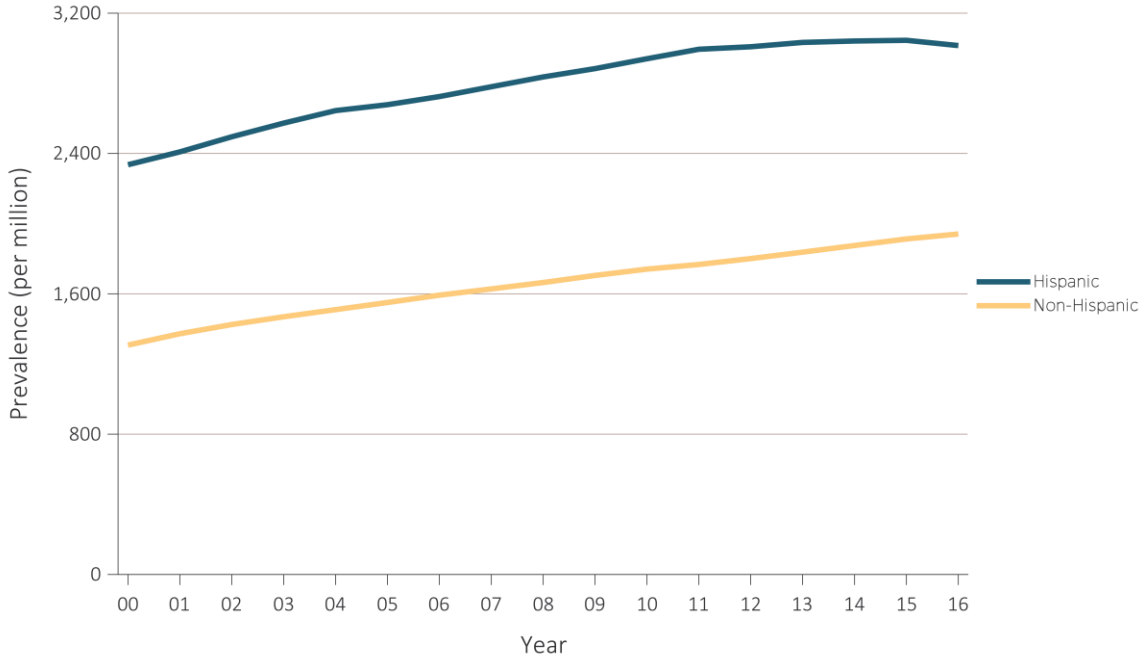
vol 2 Figure 1.12 Trends in the standardized prevalence of ESRD, by race, in the U.S. population, 2000-2016



Data Source: Special analyses, USRDS ESRD Database. Point prevalence on December 31 of each year. Standardized to the age-sex distribution of the 2011 U.S. population. Special analyses exclude unknown age, sex, and unknown/other race. Abbreviations: Af Am, African American; AI/AN: American Indian/Alaska Native; ESRD, end-stage renal disease; NH/PI: Native Hawaiian/Pacific Islander.

In 2016, the age-sex-race-standardized ESRD prevalence was 1,941 per million among non-Hispanics, and 55.3% higher, at 3,015 per million, among Hispanics (Figure 1.13). The standardized ESRD prevalence has risen for both non-Hispanics and Hispanics, though since 2011, it has shown signs of plateauing among Hispanics. The absolute difference in standardized prevalence between Hispanics and non-Hispanics was about the same in 2000 and 2016.

vol 2 Figure 1.13 Trends in the standardized prevalence of ESRD, by Hispanic ethnicity, in the U.S. population, 2000-2016



Data Source: Special analysis, USRDS ESRD Database. Point prevalence on December 31 of each year. Standardized to the age-sex-race distribution of the 2011 U.S. population. Special analyses exclude unknown age, sex, and unknown/other race. Abbreviation: ESRD, end-stage renal disease.

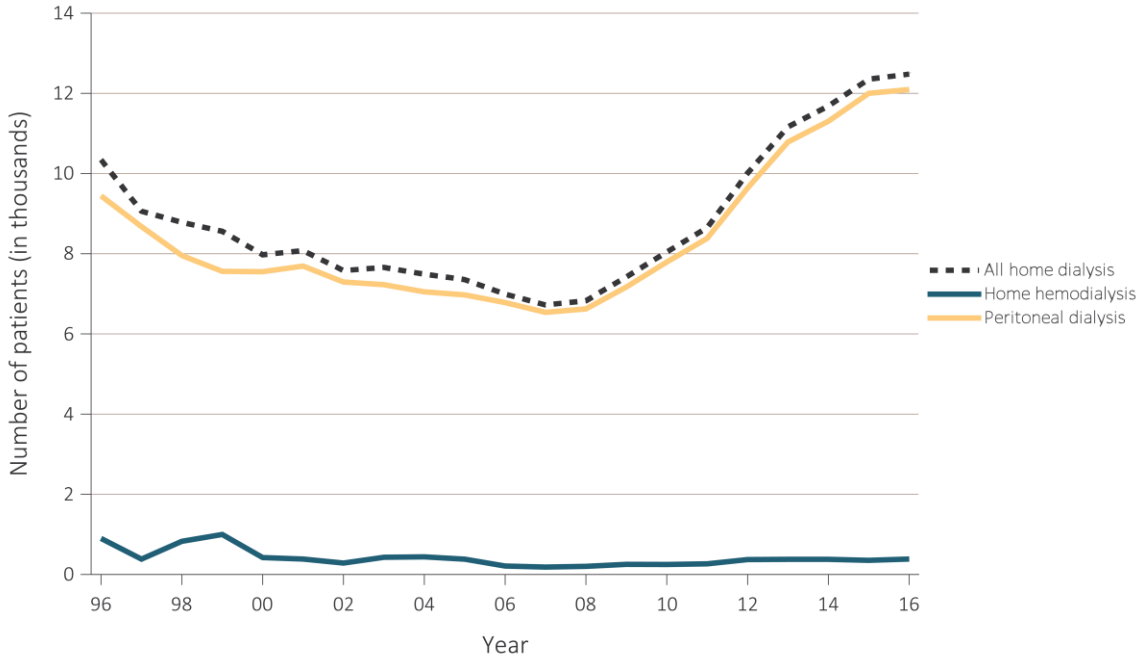
Modality of Renal Replacement Therapy: Incident ESRD Cases

As shown previously in Figure 1.2, among incident ESRD patients in 2016, 87.3% used hemodialysis as their renal replacement therapy, 9.7% used peritoneal dialysis, and 2.8% received a preemptive kidney transplant. Since 2000, the number of incident HD patients has increased by 28.8%; the number of incident PD patients has increased by 60.2%, and the number of preemptive transplants has increased by 73.1%. By comparison, the U.S. population was 14.6% larger in 2016 than in 2000.

Trends in Incident Counts: By Renal Replacement Therapy Modality

Use of home dialysis among incident ESRD patients decreased from 1996 to 2007, but has increased appreciably since 2008 through 2016 (Figure 1.14). Overall, home dialysis use in 2016 was 85.6% higher than at its least utilized point in 2007. In 2016, use of PD and home HD were 85.0% and 108.1% higher, respectively, than in 2007. PD has continued to be the dominant form of home dialysis. Despite the large proportional rise in home HD, its overall use was only 3.1% of all incident ESRD patients receiving dialysis in 2016 (*Reference Table D.1*).

vol 2 Figure 1.14 Trends in the number of incident ESRD cases using home dialysis, by type of therapy, in the U.S. population, 1996-2016



Data Source: Reference Table D.1 and special analysis, USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease.

Renal Replacement Therapy Modality Use: By Patient Characteristics

Use of peritoneal dialysis and preemptive kidney transplants were markedly more common in 2016 among younger ESRD patients than among older patients, and they were a little less common among Black/African American and Hispanic ESRD patients than in White patients (Table 1.6). Use of PD and preemptive kidney transplants were more common among ESRD patients with glomerular or cystic kidney disease as the primary cause of ESRD than in ESRD patients with other primary causes of ESRD. This difference is partially due to age, as both glomerular and cystic kidney disease are more common in younger patients.

vol 2 Table 1.6 Number and percentage of incident ESRD patients receiving hemodialysis (HD), peritoneal dialysis (PD), and a transplant, by age, sex, race, ethnicity, and primary cause of ESRD, in the U.S. population, 2016

	Total	Hemodialysis		Peritoneal dialysis		Transplant	
		n	%	n	%	n	%
Age							
0-21	1,386	714	51.5	396	28.6	276	19.9
22-44	13,648	10,742	78.7	2,055	15.1	851	6.2
45-64	47,374	40,745	86.0	4,996	10.5	1,633	3.4
65-74	33,641	30,076	89.4	2,912	8.7	653	1.9
75+	28,407	26,618	93.7	1,736	6.1	53	0.2
Sex							
Male	72,049	62,923	87.3	7,092	9.8	2,034	2.8
Female	52,407	45,972	87.7	5,003	9.5	1,432	2.7
Race							
White	83,662	72,645	86.8	8,475	10.1	2,542	3.0
Black/African American	31,921	29,047	91.0	2,547	8.0	327	1.0
American Indian or Alaska Native	1,203	1,048	87.1	95	7.9	60	5.0
Asian	5,396	4,273	79.2	772	14.3	351	6.5
Native Hawaiian or Pacific Islander	1,578	1,421	90.1	147	9.3	10	0.6
Other or Multiracial	407	317	77.9	53	13.0	37	9.1
Unknown	289	144	49.8	*	2.1	139	48.1
Ethnicity							
Hispanic	18,273	16,309	89.3	1,662	9.1	302	1.7
Non-Hispanic	104,869	91,999	87.7	10,361	9.9	2,509	2.4
Unknown	1,314	587	44.7	72	5.5	655	49.8
Primary cause of ESRD							
Diabetes	58,136	52,489	90.3	5,245	9.0	402	0.7
Hypertension	34,784	31,201	89.7	3,290	9.5	293	0.8
Glomerulonephritis	9,108	7,047	77.4	1,596	17.5	465	5.1
Cystic Kidney	3,513	2,143	61.0	803	22.9	567	16.1
Other/Unknown	18,915	16,015	84.7	1,161	6.1	1,739	9.2
Total	124,456	108,895	87.5	12,095	9.7	3,466	2.8

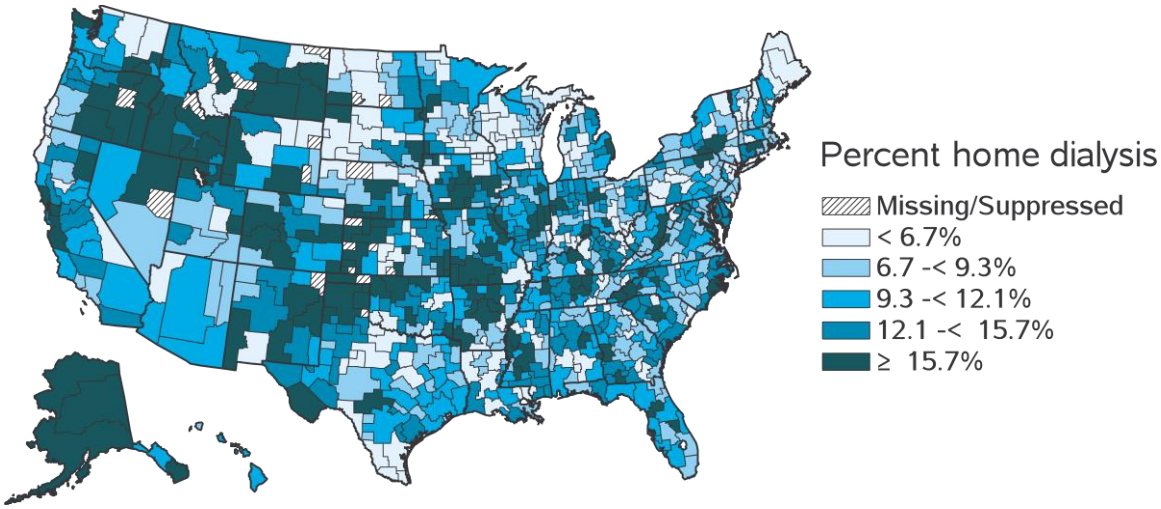
*Data Source: Reference Table D.10 and special analyses, USRDS ESRD Database. The numbers in this table exclude "Uncertain Dialysis." Hemodialysis includes home hemodialysis and in-center hemodialysis. *Values for cells with 10 or fewer patients are suppressed. Abbreviation: ESRD, end-stage renal disease.*

Renal Replacement Therapy Modality Use: By Region

Among incident ESRD cases in 2016, hemodialysis was the predominant modality in all networks, ranging from 84.2% in Network 12 (IA, KS, MO, NE) to 91.4% in Network 2 (NY; Table 1.2). Use of PD varied more than 2-fold, from 5.1% in Network 2 (Table 1.2) to 13.7% in Network 17 (N.CA, HI, GU, AS) (Table 1.2). Overall, preemptive kidney transplantation remained an uncommon initial RRT modality, at 2.6%, although its use ranged more than 3-fold from 1.6% in Network 8 (AL, MS, TN) to 4.3% in Network 11 (MI, MN, ND, SD, WI).

The proportion of incident dialysis patients using home dialysis in 2012-2016 varied substantially across 785 HSAs, ranging from 0% to 67% (interquartile range: 7.3% to 14.1%; Figure 1.15). Few geographic patterns were apparent, supporting the likelihood that differences in home dialysis use were largely driven by variations between individual dialysis centers or groups of centers, rather than by large-scale regional effects. However, relative to the geographic distribution of the standardized ESRD incidence rate during the same 5-year period (Figure 1.3), home dialysis was proportionally more common in the Western United States.

vol 2 Figure 1.15 Map of the percentage of incident dialysis cases using home dialysis (peritoneal dialysis or home hemodialysis), by Health Service Area, 2012-2016



Data Source: Special analyses, USRDS ESRD Database. Values for cells with 10 or fewer patients are suppressed. Abbreviation: ESRD, end-stage renal disease.

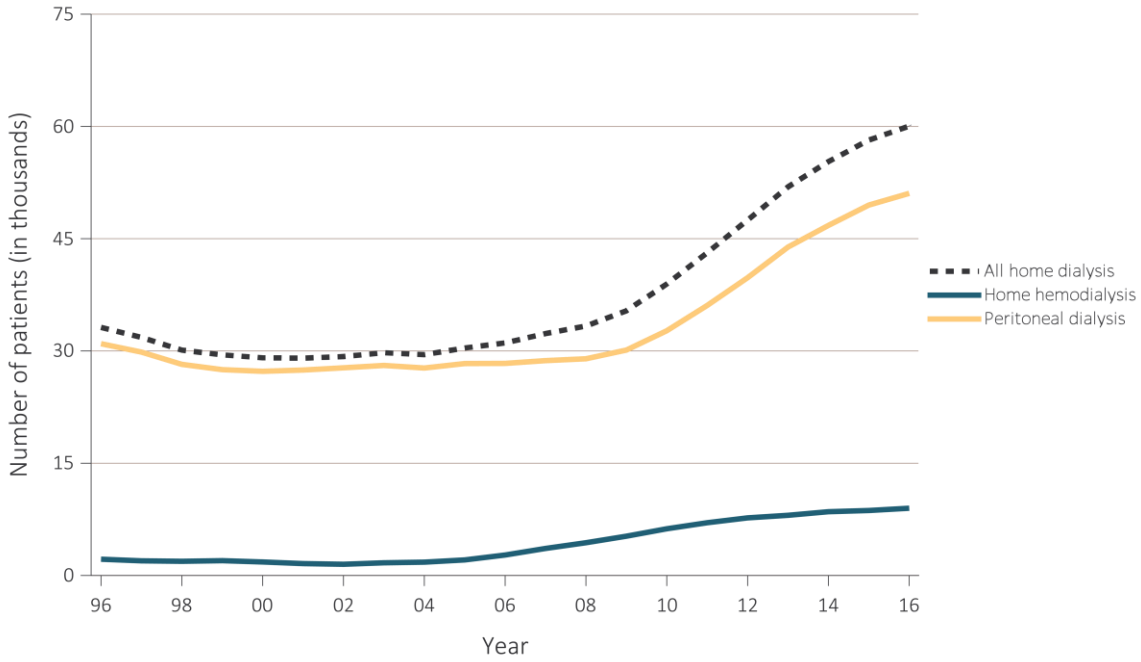
Modality of Renal Replacement Therapy: Prevalent ESRD Cases

Trends in Prevalent Counts: By Renal Replacement Therapy Modality

The use of home dialysis (PD or home HD) among prevalent ESRD patients has increased appreciably in recent years (Figure 1.16), mirroring the trend shown for incident dialysis (Figure 1.14).

Home dialysis accounted for 8.3% of all prevalent dialysis patients in 2016, up from a low of 6.1% in 2008 (*Reference Table D.1*). In this home dialysis group, the proportion using HD vs. PD was much higher in 2016 (17.6%) than in 2000 (6.7%) (Fig 1.16).

vol 2 Figure 1.16 Trends in number of prevalent ESRD cases using home dialysis, by type of therapy, in the United States, 1996-2016



Data Source: Reference Table D.1. December 31 prevalent ESRD patients. Peritoneal dialysis consists of continuous ambulatory peritoneal dialysis (CAPD), continuous cycling peritoneal dialysis (CCPD), and intermittent peritoneal dialysis (other PD) only. Abbreviation: ESRD, end-stage renal disease.

Renal Replacement Therapy Modality Use: By Patient Characteristics

Distributions of the modality used by prevalent ESRD patients (Table 1.7), by patient characteristics, generally reflect those distributions for incident ESRD patients (Table 1.6). Uses of PD and kidney transplant were more common among patients who were younger, White, non-Hispanic, and with glomerular disease or cystic kidney disease as the primary cause of their ESRD (Table 1.7).

vol 2 Table 1.7 Number and percentage of prevalent ESRD patients receiving hemodialysis, peritoneal dialysis, and a transplant, by age, sex, race, ethnicity, and the primary cause of ESRD, in the United States, 2016

	Total	HD		PD		Transplant	
		n	%	n	%	n	%
Age							
0-21	9,705	1,697	17.5	1,027	10.6	6,981	71.9
22-44	103,213	51,001	49.4	9,110	8.8	43,102	41.8
45-64	316,051	188,339	59.6	22,369	7.1	105,343	33.3
65-74	176,579	119,105	67.5	11,698	6.6	45,776	25.9
75+	118,527	97,815	82.5	6,853	5.8	13,859	11.7
Sex							
Male	419,275	262,716	62.7	28,469	6.8	128,090	30.6
Female	304,745	195,214	64.1	22,587	7.4	86,944	28.5
Race							
White	444,789	259,731	58.4	33,928	7.6	151,130	34
Black/African American	220,616	164,223	74.4	12,391	5.6	44,002	19.9
American Indian or Alaska Native	7,693	5,375	69.9	464	6.0	1,854	24.1
Asian	35,082	20,037	57.1	3,386	9.7	11,659	33.2
Native Hawaiian or Pacific Islander	9,067	6,706	74.0	670	7.4	1,691	18.7
Other or Multiracial	3,508	1,332	38.0	173	4.9	2,003	57.1
Unknown	3,320	553	16.7	45	1.4	2,722	82
Ethnicity							
Hispanic	127,337	85,415	67.1	8,058	6.3	33,864	26.6
Non-Hispanic	579,637	370,249	63.9	42,751	7.4	166,637	28.7
Unknown	17,101	2,293	13.4	248	1.5	14,560	85.1
Primary Cause of ESRD							
Diabetes	278,409	211,695	76.0	19,205	6.9	47,509	17.1
Hypertension	186,213	135,279	72.6	14,174	7.6	36,760	19.7
Glomerulonephritis	114,155	45,363	39.7	8,911	7.8	59,881	52.5
Cystic Kidney	34,987	10,907	31.2	2,600	7.4	21,480	61.4
Other/Unknown	110,311	54,713	49.6	6,167	5.6	49,431	44.8
Total	724,075	457,957	63.2	51,057	7.1	215,061	29.7

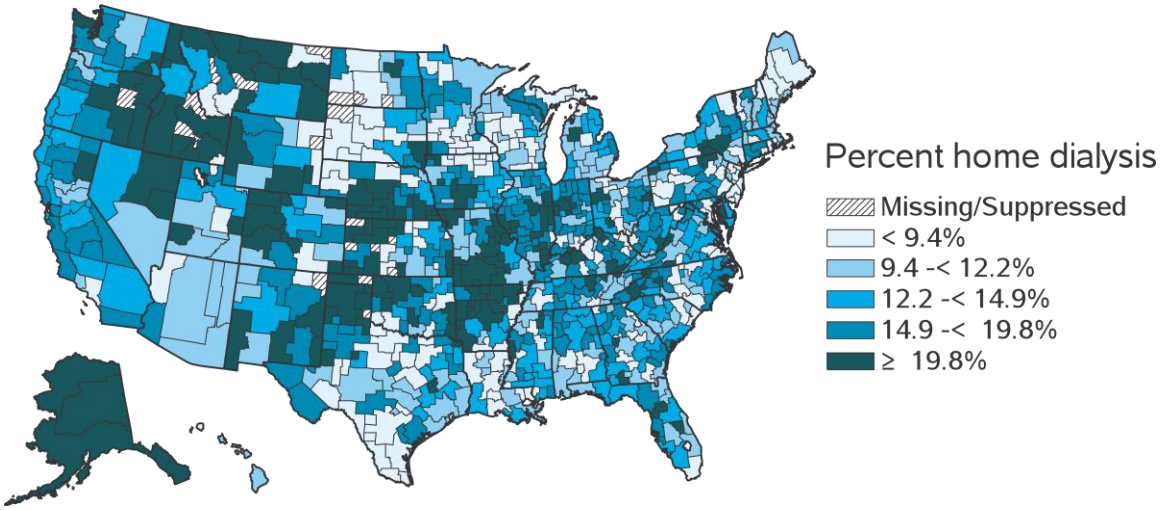
Data Source: Reference Table D.11 and special analyses, USRDS ESRD Database. The numbers in this table exclude "Uncertain Dialysis" and include "Unknown sex." Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Renal Replacement Therapy Modality Use: By Region

As observed for incident dialysis, RRT modality use among the prevalent ESRD population varied by region. Use ranged across networks, from 54.4% to 69.0% for HD, 3.7% to 8.7% for PD, and from 23.1% to 39.2% for transplantation (Table 1.5). The percentage of patients on HD was generally higher, and the percentage with a transplant was generally lower in the networks with a higher prevalence of ESRD.

The geographic distribution of home dialysis in 2012-2016 among all prevalent dialysis patients (Figure 1.17) is similar to the distribution observed for incident dialysis patients during the same period (Figure 1.15). In contrast to the distribution of standardized ESRD prevalence (Figure 1.10), home dialysis was proportionally more common in the Western and central mid-Western regions of the United States, and it varied considerably across 787 HSAs in 2012-2016. The percentage of all prevalent dialysis patients using home dialysis ranged from 1.7% to 76.9% (interquartile range: 9.9% to 18.1%; Figure 1.17).

vol 2 Figure 1.17 Map of the percentage of prevalent dialysis cases using home dialysis, by Health Service Area, 2012-2016



Data Source: Special analyses, USRDS ESRD Database. Values for cells with 10 or fewer patients are suppressed. Abbreviation: ESRD, end-stage renal disease.

Patient and Treatment Characteristics at ESRD Onset

Pre-ESRD care

In 2016, 20.8% of patients starting ESRD therapy were reported on the CMS 2728 form as not having received nephrology care before ESRD onset (Table 1.8), a decrease of 1.2% from 2015. An additional 14.6% had an unknown duration of pre-ESRD nephrology care. Because treatment characteristics, such as erythropoiesis-stimulating agent (ESA) use and dietary care, for the unknown group were similar to those with no pre-ESRD nephrology care, one may assume that up to 35.4% of new ESRD cases received little or no pre-ESRD nephrology care (Table 1.8.a).

Several differences were notable in the distributions of pre-ESRD nephrology care by patient characteristics. The youngest patients 0-21 years old were most likely (43.8%), and adults 22-44 years old were least likely (28.4%) to have had 12 months or more of pre-ESRD nephrology care. Blacks were slightly less likely to have had pre-ESRD care than were other racial groups, and Hispanics were less likely to have had pre-ESRD care than were non-Hispanics.

ESRD patients with a primary cause of their disease reported as cystic kidney disease or, to a lesser extent, glomerulonephritis, were more likely to have had pre-ESRD nephrology care than were patients with a diagnosis of DM or HTN. Having no nephrology care was most common for patients with hypertension as the primary cause of ESRD. One could surmise that some patients initially presenting with advanced CKD, approaching the need for dialysis, might be assigned the diagnosis of HTN in the absence of evidence of other possible etiologies.

Both dietary care and ESA use were more prevalent among incident ESRD cases in 2016 who had the longest duration of pre-ESRD nephrology care (Table 1.8.b). The prevalence of dietary care was 12.9% in patients with >12 months of pre-ESRD nephrology care and only 0.3% in patients with no such care. Similarly, the prevalence of ESA use was 22.7% in patients with >12 months of pre-ESRD nephrology care and only 1.9% in patients with no such care. The association between eGFR at the start of renal replacement therapy and duration of pre-ESRD nephrology care was slightly non-monotonic. The prevalence of starting RRT early (≥15 ml/min/1.73 m^2) and late (<5 ml/min/1.73 m^2) was greatest for patients with no pre-ESRD nephrology care (12.4% and 19.8%, respectively). Use of a catheter only for vascular access was strongly and inversely associated with duration of pre-ESRD nephrology care, being 35.6% for patients with >12 months of pre-nephrology care and 80.1% for patients with no such care. In contrast, AV fistula use was much more common for patients with >12 months of pre-ESRD nephrology care (25.4%) than for patients with no such care (2.3%).

vol 2 Table 1.8.a Distribution (in %) of the reported duration of pre-ESRD nephrology care, by category of each demographic variable, among incident ESRD cases in the U.S. population, 2016

(a) Demographic characteristics (% within row)

		Duration of pre-ESRD nephrology care					
	No. of cases	>12 months	6-12 months	0-6 months	None	Unknown /Missing	Unknown /Missing
Variable Category	**121,198**	**31.8**	**19.3**	**13.6**	**20.8**	**14.6**	**100**
Age							
0-21	1,412	43.8	14.5	15.9	18.8	6.9	100
22-44	13,487	28.4	18	14	26.7	13	100
45-64	45,766	29.6	19.8	14.1	22.3	14.2	100
65-74	32,687	33.6	19.7	13.4	18.4	14.9	100
75+	27,846	34.2	18.8	12.7	18.5	15.9	100
Sex							
Female	51,326	31.8	19.7	13.7	20	14.8	100
Male	69,872	31.8	19	13.4	21.4	14.4	100
Race							
White	81,985	33.6	19.4	13.4	20.1	13.5	100
Black	31,298	26.9	19.1	13.6	22.9	17.5	100
American Indian/Alaska Native	1,188	29.5	18.4	16.8	21	14.2	100
Asian	5,167	34	19.2	15.2	17.7	14	100
Native Hawaiian/ Pacific Islander	1,558	27.9	21.5	14.5	24	12.1	100
Other/Unknown	*	50	*	*	50	*	100
Ethnicity							
Hispanic	17,294	25.8	18.9	14.3	26.1	14.9	100
Non-Hispanic	103,904	32.7	19.4	13.4	19.9	14.5	100
Primary diagnosis							
Diabetes	58,308	32.2	21.4	13.9	18.3	14.2	100
Hypertension	34,906	29.1	18.7	13.2	21.7	17.3	100
Glomerulonephritis	9,189	40.3	17.7	13.6	19.7	8.7	100
Cystic kidney	3,546	55.8	16.9	10	9.7	7.6	100
Other/Unknown	15,249	25.4	14.5	14	31.4	14.8	100

Table 1.8 continued on next page.

vol 2 Table 1.8.b Distribution (in %) of clinical characteristics, by reported duration of pre-ESRD nephrology care, among incident ESRD cases in the U.S. population, 2016 (continued)

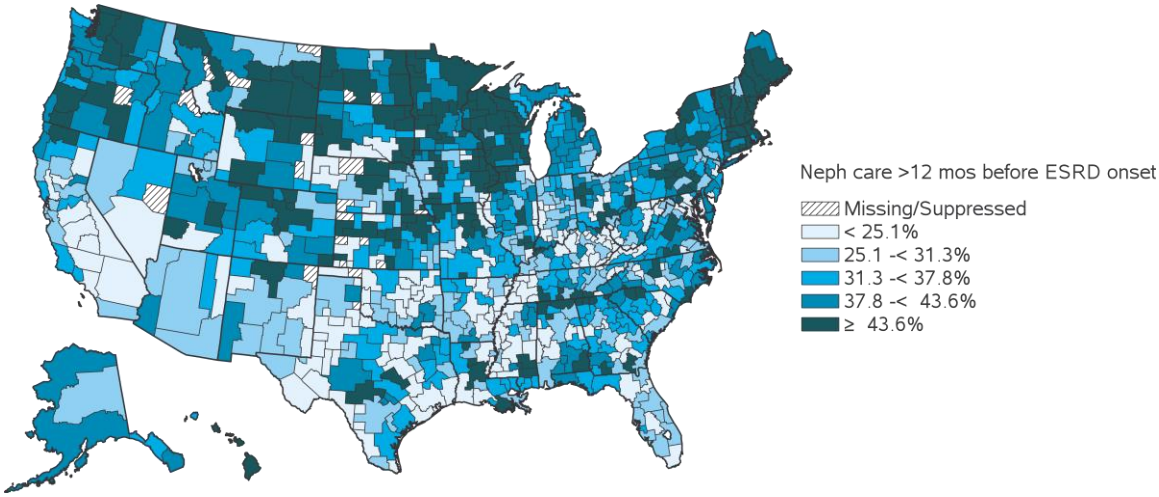
(b) Clinical characteristics (% within row)

		Duration of pre-ESRD nephrology care				
	No. of cases	>12 months	6-12 months	0-6 months	None	Unknown /Missing
Dietary care						
No	111,834	87.1	90.4	87.8	99.7	99.7
Yes	9,364	12.9	9.6	12.2	0.3	0.3
ESA use						
No	105,009	77.3	83.2	82.4	98.1	99.1
Yes	16,189	22.7	16.8	17.6	1.9	0.9
eGFR at RRT start						
<5	17,075	12.1	12.2	12.6	19.8	14.0
5-<10	57,247	50.0	49.2	47.2	43.5	44.0
10-<15	33,138	28.4	28.3	27.9	24.2	27.9
≥15	13,676	9.5	10.2	12.2	12.4	14.0
Vascular access						
AV fistula	17,855	25.4	18.7	10.0	2.3	8.3
AV graft	3,237	3.7	3.5	2.4	1.1	1.9
CV Catheter with maturing fistula/graft	18,879	16.2	17.8	16.3	13.0	14.5
CV Catheter only	66,770	35.6	45.4	59.9	80.1	70.6
Other/Unknown	14,457	19.2	14.6	11.4	3.5	4.8
Total	121,198	100	100	100	100	100

*Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with the form CMS 2728. *Count ≤10. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m^2)) for those aged ≥18 years and the Schwartz equation for those aged <18 years. Abbreviations: AV, arteriovenous; CKD-EPI, chronic kidney disease epidemiology calculation; CV, central venous; eGFR, estimated glomerular filtration rate; ESA, erythropoiesis-stimulating agents; ESRD, end-stage renal disease; RRT, renal replacement therapy.*

The proportion of incident ESRD cases in 2016 with greater than 12 months of pre-ESRD nephrology care varied substantially across 785 HSAs, ranging from a low of 5.5% to a high of 66.2% (interquartile range: 26.0% to 42.0%; Figure 1.18). Health Service Areas with the highest proportions of patients with more than 12 months of pre-ESRD care were clustered in the Northeast, Upper Midwest, and Northwest, where over 40% of patients were under a nephrologist's care for greater than 12 months before ESRD.

vol 2 Figure 1.18 Map of the percentage of incident cases who had received >12 months of pre-ESRD nephrology care, by Health Service Area, 2012-2016

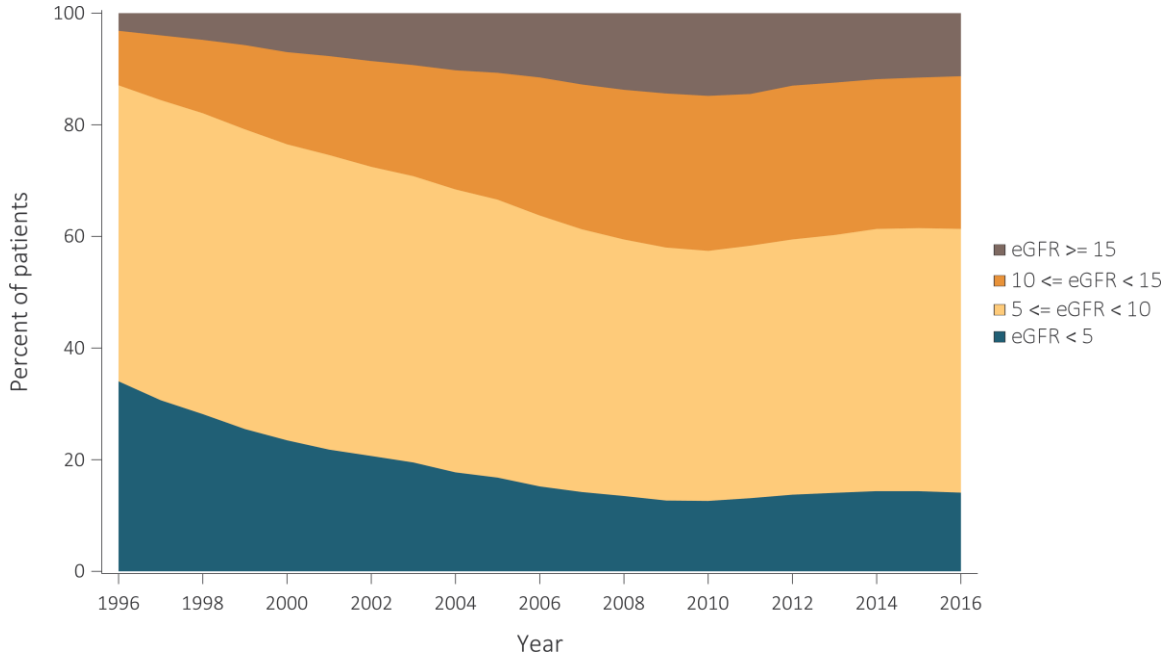


Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with the form CMS 2728. Values for cells with 10 or fewer patients are suppressed. Abbreviations: ESRD, end-stage renal disease; mos, months; Neph, nephrology.

eGFR at ESRD Onset

Figure 1.19 shows that the percentage of incident ESRD patients who initiated renal replacement therapy at higher eGFR levels increased steadily from 1996 to 2016. Since 2010, eGFR at the start of dialysis has remained stable or has slightly declined. More specifically, the percentage of incident ESRD cases starting with eGFR at ≥10 ml/min/1.73 m² (the two top bands in the figure) rose from 12.9% in 1996 to 42.6% in 2010, then decreased to 38.6% in 2016. The percentage that started therapy at eGFR <5 ml/min/1.73 m² (the bottom band in the figure) decreased from 34.0% in 1996 to 12.6% in 2010, then increased slightly to 14.1% in 2016. The trend after 2010 could reflect the influence of several publications questioning the advisability of starting dialysis early.

vol 2 Figure 1.19 Trends in the distribution of eGFR (ml/min/1.73 m^2) among incident ESRD patients, 1996-2016



Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with the form CMS 2728. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m^2)) for those aged ≥18 and the Schwartz equation for those aged <18. Abbreviations: CKD-EPI; chronic kidney disease epidemiology calculation; eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease.

Mean eGFR at ESRD start among incident ESRD patients in 2016 was higher in young patients (≤21 years), males, Whites, non-Hispanics, and those with diabetes as their primary cause of ESRD (Table 1.9). Incident ESRD patients with cystic kidney disease listed as the primary cause had higher mean Hgb levels at ESRD onset than did other groups. ESA usage among incident ESRD patients was greater in young patients (≤21 years), females, and Whites.

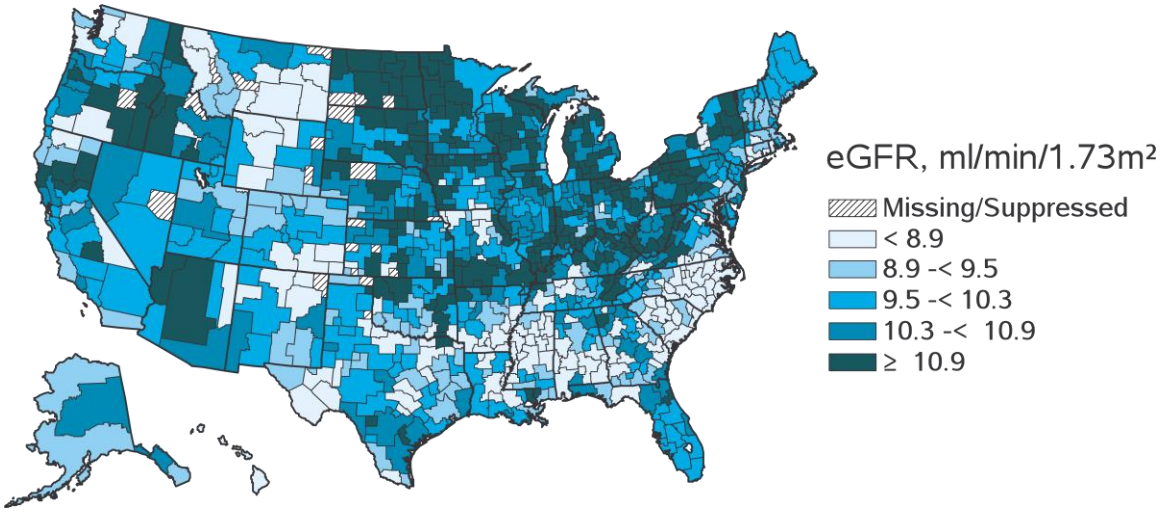
Mean eGFR at ESRD start during 2012-2016 varied substantially by HSA. HSAs with higher mean eGFRs at the initiation of ESRD clustered in the North and Midwest regions, while those with lower mean eGFRs clustered in the South (Figure 1.20).

vol 2 Table 1.9 Distributions of laboratory values (mean) and treatment characteristics (%), by age, sex, race, ethnicity, and the primary cause of ESRD, among incident ESRD cases, 2016

		Nutrition		Anemia		Lipids		Diabetes
	eGFR (mL/min/1.73 m^2)	Serum albumin (g/dL)	Dietary care (%)	Hemoglobin (g/dL)	ESA use (%)	Total cholesterol (mg/dL)	LDL (mg/dL)	HbA1c (%)
Age								
0-21	13.4	3.4	40.3	9.7	28.5	176.3	104.3	5.4
22-44	9.4	3.2	7.2	9.2	9.7	170.5	101.3	6.8
45-64	10.0	3.2	7.6	9.3	11.2	160.4	94.7	6.9
65-74	10.2	3.2	7.5	9.3	13.5	148.7	85	6.6
75+	10.3	3.2	6.6	9.4	15.1	141	79.7	6.4
Sex								
Male	10.4	3.2	7.8	9.4	11.7	148.5	87.1	6.7
Female	9.7	3.1	7.4	9.2	14.2	164.9	94.9	6.8
Race								
White	10.3	3.2	7.8	9.5	12.9	152.2	87.9	6.7
Black/African American	9.8	3.2	6.6	9.1	11.5	160.8	96.6	6.7
American Indian/Alaska Native	9.1	2.9	7.8	9.3	9.5	146.6	82.2	6.9
Asian	8.9	3.3	10.1	9.3	18.3	162.5	90.9	6.6
Native Hawaiian/Pacific Islander	8.4	3.1	9.7	9.2	14.5	149.9	88.5	7.0
Ethnicity								
Yes	9.5	3.1	7.6	9.2	12.0	154.1	89	6.8
No	10.2	3.2	7.6	9.4	13.0	155	90.4	6.7
Primary Cause of ESRD								
Diabetes	10.3	3.1	7.2	9.3	13.9	153.9	89.4	7.1
Hypertension	9.5	3.3	6.0	9.3	11.1	152.5	89.1	6.1
Glomerulonephritis	9.2	3.2	11.0	9.4	16.9	173.1	102.4	5.7
Cystic kidney	9.8	3.8	18.0	10.2	16.7	163.5	95.5	5.6
Total	10.1	3.2	7.6	9.3	12.7	154.9	90.2	6.7

Data Source: Special analyses, USRDS ESRD Database. Abbreviations: eGFR, estimated glomerular filtration rate; ESA, erythropoiesis-stimulating agents; ESRD, end-stage renal disease; HbA1c, glycosylated hemoglobin; LDL, low-density lipoprotein.

vol 2 Figure 1.20 Map of mean eGFR at initiation of renal replacement therapy, by Health Service Area, 2012-2016

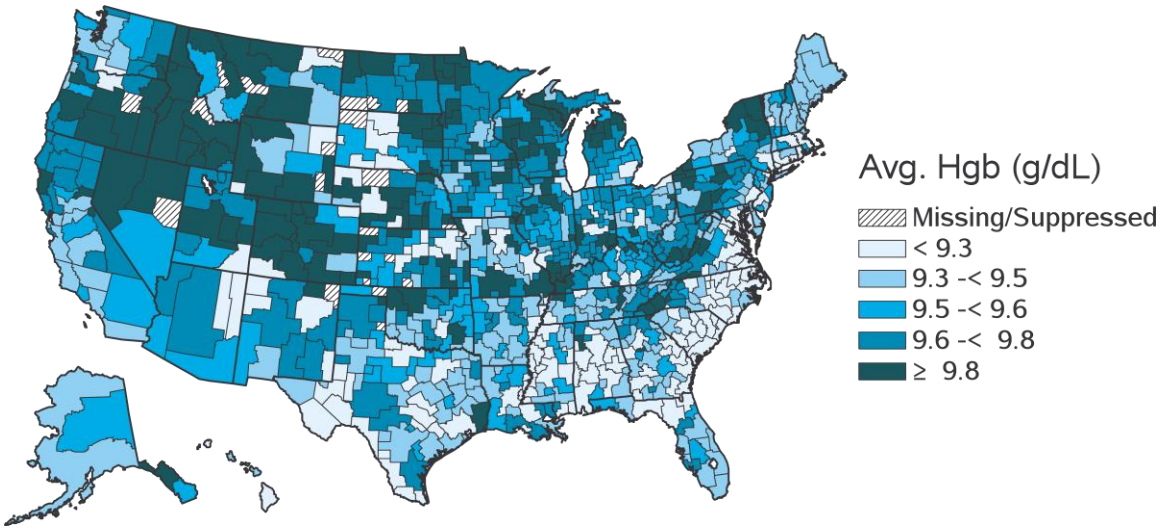


Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with the form CMS 2728. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m²)) for those aged ≥18 and the Schwartz equation for those aged <18. Values for cells with 10 or fewer patients are suppressed. Abbreviations: CKD-EPI, chronic kidney disease epidemiology calculation; eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease.

Anemia at ESRD Onset

In 2016, the overall mean hemoglobin (Hgb) level at ESRD onset was 9.3g/dL (Table 1.10). Figure 1.21 shows the distribution of mean Hgb levels by HSA across the United States. HSAs with higher average Hgb levels are observed in the Rocky Mountains region and scattered throughout the North.

vol 2 Figure 1.21 Map of mean hemoglobin level at initiation of renal replacement therapy, by Health Service Area, 2012-2016



Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with the form CMS 2728. Values for cells with 10 or fewer patients are suppressed. Abbreviation: ESRD, end-stage renal disease; Hgb, hemoglobin.

Variation in Treatment Characteristics by ESRD Network

Geographic variation in pre-ESRD care was also evident by ESRD Network (Table 1.10). Most pronounced was more than 2-fold variation in the percentage of incident ESRD patients with pre-ESRD nephrology care of greater than 12 months. Over a period of 12 months in 2016, pre-ESRD nephrology care ranged from a high of 47.8% in Network 1 (CT, MA, ME, NH, RI, and VT) to a low of 22.0% in Network 18 (S. CA). Mean eGFR at ESRD start ranged from a low of 8.9 ml/min/1.73 m^2 in Network 6 (NC, SC, and GA) to a high of 10.5 ml/min/1.73 m^2 in Network 9 (IN, KY, OH) and Network 11 (MI, MN, ND, SD, WI). Mean Hgb at ESRD start ranged from 9.2 in Network 2 (NY), Network 8 (AL, MS, TN), Network 14 (TX), Network 5 (MD, DC, VA, WV), Network 1 (CT, MA, ME, NH, RI, VT) and Network 6 (NC, SC, GA) to 9.6 g/dL in Network 15 (AZ, CO, NV, NM, UT, WY) and Network 16 (AK, ID, MT, OR, WA). At the ESRD Network level, there was little ecologic association between mean eGFR at ESRD initiation and duration of pre-ESRD nephrology care.

vol 2 Table 1.10 Distribution of duration of pre-ESRD nephrology care (in %), mean hemoglobin level, and mean eGFR, by ESRD Network, among incident ESRD cases in the U.S. population, 2016

Network	States in network*	Duration of pre-ESRD nephrology care (row percentages sum to 100)					Mean eGFR (ml/min/1.73 m^2)	Mean hemoglobin
		>12 months	6-12 months	0-6 months	None	Unknown		
18	S. CA	22.0	17.8	17.7	22.2	20.2	10.1	9.4
14	TX	25.6	18.6	13.5	26.6	15.6	9.4	9.2
7	FL	26.2	19.1	13.1	22.5	19.0	10.0	9.3
10	IL	27.1	17.2	13.2	18.4	24.1	10.3	9.3
5	MD, DC, VA, WV	28.8	21.1	14.1	17.9	18.1	9.4	9.2
8	AL, MS, TN	29.2	21.3	12.8	23.7	12.9	9.1	9.2
3	NJ, PR, VI	30.1	19.7	11.1	29.9	9.3	9.5	9.4
13	AR, LA, OK	30.2	18.7	12.8	23.7	14.5	9.6	9.3
17	N. CA, HI, GU, AS, MP	31.6	22.1	15.9	18.7	11.6	9.4	9.4
9	IN, KY, OH	32.2	21.6	11.9	17.3	17.0	10.5	9.4
2	NY	32.5	17.4	11.3	22.0	16.8	9.2	9.2
15	AZ, CO, NV, NM, UT, WY	32.6	19.6	16.1	19.2	12.6	10.2	9.6
6	NC, SC, GA	34.2	19.3	13.4	19.4	13.7	8.9	9.2
12	IA, KS, MO, NE	37.0	19.0	12.4	21.7	9.9	10.4	9.5
4	DE, PA	38.0	19.9	13.8	17.2	11.1	9.9	9.4
11	MI, MN, ND, SD, WI	42.3	17.4	14.1	17.6	8.6	10.5	9.5
16	AK, ID, MT, OR, WA	43.6	18.1	14.9	17.6	5.8	9.7	9.6
1	CT, MA, ME, NH, RI, VT	47.8	20.2	10.6	13.3	8.2	9.1	9.2
	All networks	31.8	19.3	13.6	20.8	14.5	9.7	9.3

*Data Source: Special analyses, USRDS ESRD Database. Population only includes incident cases with the form CMS 2728. eGFR calculated using the CKD-EPI equation (CKD-EPI eGFR (ml/min/1.73 m^2)) for those aged ≥18 years and the Schwartz equation for those aged <18 years. Listed from lowest to highest by >12 months duration of pre-ESRD nephrology care. ** Includes 50 states, Washington, D.C. (DC), Puerto Rico (PR), Guam (GU), American Samoa (AS), U.S. Virgin Islands (VI), and the Northern Mariana Islands (MP). Northern and Southern California (CA) split into Networks 17 and 18. Abbreviations: CKD-EPI, chronic kidney disease epidemiology calculation; eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease.*

References

Albertus P, Morgenstern H, Robinson B, Saran R. Risk of end-stage renal disease in the United States. *Am J Kidney Dis* 2016; 68(6):862-872. PMC5123906

Centers for Disease Control and Prevention (CDC) *http://www.cdc.gov/diabetes/statistics/prev/national/figbyrace.htm*

DevCan. Probability of Developing or Dying of Cancer Software, Version 6.7.2 [Internet]. National Cancer Institute, 2005. http://srab.cancer.gov/devcan/. Accessed October 15, 2015.

Longenecker JC, Coresh J, Klag MJ, Levey AS, Martin AA, Fink NE, Powe NR. Validation of comorbid conditions on the end-stage renal disease medical evidence report: the CHOICE study. Choices for Healthy Outcomes in Caring for ESRD. *J Am Soc Nephrol* 2000 Mar; 11(3):520-9. PMID: 10703676.

Tucker BM, Freedman BI. Need to Reclassify Etiologies of ESRD on the CMS 2728 Medical Evidence Report. Clinical Journal of the American Society of Nephrology. 2018;13(3):477-479. PMC5967672

Yuan CM, Nee R, Ceckowski KA, Knight KR, Abbott KC. Diabetic nephropathy as the cause of end-stage kidney disease reported on the medical evidence form CMS2728 at a single center. *Clin Kidney J* 2017; 10(2):257-262. PMC5381235

Notes