Chapter 9: Transition of Care in Chronic Kidney Disease

- Compared to all USRDS patients who transitioned to end stage renal disease (ESRD) between 10/1/2007-3/31/2015, U.S. veteran patients were older, more likely to be non-Hispanic and White, more likely to have cardiovascular or pulmonary comorbidities, and more likely to have pre-transition nephrology care or have an arteriovenous (AV) fistula as their primary access type (Table 9.1).
- Kaiser Permanente Southern California (KP-SC) patients had a lower age and sex adjusted incidence rate of ESRD, compared to the general population (Table 9.7). In KP-SC patients who transitioned to ESRD between 1/1/2007-12/31/2016, 20% were Black, 37% Hispanic, 11% Asian, and 42% female.
- Female U.S. veterans comprised less than 2% of all USRDS females transitioning to ESRD between 10/1/2007 and 3/31/2015. Female veterans were similar in most characteristics with the total USRDS female population transitioning to ESRD during this period, with the exception that they were more likely to be Black.
- Across the incidence years of transition to ESRD, female U.S. veterans were increasingly more likely to be Black, to have less cardiovascular comorbidities at transition, and were increasingly more likely to have had nephrology care prior to transition or an AV fistula as the primary access type.
- Both U.S. veterans and KP-SC patients had seasonal variations in the number of patients who transitioned to ESRD, where there were peaks in the number of patients transitioning to ESRD in January and March, and lower numbers in November (Figures 9.13 and 9.54).
- The median estimated glomerular filtration rate (eGFR) at transition for U.S. veterans was higher than that of the total USRDS population. The highest median eGFRs at transition were found in North Dakota, Idaho, and Arizona, while the lowest were in South Carolina, District of Columbia, and Alabama. Females had lower median eGFRs at transition to ESRD, compared to males.
- In the year prior to ESRD transition, the median slope of eGFR for U.S. veterans was -10.4 mL/min/1.73m^2/year. Median eGFR slope varied across states differently for all U.S. veterans, and in patients with diabetes or hypertension as the primary cause of ESRD.
- Across states, U.S. veterans showed different proportions and temporal changes in the proportions of patients with diabetes or hypertension as the primary cause of ESRD, preemptive transplants, AV fistula or AV graft as the initial access type, cardiovascular disease and infection-related cause of death, and hospitalizations during transition.
- U.S. veterans had a lower body mass index (BMI) at transition compared to all USRDS patients transitioning between 10/1/2007-3/31/2015. There were also differences in mean BMI per state overall and for each racial ethnic group. Although mean BMI at transition has increased over time for all racial/ethnic groups, compared to racial/ethnic differences in mean BMI level in the total USRDS, there was less difference in mean BMI level across racial ethnic categories in U.S. veterans.
- Of the 12,242 KP-SC patients who transitioned to ESRD, 315 (2.6%) had a preemptive transplant and 1,731 (14%) initiated dialysis with peritoneal dialysis (PD). Hemodialysis (HD) catheter was the most frequent access type at the initiation of dialysis, while AV grafts remained the least frequent access type (Figure 9.53). Between 2010 and 2012, there was a marked decrease in the use of HD catheters and an increase in the use of fistulas and PD catheters.
- In the year prior to ESRD transition, the median eGFR decreased from 18.4 to 11.2 mL/min/1.73m^2 among 11,927 KP-SC patients (Figure 9.58). Younger patients had a more rapid decrease of eGFR than older ones (Figure 9.59). Patients with diabetes had a faster progression rate of eGFR than those with other health conditions (Figure 9.60).

- Among U.S. veterans, in the quarter immediately prior to transition, there was a sharp increase in the proportion of patients with serum phosphorous ≥5.5 mg/dL; however, by the first quarter post-transition to ESRD, the proportion of patients with a phosphorous level in the target range of 3.5-<5.5 mg/dL or lower increased again and remained relatively stable after the third quarter post-transition. Similarly, in KP-SC patients, mean phosphorous levels increased in the prelude (pre-ESRD) period from 4.2 mg/dL to 5.2 mg/dL and decreased to 4.4 mg/dL immediately after transition (Figure 9.63).
- Among U.S. veterans, increases in beta blocker prescriptions prior to ESRD were mostly attributed to increases in prescriptions for non-dialyzable beta blockers.
- The proportions of U.S. veteran patients within different pain score categories did not vary across the quarters prior to and after transition to ESRD; however, the proportion of patients prescribed opioids increased in the period prior to transition, and reached the highest proportion (46%) in the 6 months after transition to ESRD, but then gradually declined.
- The proportion of U.S. veterans who received an opioid prescription in the 6 months prior to transition increased linearly between 2007 and 2013, then decreased sharply during 2014 and 2015, with the proportion of veterans receiving opioids in 2015 falling below the level observed in 2007.

Introduction

The Transition of Care in Chronic Kidney Disease (TC-CKD) Special Study Center examines the transition of care to renal replacement therapy (i.e. dialysis or transplantation) in patients with very-late-stage (advanced) non-dialysis dependent (NDD) CKD. These are often people with an estimated glomerular filtration rate (eGFR) <25 mL/min/1.73m^2. The primary sources used in these analyses were created from the linkage between the national USRDS data and two large longitudinal data sources of NDD-CKD patients—the national Veterans Health Administration (VHA) database and the electronic medical records capturing the care delivered to members of the Kaiser Permanente Southern California (KP-SC) health plan. These linkages have allowed for the identification of nearly all VHA and KP-SC patients who transitioned to end-stage renal disease (ESRD) from the index point (Year 2007) in time onwards. Each of these linked databases included thousands of NDD-CKD patients who transitioned to ESRD each year, in whom historical data for up to -5 (minus five) years prior to ESRD ("prelude" period) and up to +2 (plus two) years after ESRD transition (early "vintage" period) were examined.

In this USRDS Special Study, we have examined the most recent VHA and KP-SC cohorts of incident ESRD patients. We have provided pre-ESRD (prelude) data on all available ESRD transitions since 10/1/2007 among veterans. Analyses that examined pre- and post-ESRD data of approximately 52,000 incident ESRD veterans who transitioned to ESRD between 10/1/2007-9/30/2011 were presented in our 2014 and 2015 Annual Data Report (ADR) chapters. In our 2016 ADR chapter, we presented transition-to-ESRD data on approximately 85,000 incident ESRD veterans who transitioned to ESRD over 6.5 years (10/1/2007-3/31/2014) across the entire nation, and in the 2017 ADR, we presented similar data on more than 100,000 incident ESRD veterans who transitioned between 10/1/2007 and 3/31/2015. In this year's chapter, we feature additional data on these 100,000 veterans, including comparisons with the entire USRDS cohort that transitioned over that period, seasonal trends, and variations across the United States. We also include data on the racially and ethnically diverse KP-SC member population who transitioned to ESRD over 10 years between 1/1/2007-12/31/2016.

As stated in the original goals of this Special Study Center, we have continued to test the hypotheses that a pre-ESRD (prelude) data-driven personalized approach to the transition of care into ESRD in very-late-stage NDD-CKD is associated with more favorable outcomes, particularly if the decision is based on pre-ESRD factors such as

clinical and laboratory variables, including CKD progression rate, comorbid conditions during the prelude period, and demographics. Some of these concepts and data have been published in the form of abstracts, as well as peer-reviewed manuscripts over the past 4 years.[1-26] We have also developed and validated a scoring system derived from these pre-ESRD data to better ascertain the extent to which timing, preparation, and modality of ESRD may be associated with better outcomes.[13]

The Veterans Health Administration

There are more than 20 million veterans in the United States; approximately nine million are enrolled in the VHA, including approximately six million who receive their healthcare in one of the VHA facilities. Whereas approximately 90% of the U.S. veteran population is presently male, it is estimated that in the next decade the proportion of females will rise to 18 to 20%.[27, 28] Minority veterans currently comprise about 22% of the overall veteran population, among whom the majority are of Black or African American race (12% of all veterans) and Hispanic or Latino ethnicity (7% of all veterans).[29, 30] Each year, approximately 13,000 veterans transition to renal replacement therapy, mostly in the form of maintenance dialysis treatment.[3] Among >6,000 dialysis units nationwide, there are currently approximately 70 VHA dialysis centers.[3] Given this number of VHA dialysis centers and their limited capacity, only 10% of all incident dialysis veterans initiate treatment in a VHA dialysis center.[3] Although almost 90% of the ESRD veterans receive dialysis treatment in non-VHA facilities, including large dialysis organizations, the transition data of these and other outsourced veterans, and in particular, their prelude and early vintage analyses and other data are also included in this chapter. Hence, our transition-of-care data for more than 100,000 (n=102,477) veterans with ESRD are inclusive and comprehensive.

ESRD Rates among Veterans

As reported in previous ADR chapters on the Transition of Care in CKD, on average 13,664 veterans transitioned to ESRD each year over the period of 2007-2015 (see below additional analyses on secular trend data), with an average rate of ESRD transition of 1,139 veterans per month across the entire nation. In the 2017 ADR, we also reported crude ESRD incident rates among U.S. veterans between 2008 and 2014, which were 635.3, 664.1, 646.5, 620.9, 635.6, 669.8, and 665.0 per million veterans, respectively; and compared them to the given ESRD incident rates of 488.1, 499.6, 495.7, 482.4, 485.5, 484.7, and 492.0 per million in the general U.S. population, respectively. This yielded the calculated crude rate ratios of ESRD incidence among veterans compared to the U.S. general population as 1.30, 1.33, 1.30, 1.29, 1.31, 1.38, and 1.35 for calendar years 2008 through 2014, respectively, suggesting that ESRD is 29% to 38% more likely to occur among veterans than the general U.S. population. However, due to the fact that the VHA population is considerably older than the general U.S. population, age-specific and age-adjusted VHA rates of ESRD were 25% to 40% lower than the U.S. rate of ESRD. The remarkably lower adjusted rate of ESRD among VHA patients, despite higher crude ESRD incidence rates, is currently unexplained. Further research may shed some light on this issue.

Comparisons of the Incident ESRD Veteran Population to the entire USRDS Incident ESRD Population between 10/1/2007 and 3/31/2015

Between 10/1/2007 and 3/31/2015 (over 7.5 years) 872,816 patients transitioned to ESRD, of which 102,477 were veterans. Among the U.S. veterans who transitioned to ESRD during this period, 14% were World War II veterans, 38% were Vietnam era veterans, 16% were Korean War veterans, 4% were Persian Gulf War veterans, 6% were from the post-Vietnam era, 8% were from the post-Korean era, and 14% were other or unknown. Across the years of transition, the proportion of veterans who served in World War II and Korea decreased, whereas the proportion who served in the post-Korean, post-Vietnam era and Persian Gulf War increased. In this veteran ESRD population, the mean ± standard deviation age was 70.2 ±12.0 years, and included 24% patients of Black race and 7% of Hispanic ethnicity. Compared to all USRDS patients who transitioned to

ESRD during this period (Table 9.1), U.S. veteran patients were older, more likely to be non-Hispanic and White, and more likely to have reported a cardiovascular or pulmonary comorbidity on the Centers for Medicare & Medicaid Services (CMS) 2728 form at the time of transition. They were also less likely to have peritoneal dialysis as a first dialysis modality, but more likely to have pre-transition nephrology care or have an arteriovenous (AV) fistula as their initial access type.

Approximately 19% of all male USRDS patients that transitioned to ESRD between 10/1/2007 and 3/31/2015 were U.S. veterans (Table 9.2). Among the male patients transitioning to ESRD, the TC-CKD veterans were still more likely to be older, non-Hispanic White and reported higher percentages of cardiovascular and pulmonary comorbidities at transition. However, among males, there was a slight difference in percentage of Blacks but no difference in percentage of reported tobacco use.

Conversely, U.S. female veterans comprised less than 2% of the USRDS females transitioning to ESRD between 10/1/2007 and 3/31/2015 (Table 9.3). The TC-CKD U.S. veteran females had similar characteristics to those of the entire population of female patients transitioning to ESRD, with the exception that they were more likely to be Black. They were also slightly older, and more likely to have certain cardiovascular comorbidities. They were equally likely to report tobacco use and have peritoneal dialysis as their first dialysis modality, but were more likely to have pre-transition nephrology care or AV fistula as their initial access type.

Across the incidence years of transition to ESRD, TC-CKD U.S. veteran females were increasingly more likely to be Black, had fewer cardiovascular comorbidities at transition, with the exception of cerebrovascular disease and other cardiac disease, and were increasingly more likely to report having had nephrology care prior to transition or an AV fistula as the primary access type (Table 9.4).

vol 1 Table 9.1 Baseline characteristics of 102,477 incident ESRD veterans compared to all 872,816 USRDS patients who transitioned to ESRD between 10/1/2007 and 3/31/2015 (For gender decomposed components, see Tables 9.2 and 9.3)

Variables	TC-CKD Total Veteran Cohort	USRDS Total Cohort
N	102,477	872,816
Age (mean±SD, years)	70.2±12.0	62.9±15.1
Female (%)	7	43
Race (%)		
White	73	67
Black	24	27
Asian	2	5
Native American	0.83	0.93
Other	0.19	0.26
Unknown	0.10	0.38
Ethnicity (%)		
Hispanic	7	15
Non-Hispanic	3	5
Unknown	1.06	1.90
Non-Hispanic White	66	52
Non-Hispanic Black	24	26
Access type (%)		
AV fistula	20	15
AV graft	3	3
Central venous catheter	77	81
Other	0.52	0.45
Comorbidity (%)		
Atherosclerotic heart disease	26	18
Congestive heart failure	36	31
Peripheral vascular disease	16	12
Cerebrovascular disease	10	9
Other cardiac disease	23	18
Chronic obstructive pulmonary disease	13	9
Tobacco use (current smoker)	7	6
Drug dependence	1.25	1.24
Alcohol dependence	2.02	1.61
Diabetes‡	54	55
Malignant neoplasm, cancer	11	7
Inability to ambulate	7	7
Inability to transfer	4	4
Amputation	3	3
Institutionalized	9	8
Institutionalized (assisted living)	0.82	0.64
Institutionalized (nursing home)	8	7
Institutionalized (other)	0.67	0.57
Needs assistance with daily activities	13	13
Non-renal congenital abnormality	0.11	0.24
Toxic nephropathy	0.45	0.42
Body mass index (kg/m^2)	28.5±6.9	29.5±8.0
Estimated GFR (mL/min/1.73m^2)	9.5 (6.9, 12.7)	8.9 (6.4, 12.2)
Initial dialysis modality (%)		
Hemodialysis	81	79
Home hemodialysis	0.51	0.54
Peritoneal dialysis	6	8
Uncertain dialysis	11	10
Preemptive transplant	1	2
Nephrologist care (%)		
Yes	64	59

Data source: VHA, CMS, and USRDS ESRD Databases. ‡Diabetes is presence of any of the following: Diabetes, currently on insulin; Diabetes, without medications; Diabetes, on oral medications; Diabetic, retinopathy. Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous; GFR, glomerular filtration rate; kg, kilogram; m, meters; mL, milliliters; min, minute.

vol 1 Table 9.2 Baseline characteristics of 95,559 male incident ESRD veterans compared to all 499,643 USRDS males who transitioned to ESRD between 10/1/2007 and 3/31/2015

Variables	TC-CKD Veteran Male Cohort	USRDS Male Cohort
N	95,559	499,643
Age (mean±SD, years)	70.6±11.8	62.5±15.0
Race (%)		
White	74	69
Black	24	25
Asian	2	4
Native American	0.73	0.83
Other	0.18	0.26
Unknown	0.09	0.40
Ethnicity (%)		
Hispanic	7	15
Non-Hispanic	2	5
Unknown	1.04	1.87
Non-Hispanic White	67	54
Non-Hispanic Black	23	24
Access type (%)		
AV fistula	20	17
AV graft	2	2
Central venous catheter	77	80
Other	0.52	0.44
Comorbidity (%)		
Atherosclerotic heart disease	26	20
Congestive heart failure	36	30
Peripheral vascular disease	16	13
Cerebrovascular disease	11	9
Other cardiac disease	24	19
Chronic obstructive pulmonary disease	13	9
Tobacco use (current smoker)	7	7
Drug dependence	1.28	1.54
Alcohol dependence	2	2
Diabetes‡	54	54
Malignant neoplasm, cancer	11	8
Inability to ambulate	7	6
Inability to transfer	4	3
Amputation	3	4
Institutionalized	9	7
Institutionalized (assisted living)	0.82	0.56
Institutionalized (nursing home)	8	6
Institutionalized (other)	0.68	0.61
Needs assistance with daily activities	13	11
Non-renal congenital abnormality	0.10	0.24
Toxic nephropathy	0.45	0.43
Body mass index (kg/m^2)	28.4±6.8	28.8±7.3
Estimated GFR (mL/min/1.73m^2)	9.6 (7.0, 12.8)	9.2 (6.6, 12.6)
Initial dialysis modality (%)		
Hemodialysis	81	79
Home hemodialysis	0.52	0.57
Peritoneal dialysis	6	8
Uncertain dialysis	11	10
Preemptive transplant	1	2
Nephrologist care (%)		
Yes	64	59

Data source: VHA, CMS, and USRDS ESRD Databases. ‡Diabetes is presence of any of the following: Diabetes, currently on insulin; Diabetes, without medications; Diabetes, on oral medications; Diabetic, retinopathy. Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous; GFR, glomerular filtration rate; kg, kilogram; m, meters; mL, milliliters; min, minute.

vol 1 Table 9.3 Baseline characteristics of 6,918 female incident ESRD veterans compared to all 373,143 USRDS females who transitioned to ESRD between 10/1/2007 and 3/31/2015 (For decomposition of female incident ESRD veterans across incident years, see Table 9.4)

Variables	TC-CKD Veteran Female Cohort	USRDS Female Cohort
N	6,918	373,143
Age (mean±SD, years)	64.9±13.5	63.5±15.1
Race (%)		
White	60	64
Black	33	30
Asian	4	5
Native American	2.08	1.05
Other	0.32	0.27
Unknown	0.19	0.37
Ethnicity (%)		
Hispanic	9	14
Non-Hispanic	6	6
Unknown	1.24	1.94
Non-Hispanic White	50	49
Non-Hispanic Black	33	29
Access type (%)		
AV fistula	15	13
AV graft	4	4
Central venous catheter	80	82
Other	0.40	0.45
Comorbidity (%)		
Atherosclerotic heart disease	17	17
Congestive heart failure	31	31
Peripheral vascular disease	12	11
Cerebrovascular disease	10	9
Other cardiac disease	18	17
Chronic obstructive pulmonary disease	10	9
Tobacco use (current smoker)	5	5
Drug dependence	0.86	0.85
Alcohol dependence	0.79	0.79
Diabetes‡	57	57
Malignant neoplasm, cancer	7	6
Inability to ambulate	8	8
Inability to transfer	4	4
Amputation	2	2
Institutionalized	10	10
Institutionalized (assisted living)	0.76	0.75
Institutionalized (nursing home)	8	8
Institutionalized (other)	0.46	0.51
Needs assistance with daily activities	14	14
Non-renal congenital abnormality	0.24	0.25
Toxic nephropathy	0.51	0.41
Body mass index (kg/m^2)	30.2±8.5	30.3±8.8
Estimated GFR (mL/min/1.73m^2)	8.6 (6.2, 11.6)	8.6 (6.1, 11.7)
Initial dialysis modality (%)		
Hemodialysis	79	80
Home hemodialysis	0.48	0.51
Peritoneal dialysis	8	8
Uncertain dialysis	10	10
Preemptive transplant	2	2
Nephrologist care (%)		
Yes	63	60

Data source: VHA, CMS, and USRDS ESRD Databases. ‡Diabetes is presence of any of the following: Diabetes, currently on insulin; Diabetes, without medications; Diabetes, on oral medications; Diabetic, retinopathy. Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous; GFR, glomerular filtration rate; kg, kilogram; m, meters; mL, milliliters; min, minute.

vol 1 Table 9.4 Baseline characteristics of 6,918 female incident ESRD veterans who transitioned to ESRD between 10/1/2007 and 3/31/2015 according to incidence year at transition to ESRD

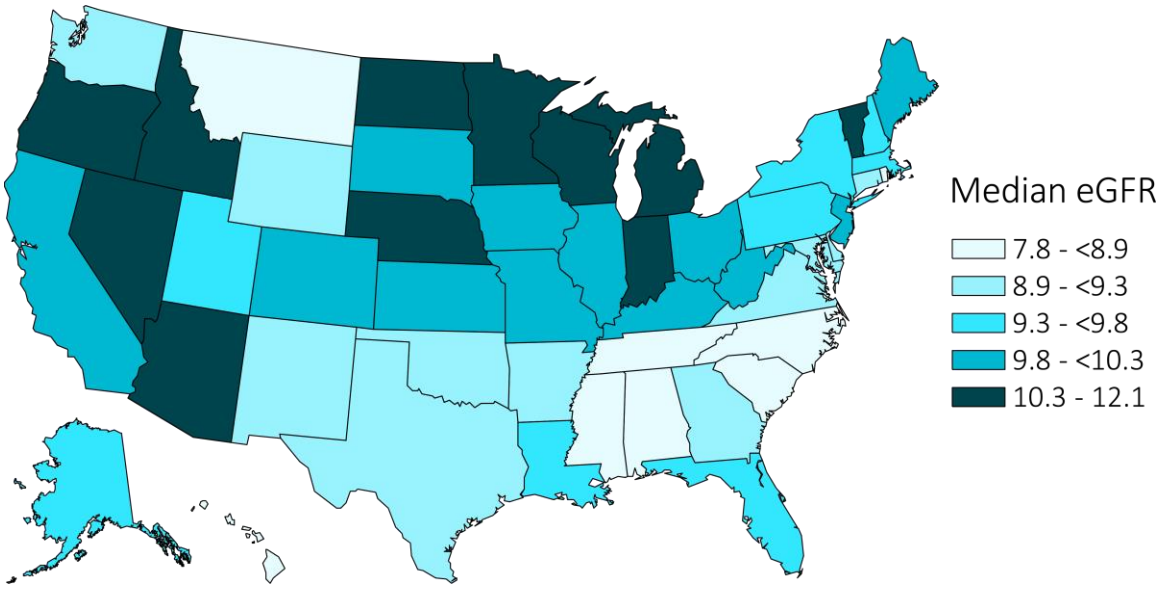
		Incidence Year								
Variables	**Total**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
N (%)	6,918	205 (3)	858 (12)	955 (14)	899 (13)	914 (13)	894 (13)	979 (14)	939 (14)	275 (4)
Age (mean±SD, years)	64.9±13.5	63.5±13.9	65.6±13.4	64.4±14.0	65.0±14.3	64.8±14.2	65.1±12.6	64.8±13.1	64.4±13.2	66.1±12.9
Race (%)										
White	60	61	60	59	62	61	58	61	57	59
Black	33	32	32	34	31	33	34	33	35	35
Asian	4	6	4	4	4	4	5	4	5	5
Native American	2.08	0.98	2.56	2.62	2.00	2.52	1.90	1.53	1.92	1.45
Other	0.32	0	0.35	0.21	0.33	0.11	0.34	0.10	0.85	0.36
Unknown	0.19	0	0.12	0.10	0.44	0	0.56	0	0.21	0
Ethnicity (%)										
Hispanic	9	10	8	11	10	9	9	11	9	7
Non-Hispanic	6	7	7	6	6	6	6	6	7	6
Unknown	1.24	0.49	1.75	1.68	1.89	1.20	1.57	0.41	0.85	0
Non-Hispanic White	50	52	51	48	52	53	50	50	49	53
Non-Hispanic Black	33	31	32	34	30	32	33	33	35	35
Access type (%)										
AV fistula	15	11	13	14	14	14	16	16	19	15
AV graft	4	3	3	5	4	6	5	4	5	3
Central venous catheter	80	84	82	80	82	80	79	79	76	82
Other	0.40	1.08	0.77	0.83	0.13	0.37	0.38	0.12	0	0.43
Comorbidity (%)										
Atherosclerotic heart disease	17	18	19	18	19	18	17	15	15	15
Congestive heart failure	31	35	32	32	32	31	32	29	29	31
Peripheral vascular disease	12	9	12	13	14	11	12	10	10	7
Cerebrovascular disease	10	8	11	11	10	10	10	10	9	10
Other cardiac disease	18	16	15	18	18	16	20	19	17	18
Chronic obstructive pulmonary disease	10	8	9	10	9	12	11	11	10	10
Tobacco use (current smoker)	5	4	5	5	5	6	5	5	7	2
Drug dependence	0.86	0.49	0.71	0.64	1.25	0.89	0.70	1.28	0.56	1.15
Alcohol dependence	0.79	0.98	0.83	0.53	0.68	0.78	0.93	1.17	0.79	0
Diabetes[‡]	57	51	58	56	57	52	57	61	60	57
Malignant neoplasm, cancer	7	5	5	7	9	7	7	7	8	9
Inability to ambulate	8	6	9	7	7	6	7	9	10	8
Inability to transfer	4	1	5	4	3	4	4	5	4	5
Amputation	2	2	2	2	2	3	2	2	2	2
Institutionalized	10	6	10	8	8	10	10	10	11	11
Institutionalized (assisted living)	0.76	0.49	0.95	0.32	0.91	0.78	0.81	0.64	0.90	1.15
Institutionalized (nursing home)	8	5	9	7	7	9	9	9	10	10
Institutionalized (other)	0.46	0.49	0.47	0.75	0.57	0.44	0.46	0.11	0.45	0.38
Needs assistance with daily activities	14	10	14	12	12	13	14	15	15	15
Non-renal congenital abnormality	0.24	0	0.24	0.43	0.23	0.33	0.23	0.11	0.11	0.38
Toxic nephropathy	0.51	0	0.36	0.96	0.91	0.67	0.23	0.53	0.11	0
Body mass index (kg/m^2)	30.2±8.5	29.0±8.1	30.0±8.5	30.1±8.7	30.1±8.5	30.1±8.5	30.2±8.2	30.5±8.5	30.5±8.5	30.2±7.8
Estimated GFR (mL/min/1.73m^2)	8.6 (6.2, 11.6)	9.0 (6.3, 11.6)	8.9 (6.2, 11.8)	8.6 (6.3, 11.8)	8.9 (6.5, 12.4)	8.5 (6.4, 11.7)	8.3 (6.2, 11.4)	8.5 (6.1, 11.8)	8.4 (5.9, 11.0)	8.7 (6.3, 11.3)
Initial dialysis modality (%)										
Hemodialysis	79	78	80	81	78	79	80	78	78	81
Home hemodialysis	0.48	0.98	0.47	0.42	0.11	0.55	0.67	0.51	0.21	1.45
Peritoneal dialysis	8	7	7	9	9	7	8	9	9	7
Uncertain dialysis	10	11	10	8	10	10	10	10	11	7
Preemptive transplant	2	4	2	2	2	3	2	2	2	3
Nephrologist care (%)										
Yes	63	58	62	61	63	63	63	63	66	71

Data source: VHA, CMS, and USRDS ESRD Databases. [‡]Diabetes is presence of any of the following: Diabetes, currently on insulin; Diabetes, without medications; Diabetes, on oral medications; Diabetic, retinopathy. Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous; GFR, glomerular filtration rate; kg, kilogram; m, meters; mL, milliliters; min, minute.

ESTIMATED GLOMERULAR FILTRATION RATE PROFILE BETWEEN 10/1/2007 AND 3/31/2015

Of 102,477 veterans transitioning to ESRD, there were 99,614 patients with data on eGFR at the time of transition (within 45 days) as reported by the CMS 2728 form. Overall, the median eGFR in these patients was 9.5 mL/min/1.73m² (Table 9.1). We examined the median eGFR per state for TC-CKD veteran patients and found the highest median eGFRs at transition in North Dakota (12.1 mL/min/1.73m²), Idaho (11.1 mL/min/1.73m²), and Arizona (10.7 mL/min/1.73m²) (Figure 9.1). Nebraska, Oregon, Vermont and Nevada, as well as Midwestern states Minnesota, Wisconsin, Michigan, and Indiana were also in the highest quintile of eGFR at transition. The lowest median eGFRs at transition were in South Carolina (7.8 mL/min/1.73m²), the District of Columbia (8.0 mL/min/1.73m²), and Alabama (8.2 mL/min/1.73m²). Hawaii, Rhode Island, Montana, and the Southern states of Tennessee, Mississippi, and North Carolina were also in the lowest quintile of eGFR at transition to ESRD.

vol 1 Figure 9.1 Median estimated glomerular filtration rate (eGFR) at transition among 99,614 incident ESRD veterans across the United States, 10/1/2007-3/31/2015 (For gender decomposed components, see Figures 9.2 and 9.3) (For decomposition according to cause of ESRD, see Figures 9.4 and 9.5)

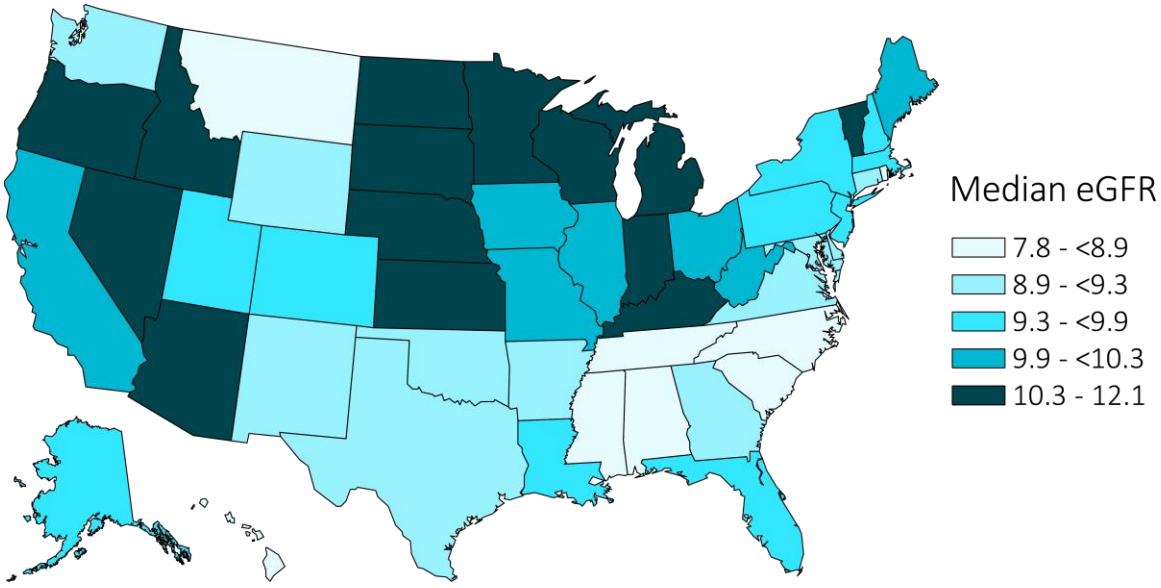


Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate.

The median eGFR in 92,894 male veterans who transitioned to ESRD between 10/1/2007 and 3/31/2015 was 9.6 mL/min/1.73m² (as shown in Table 9.2) and in 6,720 female veterans was 8.6 mL/min/1.73m². We created quintiles of eGFR for males and females separately. In both males and females, the highest median eGFRs per state were found in North Dakota (12.1 mL/min/1.73m² for males and 12.7 mL/min/1.73m² for females), and Idaho (11.1 mL/min/1.73m² for males and 11.7 mL/min/1.73m² for females) (Figure 9.2 and Figure 9.3, respectively). Michigan, Arizona, Minnesota, Oregon, Vermont, and Wisconsin were also in the highest eGFR quintiles for both male and female veterans. Indiana, South Dakota, Nebraska, Nevada, Kentucky, and Kansas were in the highest eGFR quintile for males, and Alaska, Iowa, and Maine were other states in the highest eGFR quintile for females. For males, South Carolina (7.8 mL/min/1.73m²), District of Columbia (8.0 mL/min/1.73m²), and Alabama (8.3 mL/min/1.73m²) had the lowest eGFRs at transition, and for females, Rhode Island (6.6 mL/min/1.73m²), South Carolina (6.7 mL/min/1.73m²), and Alabama (7.4

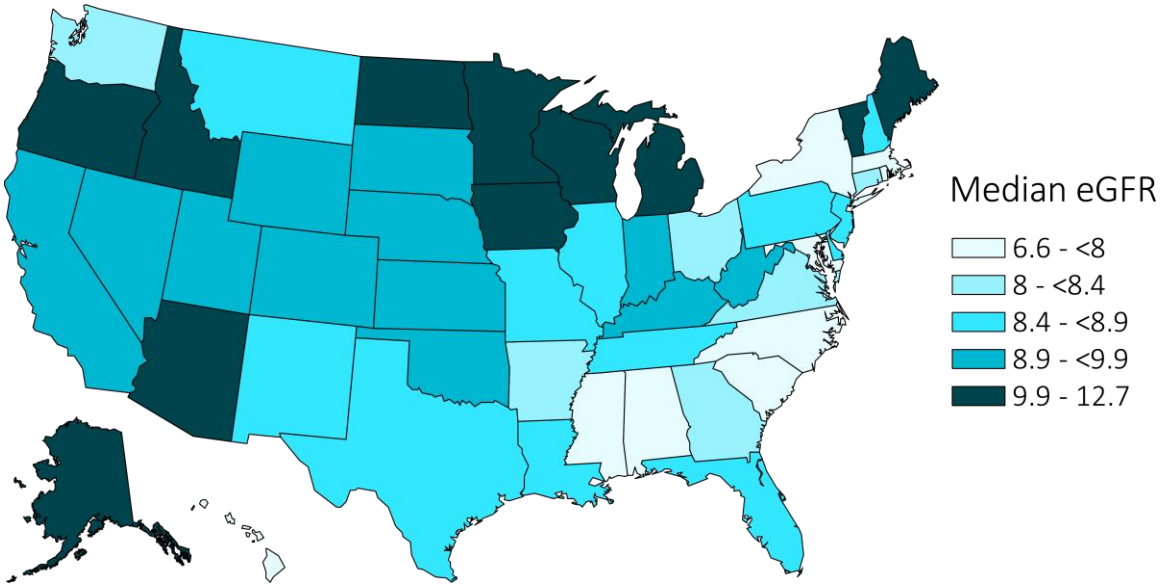
mL/min/1.73m²) had the lowest. For both males and females, lower eGFRs at transition were also present in North Carolina, Hawaii, and Mississippi. Additionally males had lower eGFRs in Rhode Island, Tennessee, and Montana, while females also had lower eGFRs at transition in District of Columbia, New York, Massachusetts, and Maryland.

vol 1 Figure 9.2 Median estimated glomerular filtration rate (eGFR) at transition among 92,894 male incident ESRD veterans across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate.

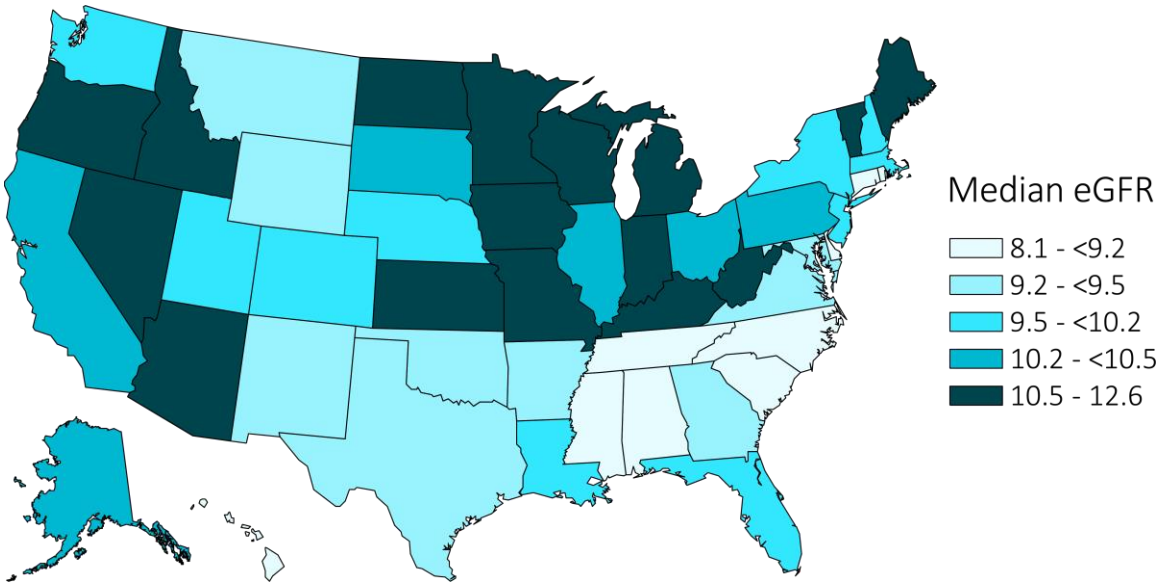
vol 1 Figure 9.3 Median estimated glomerular filtration rate (eGFR) at transition among 6,720 female incident ESRD veterans across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate.

For 43,062 veteran patients with diabetes as the primary cause of ESRD and an available eGFR measurement at transition, the median eGFR was 9.8 mL/min/1.73m^2. Vermont (12.6 mL/min/1.73m^2), North Dakota (12.5 mL/min/1.73m^2), and Idaho (12.0 mL/min/1.73m^2) had the highest eGFR at transition for veterans with diabetes listed as the primary cause of ESRD, while South Carolina (8.1 mL/min/1.73m^2), District of Columbia (8.3 mL/min/1.73m^2), and Alabama (8.4 mL/min/1.73m^2) had the lowest (Figure 9.4). Other states in the same Southern region (Tennessee, North Carolina, and Mississippi) as well as Hawaii, Delaware, Connecticut and Rhode Island also had veterans with diabetes as primary cause of ESRD with low eGFRs at transition. Other states with higher eGFRs at transition in veterans with diabetes as the primary cause of ESRD included Western states: Arizona, Oregon, and Nevada, and Midwestern states: Kansas, Michigan, Missouri, Minnesota, Iowa, Wisconsin, Indiana, as well as West Virginia, Kentucky and Maine.

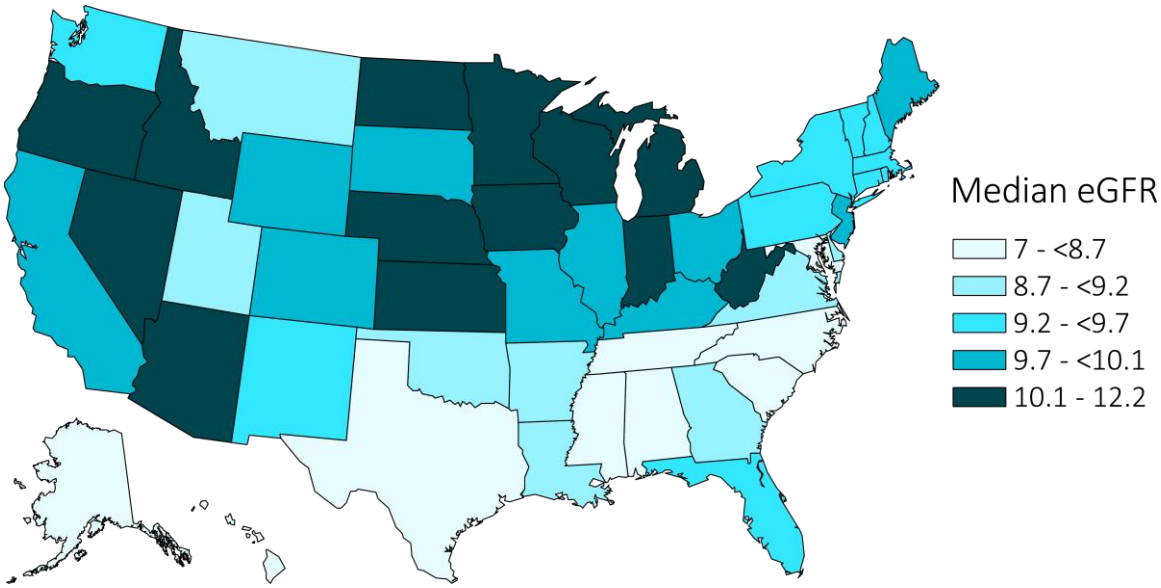
vol 1 Figure 9.4 Median estimated glomerular filtration rate (eGFR) at transition among 43,062 incident ESRD veterans with diabetes as the primary cause of ESRD across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate.

For 32,273 veteran patients with hypertension as the primary cause of ESRD and an available eGFR, the median was 9.3 mL/min/1.73m^2. North Dakota (12.2 mL/min/1.73m^2), Idaho (11.6 mL/min/1.73m^2), and Arizona (10.8 mL/min/1.73m^2) had the highest eGFRs at transition for these patients, while Alaska (7.0 mL/min/1.73m^2), South Carolina (7.3 mL/min/1.73m^2), and the District of Columbia (7.9 mL/min/1.73m^2) had the lowest (Figure 9.5). Similar to patients with diabetes as the primary cause of ESRD, for veterans with hypertension as the primary cause of ESRD, Midwestern states: Iowa, Indiana, Wisconsin, Minnesota, and Michigan as well as Kansas and Nevada had the higher median eGFRs at transition, and Southern States (North Carolina, Alabama, Mississippi, and Tennessee) as well as Hawaii, had the lower median eGFRs. For veteran patients with hypertension as the primary cause of ESRD, Texas and Maryland, additionally, had lower eGFRs at transition while Nebraska, Oregon, and West Virginia had higher eGFRs.

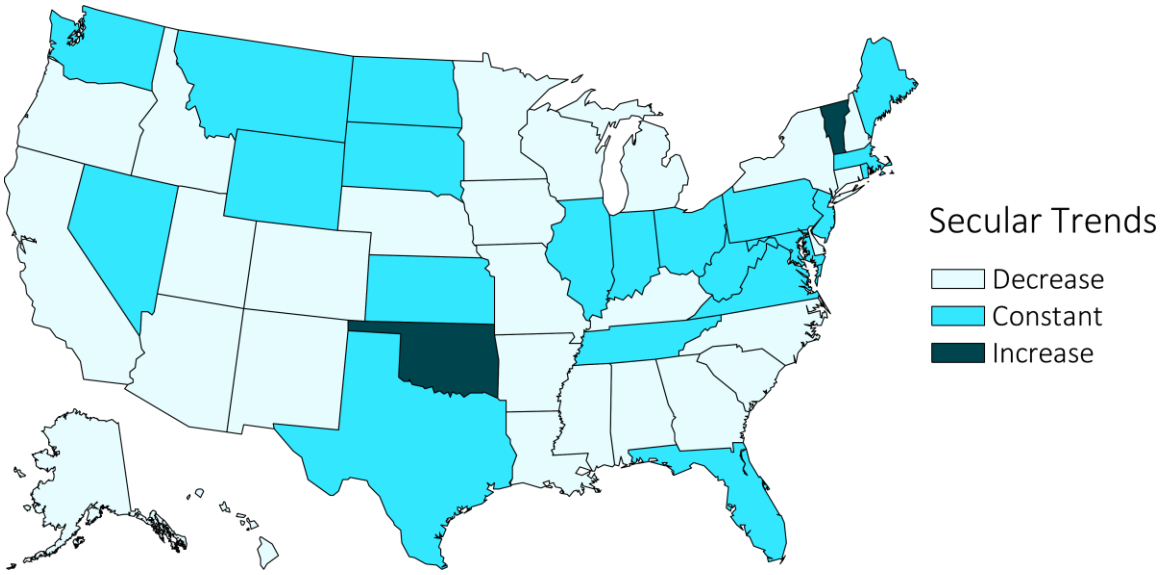
vol 1 Figure 9.5 Median estimated glomerular filtration rate (eGFR) at transition among 32,273 incident ESRD veterans with hypertension as the primary cause of ESRD across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate.

Over the 7.5 year period between 10/1/2007 and 3/31/2015, median eGFRs at transition decreased or remained the same for most states, while median eGFRs at transition increased for Oklahoma and Vermont (Figure 9.6).

vol 1 Figure 9.6 Distribution of secular trends of median estimated glomerular filtration rates (eGFR) between 10/1/2007-3/31/2015 among 99,614 incident ESRD veterans across the United States

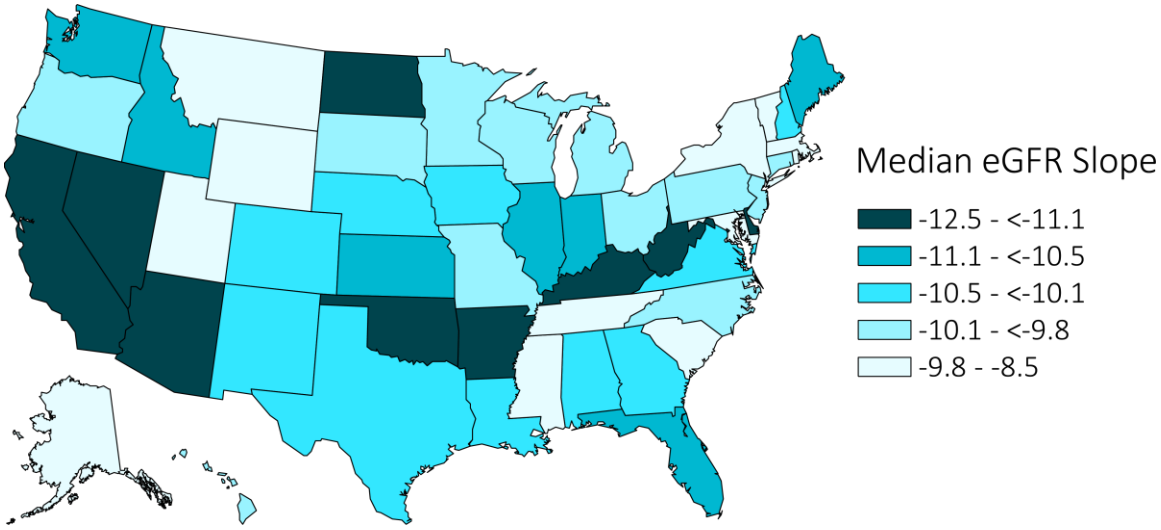


Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (mL/min/1.73m² per year). Abbreviation: ESRD, end-stage renal disease.

KIDNEY DISEASE PROGRESSION ACCORDING TO SLOPE OF ESTIMATED GLOMERULAR FILTRATION RATE PROFILE BETWEEN 10/1/2007 AND 3/31/2015

Of 102,477 veterans transitioning to ESRD, we were able to create a profile of kidney disease progression in the year prior to transition by estimating the slope of eGFR in the last year prior to ESRD in 29,277 veterans who had at least two quarterly averaged eGFR measurements within one year prior to ESRD transition. Overall, the median slope of eGFR in the year prior to transition to ESRD was -10.4 mL/min/1.73m²/year. We also examined the median prelude (pre-ESRD) eGFR slope per state for TC-CKD veteran patients and found that the states with the steepest prelude slopes (rapid kidney disease progression) were North Dakota (-12.5 mL/min/1.73m²/year), Arizona (-12.0 mL/min/1.73m²/year), and the District of Columbia (-11.6 mL/min/1.73m²/year), while more gradual prelude slopes were found in Mississippi (-9.0 mL/min/1.73m²/year), Vermont (-8.9 mL/min/1.73m²/year) and Rhode Island (-8.5 mL/min/1.73m²/year) (Figure 9.7).

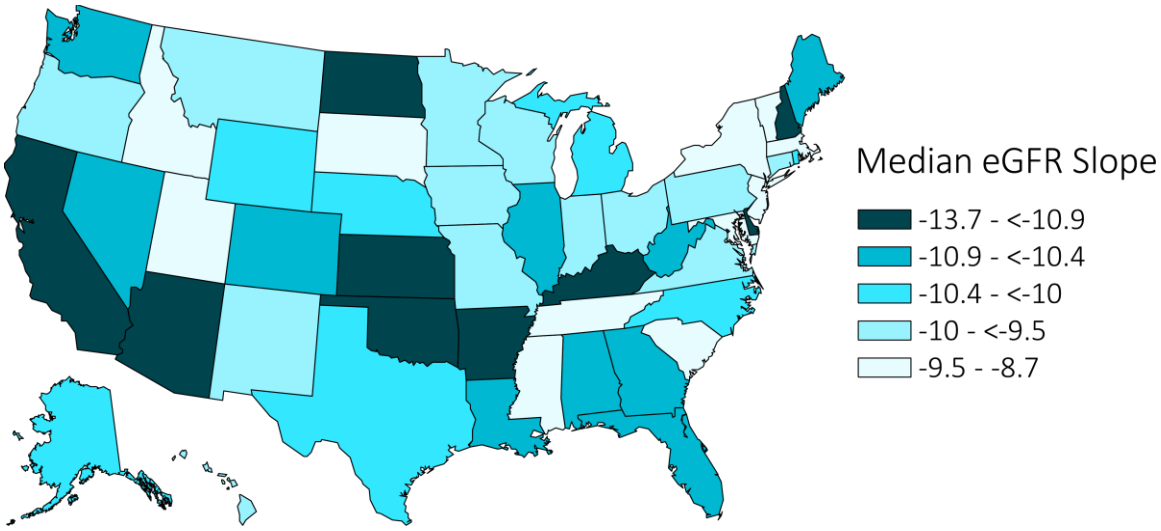
vol 1 Figure 9.7 Median estimated glomerular filtration rate (eGFR) slope in the one-year prelude (prior to transition) among 29,277 incident ESRD veterans across the United States, 10/1/2007-3/31/2015 (For decomposition according to cause of ESRD, see Figures 9.8 and 9.9)



Data source: VHA and USRDS ESRD Databases. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate.

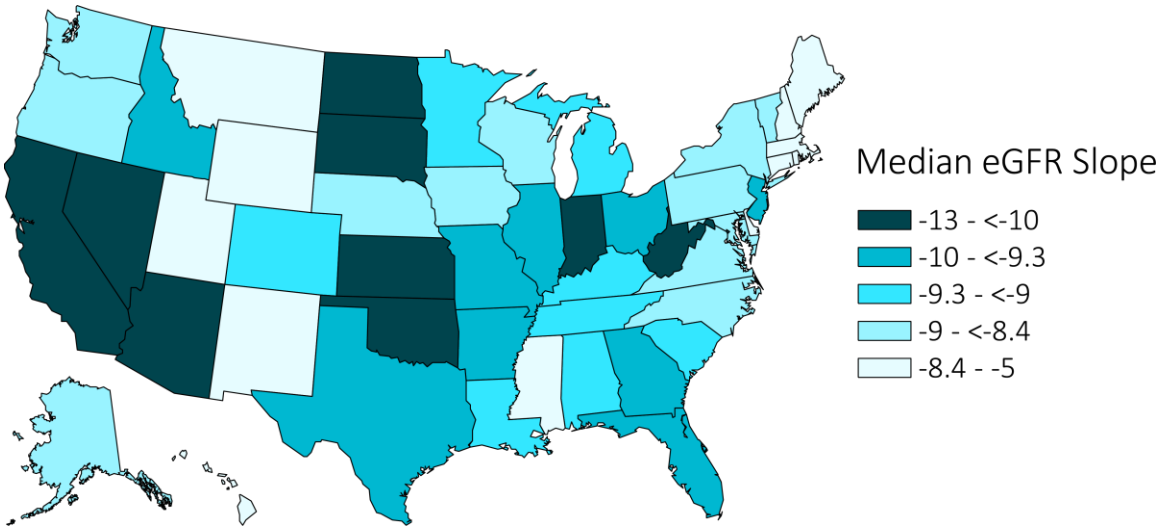
In 14,349 veterans with diabetes as the primary cause of ESRD and with an available prelude slope of eGFR in the last year prior to ESRD (Figure 9.8), the median pre-ESRD slope was -10.2 mL/min/1.73m²/year, and states with the steepest median pre-ESRD slopes were North Dakota (-13.7 mL/min/1.73m²/year), District of Columbia (-11.9 mL/min/1.73m²/year), and Arizona (-11.8 mL/min/1.73m²/year), while New Jersey (-9.1 mL/min/1.73m²/year), Vermont (-8.9 mL/min/1.73m²/year), and Tennessee (-8.7 mL/min/1.73m²/year) had the gentlest. California, Oklahoma, Kansas, Arkansas, Kentucky, Delaware, and New Hampshire were also among the states with steeper slopes prior to ESRD transition in veterans with diabetes as the cause of ESRD, while Idaho, South Dakota, Mississippi, South Carolina, Maryland, Massachusetts, and New York had gentler median eGFR slopes. However, for 7,845 veterans where hypertension was the primary cause of ESRD, the median pre-ESRD slope was -9.4 mL/min/1.73m²/year (Figure 9.9) and the states with the steepest slopes were Kansas (-13.0 mL/min/1.73m²/year), Nevada (-11.8 mL/min/1.73m²/year), and North Dakota (-12.1 mL/min/1.73m²/year), while the states with the gentlest slopes were Wyoming (-5.0 mL/min/1.73m²/year), Rhode Island (-7.1 mL/min/1.73m²/year), and New Hampshire (-6.3 mL/min/1.73m²/year).

vol 1 Figure 9.8 Median estimated glomerular filtration rate (eGFR) slope in the one-year prelude (prior to transition) among 14,349 incident ESRD veterans with diabetes as the cause of ESRD across the United States, 10/1/2007-3/31/2015



Data source: VHA and USRDS ESRD Databases. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate.

vol 1 Figure 9.9 Median pre-ESRD estimated glomerular filtration rate (eGFR) slope in the one-year prelude (prior to transition) among 7,845 incident ESRD veterans with hypertension as the cause of ESRD across the United States, 10/1/2007-3/31/2015

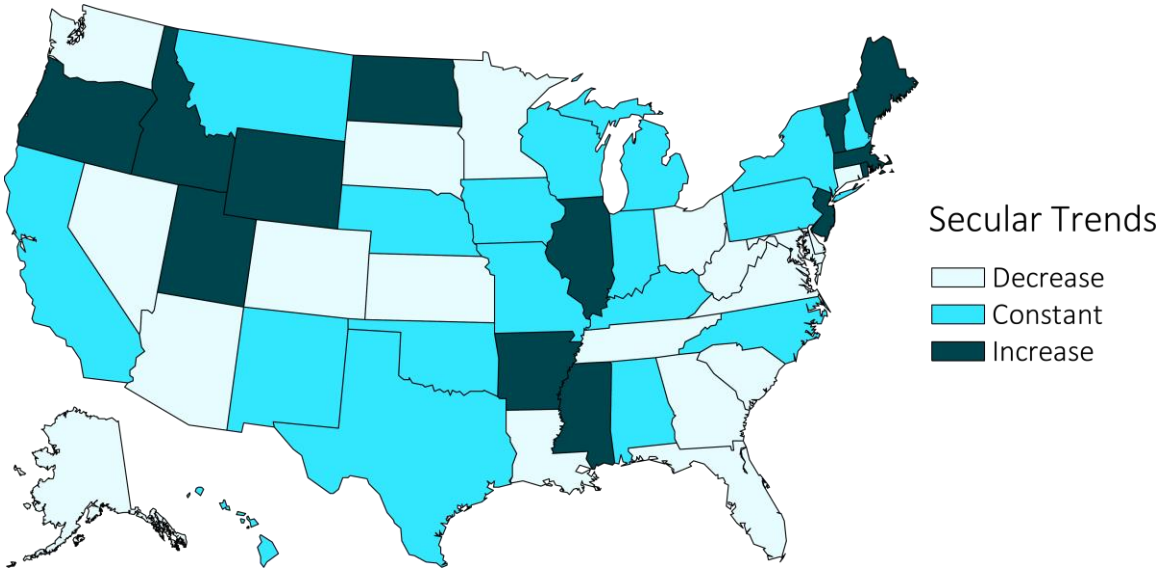


Data source: VHA and USRDS ESRD Databases. Abbreviations: ESRD, end-stage renal disease; eGFR, estimated glomerular filtration rate.

SECULAR TRENDS IN PRIMARY CAUSE OF ESRD AND SECULAR AND SEASONAL TRENDS OF TRANSPLANTS OVER 7.5 YEARS IN THE INCIDENT ESRD VETERAN POPULATION BETWEEN 10/1/2007 AND 3/31/2015

In the 2017 ADR chapter, we reported that the distribution of veteran patients with ESRD primarily due to diabetes between 10/1/2007- 3/31/2015 varied. Primarily, Southwestern states, such as Texas, New Mexico, Arizona, and Oklahoma, as well as California had a higher proportion of veterans with ESRD due to diabetes. In this year's chapter, we show that these higher proportions have remained constant over 7.5 years in Texas, New Mexico, Oklahoma, and California (Figure 9.10), while the proportions of ESRD primarily due to diabetes have actually decreased over the years in Alaska, Arizona, Nevada, Colorado, and Kansas. Proportions of ESRD primarily due to diabetes in veterans have also declined over time in the South and Southeast United States, including Georgia, Louisiana, Florida, Tennessee, and South Carolina, while states in the Northwest such as Oregon, Idaho, Utah, and Wyoming have had an increase in the proportion of veterans transitioning to ESRD primarily due to diabetes.

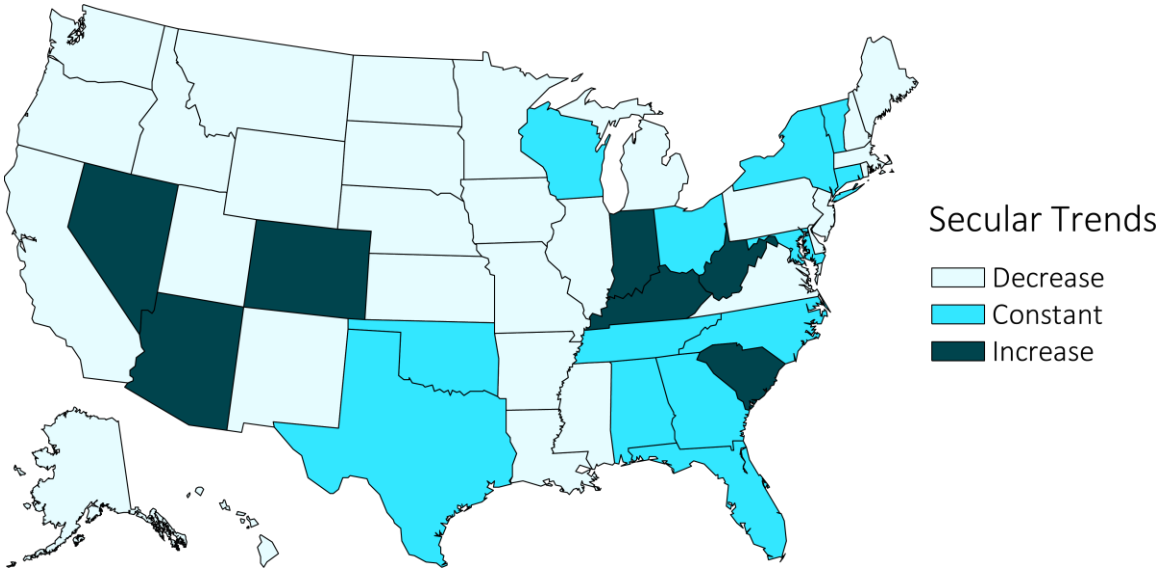
vol 1 Figure 9.10 Distribution of secular trends of diabetes (%) as the primary cause of ESRD between 10/1/2007-3/31/2015 among 102,477 incident ESRD veterans across the United States



Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (% per year). Abbreviation: ESRD, end-stage renal disease.

Conversely, the proportions of veterans transitioning to ESRD primarily due to hypertension have increased between 10/1/2007 and 3/31/2015 in Nevada, Arizona, Colorado, Indiana, Kentucky, West Virginia, and South Carolina, and remained constant in Texas, Oklahoma, and the Southeastern states of Florida, Alabama, Georgia, Tennessee, and North Carolina (Figure 9.11).

vol 1 Figure 9.11 Distribution of secular trends of hypertension (%) as the primary cause of ESRD among 102,477 incident ESRD veterans across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (% per year). Abbreviation: ESRD, end-stage renal disease.

Across the entire nation, 5,491 out of 102,477 veterans received a transplant between 10/1/2007 and 9/1/2015, including 1,355 preemptive transplantations. As in the general ESRD population, preemptive transplantation is fairly rare (Table 9.1) and even more rare in the veteran population. In Table 9.5, we show the characteristics of 5,169 patients who received a kidney transplant at or within 5 years after transition to ESRD according to the timing of kidney transplantation. Compared to the overall TC-CKD veteran cohort, veteran patients who received a transplant were younger, more likely to be female, White, and be on peritoneal dialysis prior to receiving a kidney transplant, if the transplant was not preemptive. Among the group of veteran patients who received a kidney transplant within Days 1-30 after ESRD transition, the proportion of females was lower than in other time periods, whereas the percentage of non-White veterans receiving a kidney transplant was higher from Day 365 to 5 years after ESRD transition.

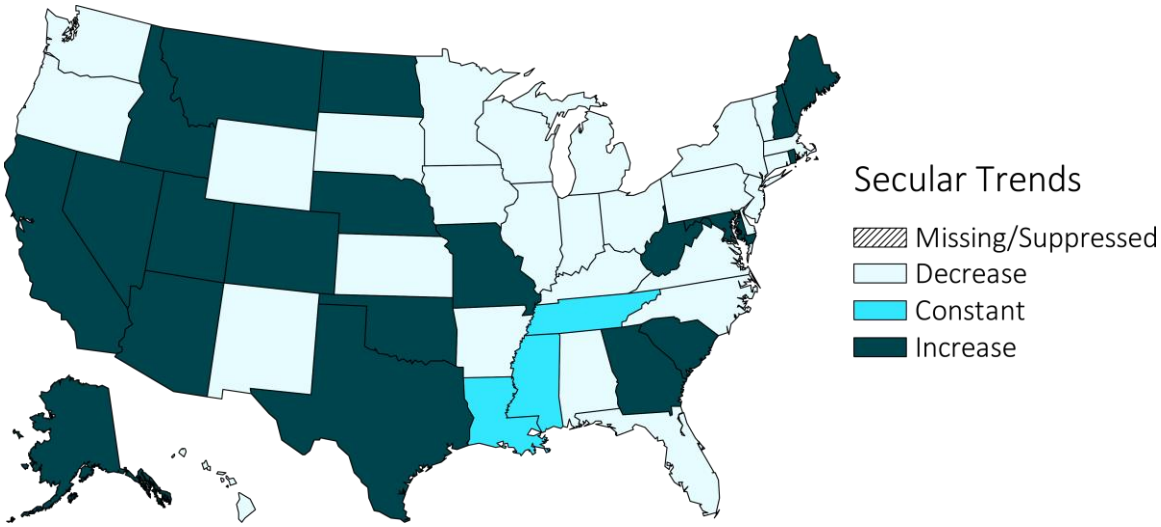
vol 1 Table 9.5 Baseline characteristics of 5,169 incident ESRD veterans who received a kidney transplant at or after ESRD transition between 10/1/2007 and 9/1/2015, according to timing of kidney transplant

	Timing of Renal Transplant in Relation to Transition to ESRD					
	Preemptive	**Day 1-30**	**Day 30-60**	**Day 60-90**	**Day 90-365**	**Day 365-5 years**
N	1,355	48	69	68	867	2,762
Age (mean±SD, years)	59.7±11.2	59.8±11.6	57.4±11.8	58.6±12.4	57.6±12.0	58.0±10.6
Female (%)	11	6	10	9	11	9
Race (%)						
White	79	83	78	84	77	64
Black	17	15	19	16	19	32
Asian	3	0	3	0	3	3
Native American	0.44	0	0	0	0.81	0.94
Other	1	2	0	0	0	0
Unknown	0	0	0	0	0	0
Ethnicity (%)						
Hispanic	7	4	4	4	8	9
Non-Hispanic	3	2	3	0	3	4
Unknown	8	0	0	0	1	0
Non-Hispanic White	68	79	74	79	69	55
Non-Hispanic Black	15	15	19	16	19	31
Access type (%)						
AV fistula	14	36	19	38	37	37
AV graft	0	4	2	2	4	3
Central venous catheter	71	54	77	60	59	59
Other	14	7	2	0	0	1
Comorbidity (%)						
Atherosclerotic heart disease	6	7	4	16	12	12
Congestive heart failure	4	18	6	6	11	13
Peripheral vascular disease	3	2	7	3	6	6
Cerebrovascular disease	2	2	6	3	4	4
Other cardiac disease	10	2	19	6	10	11
Chronic obstructive pulmonary disease	2	4	0	0	3	3
Tobacco use (current smoker)	1	2	3	6	4	4
Drug dependence	0.09	0.00	1.45	0.00	0.47	0.84
Alcohol dependence	2.33	6.67	1.45	1.49	1.29	0.91
Diabetes‡	30	27	39	36	42	46
Malignant neoplasm, cancer	5	4	3	6	5	5
Inability to ambulate	1	0	1	0	0	1
Inability to transfer	0	0	1	0	0	0
Amputation	1	0	0	0	1	2
Institutionalized	0	0	1	1	0	0
Institutionalized (assisted living)	0.09	0.00	0.00	0.00	0.00	0.11
Institutionalized (nursing home)	0	0	1	1	0	0
Institutionalized (other)	0.09	0.00	0.00	0.00	0.00	0.15
Needs assistance with daily activities	2	0	1	1	1	2
Non-renal congenital abnormality	1.81	0.00	0.00	0.00	0.23	0.04
Toxic nephropathy	0.35	2.22	0.00	0.00	0.35	0.47
Body mass index (kg/m^2)	28.9±5.8	28.6±4.3	28.1±6.1	28.8±5.4	28.9±5.9	29.4±5.8
Estimated GFR (eGFR) (mL/min/1.73m^2)	12.7 (9.4,17.1)	9.4 (6.4,11.7)	9.0 (6.1,12.0)	8.7 (6.7,9.9)	8.4 (6.2,11.3)	8.2 (6.0,11.0)
Initial dialysis modality (%)						
Hemodialysis	0	0	0	78	74	80
Home hemodialysis	0	0	0	0	1	1
Peritoneal dialysis	0	0	0	22	23	18
Uncertain dialysis	0	100	100	0	2	1
Nephrologist care (%)						
Yes	89	78	87	91	82	79

Data source: VHA, CMS, and USRDS ESRD Databases. ‡Diabetes is presence of any of the following: Diabetes, currently on insulin; Diabetes, without medications; Diabetes, on oral medications; Diabetic, retinopathy. Abbreviations: ESRD, end-stage renal disease AV, arteriovenous; eGFR, estimated glomerular filtration rate; kg, kilogram; m, meters; mL, milliliter; min, minute.

In the 2017 ADR, we showed that the states with the highest preemptive kidney transplant rates among veterans (>2.2%) were Alaska, Colorado, Delaware, Minnesota, Montana, Nebraska, New Mexico, Utah, Vermont, and Wyoming. In evaluating the proportion of 1,319 patients with preemptive transplantation between 10/1/2007-12/31/2014, the proportion of veterans with ESRD per state who received a preemptive transplant has increased in most Southwestern and Western states, while proportions have decreased in the Midwest and Northeast (Figure 9.12).

vol 1 Figure 9.12 Secular trends in the distribution of preemptive kidney transplant rates among 1,319 incident ESRD veterans across the United States between 10/1/2007-12/31/2014



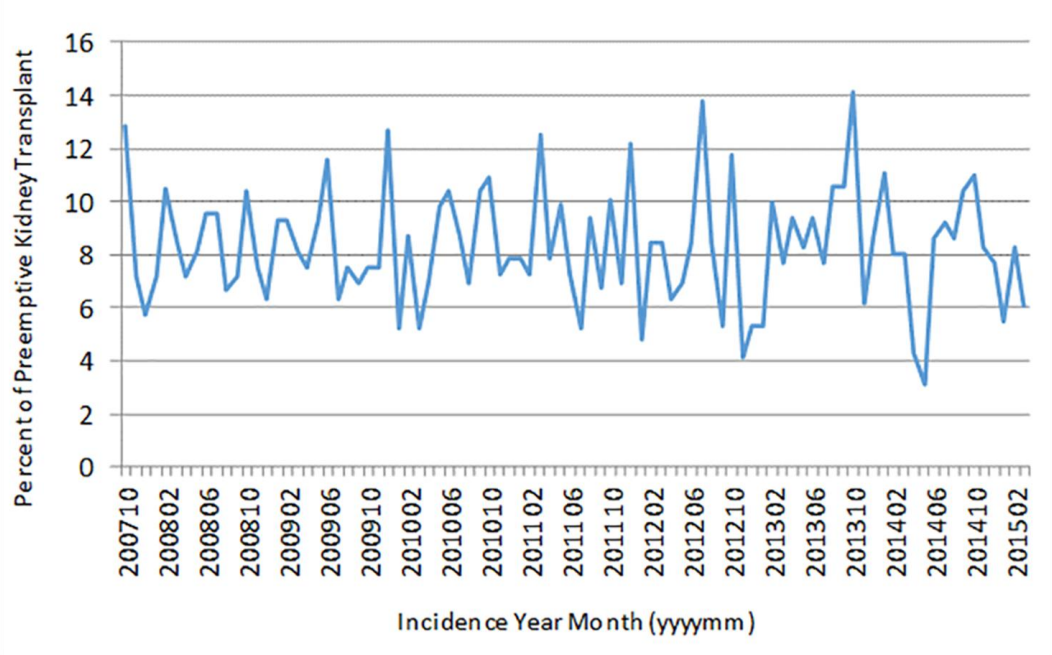
Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (% per year). Abbreviation: ESRD, end-stage renal disease.

Between 10/1/2007 and 3/31/2015, 4,136 out of 102,477 U.S. veterans received a transplant after treatment with dialysis, which is a rate of 2 per 100 patient-years. Over 7.5 years, the proportion of veteran patients who received a transplant post-dialysis decreased for all states with the exception of Iowa (map not shown). For both preemptive and post-dialysis kidney transplants, the proportion of veterans receiving a kidney transplant per state decreased for all states, except Maine, which increased due to the higher number of preemptive transplants (data not shown).

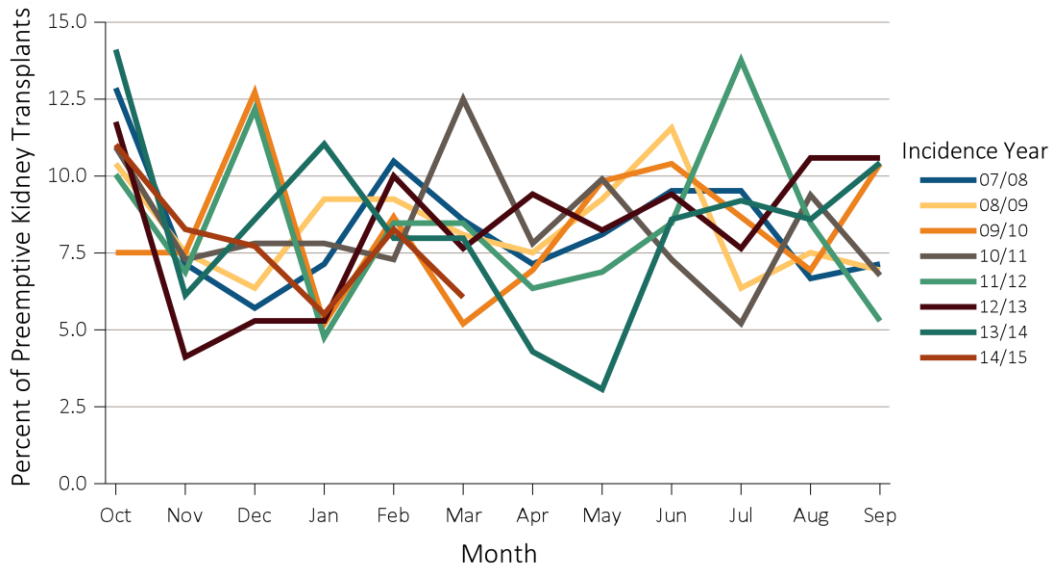
The percent of kidney transplants for each month per fiscal year between 10/1/2007 and 3/31/2015 can be seen in Figure 9.13. For most fiscal years (October-September), there was a peak in kidney transplants in October, with secondary peaks in summer months of May, June, or July, and for some years during the winter months of December, January, and February. In fiscal year 2011, the highest number of transplants occurred in March 2011. For 2012-2013, the lowest number of transplants occurred in the winter months of December or January, or in November. In fiscal year 2014, the lowest number of transplants occurred in May 2014.

vol 1 Figure 9.13 Seasonal variations across secular trends in the percent of kidney transplants among 1,355 incident ESRD veterans who received a preemptive kidney transplant between 10/1/2007 and 3/31/2015*

(a) Percent of patients for each month per fiscal year over 7.5 years



(b) Percent of patients for each month per fiscal year stratified by fiscal year

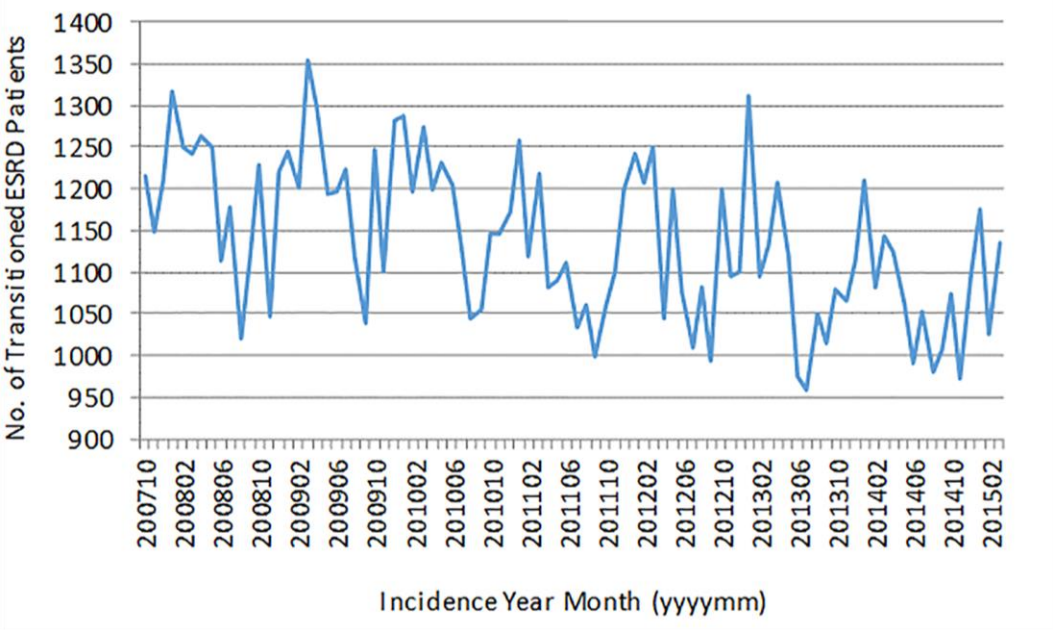


*Data source: USRDS ESRD Database. For Fiscal Year 14/15, percent was based on the averaged total number of preemptive transplants of previous 7 fiscal years. *Values for 10 or fewer patients are suppressed. Abbreviation: ESRD, end-stage renal disease.*

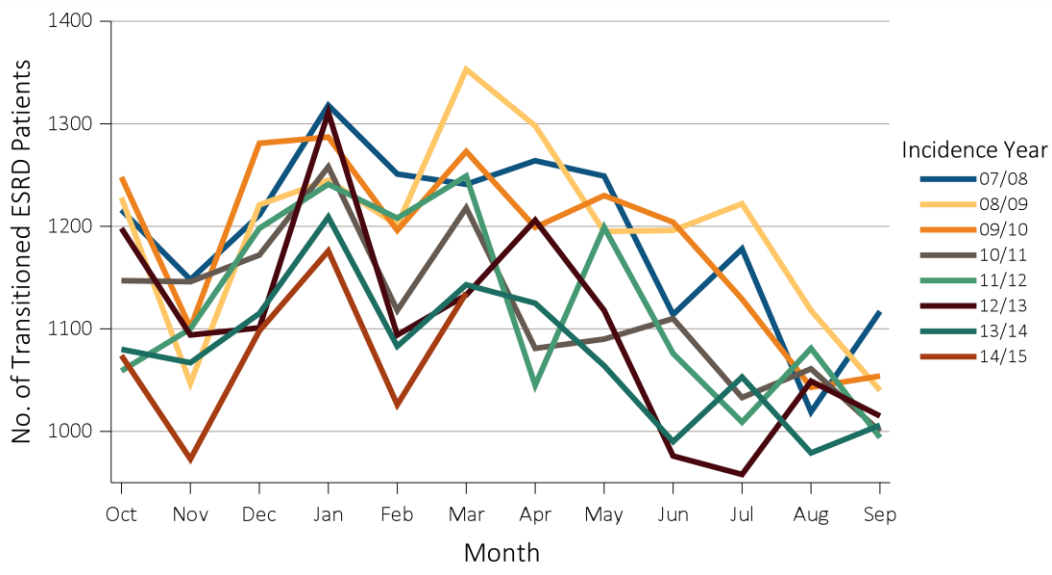
The frequency of veterans transitioning to ESRD has been relatively consistent over 7.5 years between 10/1/2007 and 3/31/2015 (Figure 9.14), with a slight downward trend in the latter years. The seasonal trend pattern of veterans transitioning to ESRD shows peaks in January and March and troughs in the summer months of June, July, August, and September, and secondary troughs in November and February.

vol 1 Figure 9.14 Seasonal variations across secular trends in the frequency of transition to ESRD in 102,477 veterans between 10/1/2007-3/31/2015

(a) Frequency of patients transitioned to ESRD per month over 7.5 years



(b) Frequency of patients transitioned to ESRD per month stratified by fiscal year



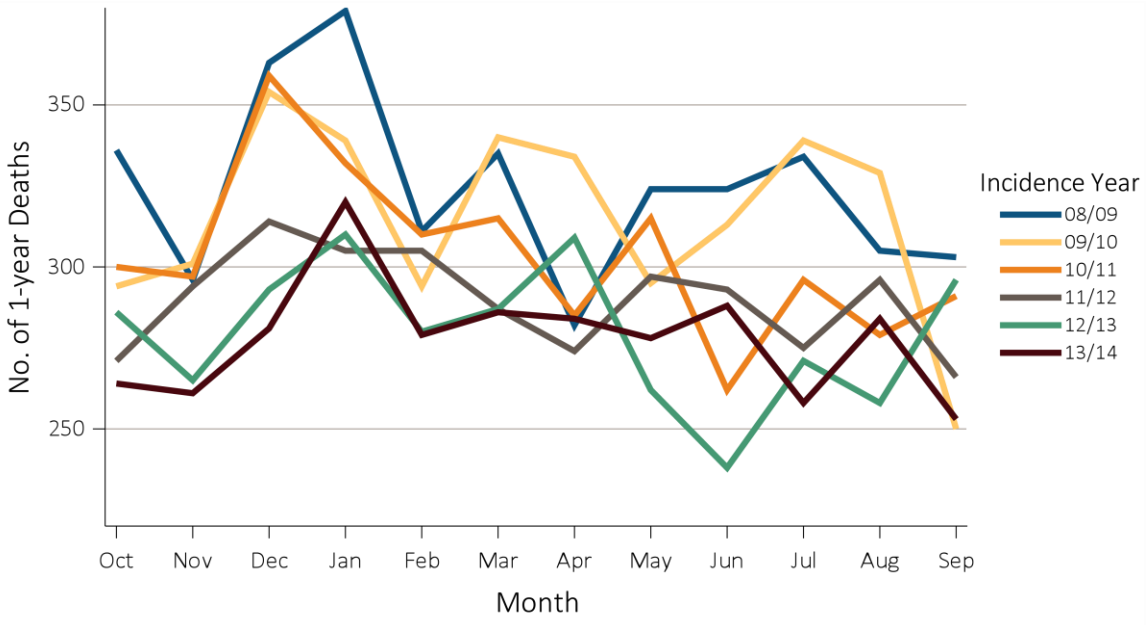
Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; No., number.

SEASONAL AND SECULAR TRENDS AND STATE MAPS OF CAUSE OF DEATH OVER 7.5 YEARS IN THE INCIDENT ESRD VETERAN POPULATION BETWEEN 10/1/2007 AND 3/31/2015

In the previous TC-CKD ADR chapters, we have shown mortality peaks within the first 3 months after transition to ESRD in incident veteran ESRD patients. Out of 102,477 who transitioned to ESRD between 10/1/2007 and 3/31/2015, there were 10,324 (10%) veterans who died by Day 90 post-transition to ESRD. Follow-up information on all-cause mortality was available through September 1st, 2015 and for cause of death through August 1st 2015. Of 93,912 patients who transitioned to ESRD between 10/1/2007 and 9/1/2014 and had information on mortality, there were 24,982 deaths that occurred in the first year post-transition between 10/1/2007-9/1/2015.

In Figure 9.15, we show the seasonal patterns of mortality frequency in 21,483 of the 24,982 incident ESRD veterans who died between 10/1/2008 and 9/30/2014. Across all years, there was a peak in the number of deaths in winter months, either December or January, while in most years there were troughs with the lowest death frequency in the summer months of June and September.

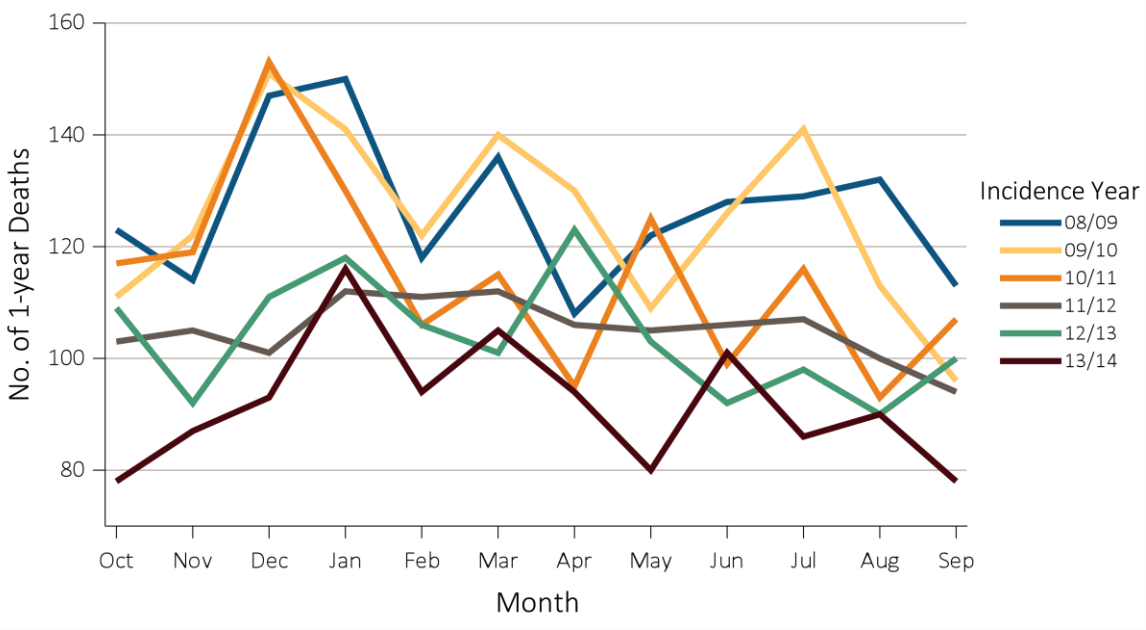
vol 1 Figure 9.15 Seasonal variations across secular trends for the one-year all-cause mortality frequency among 21,483 incident ESRD veterans who transitioned to ESRD between 10/1/2007-9/1/2014 and died between 10/1/2008 and 9/1/2014



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; No., number.

Of 92,987 patients who transitioned to ESRD between 10/1/2007 and 8/1/2014 and had information on mortality and cause of death, there were 9,234 deaths that occurred from cardiovascular causes in the first year post-transition and between 10/1/2007-8/1/2015. In Figure 9.16, we show the seasonal patterns of one-year cardiovascular mortality frequency in 8,004 incident ESRD veterans who died from cardiovascular causes within the first year post-transition to ESRD and between 10/1/2008-9/30/2014. The number of first year cardiovascular related deaths typically peaked in the winter months, December or January, with a secondary peak in March or April, while the lowest frequency of deaths typically occurred in the end of summer or beginning of autumn, in August, September, or October.

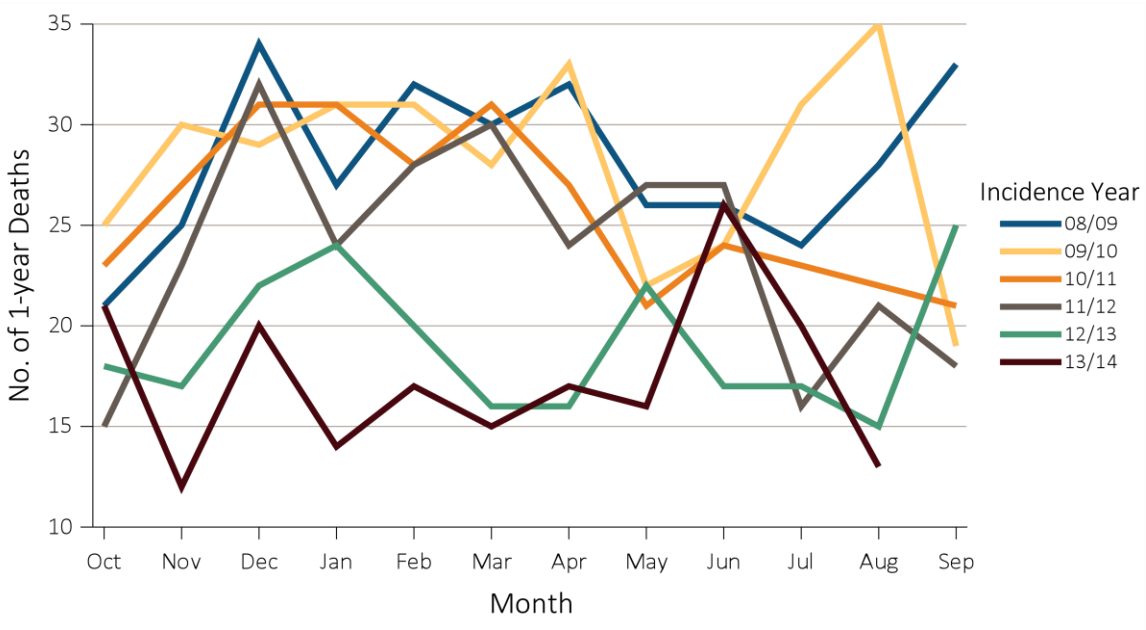
vol 1 Figure 9.16 Seasonal variations across secular trends for the one-year cardiovascular mortality frequency among 8,004 incident ESRD veterans who transitioned to ESRD between 10/1/2007-8/1/2013 and died from cardiovascular related causes between 10/1/2008 and 9/30/2014



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; No., number.

Seasonal patterns in infection-related mortality frequency were less discernable (Figure 9.17). Of 92,987 patients who transitioned to ESRD between 10/1/2007 and 8/1/2014 and had information on mortality and cause of death, there were 1,980 deaths that occurred from infection-related causes in the first year post-transition and between 10/1/2007-8/1/2015. Among 1,690 patients who died of infection-related causes in the first year after transition to ESRD and between 10/1/2008 - 8/31/2014, there appeared to be troughs in autumn months: September and October. Although less clear, there appeared to be peaks in December, March, and April for infection-related deaths in earlier years.

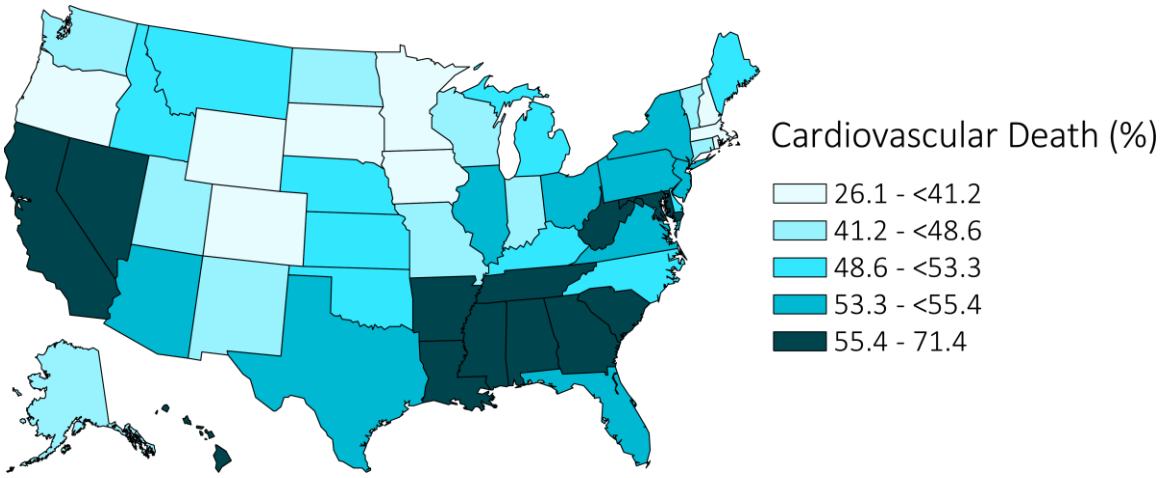
vol 1 Figure 9.17 Seasonal variations across secular trends for the one-year infection-related mortality frequency among 1,690 incident ESRD veterans who transitioned to ESRD between 10/1/2007-8/1/2013 and died from infection-related causes between 10/1/2008 and 8/31/2014*



*Data source: USRDS ESRD Database. *Values for 10 or fewer patients are suppressed. Abbreviations: ESRD, end-stage renal disease; No., number.*

We then examined the proportion of deaths attributed to particular cause of death categories in veterans who died in the first year after transition to ESRD between 10/1/2007-8/1/2015. From the 24,982 veterans that died in this period, 18,492 had a known cause of death. The proportion of these deaths attributed to cardiovascular causes (Figure 9.18) was highest in Hawaii (71%), Louisiana (63%), and Georgia (62%), and the lowest was in Wyoming (26%), District of Columbia (30%), and South Dakota (35%). Western states (California and Nevada) and Southern states (Tennessee, South Carolina, Mississippi, and Alabama) also had a higher proportion of first-year deaths attributed to cardiovascular causes; whereas Oregon, some Midwest states (Minnesota and Iowa), and Northeast states (New Hampshire, Rhode Island, and Massachusetts) had lower proportions of post-transition first-year deaths attributed to cardiovascular causes.

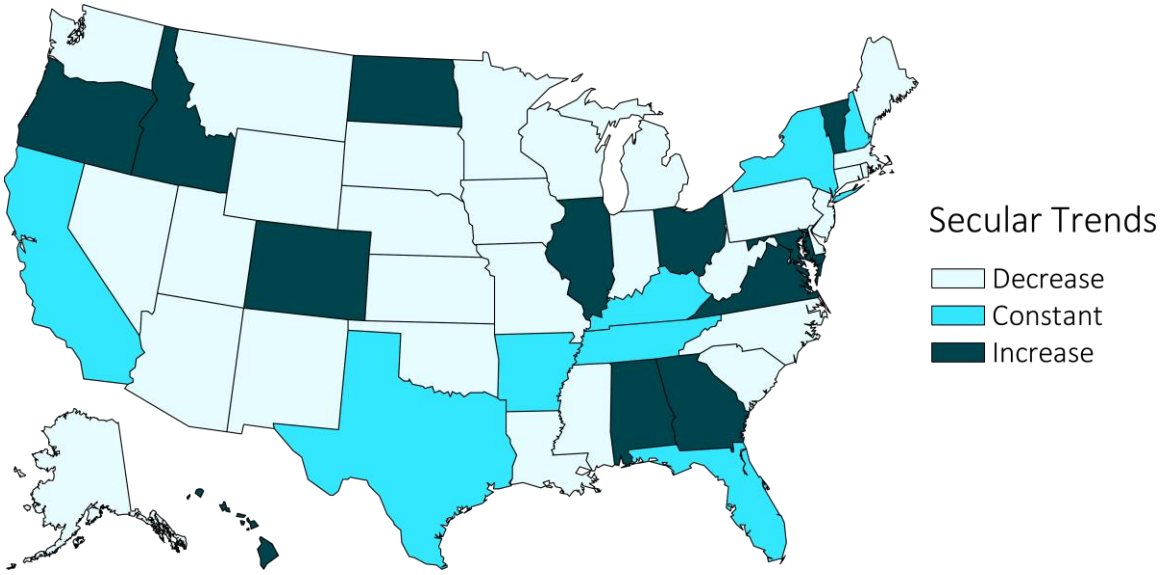
vol 1 Figure 9.18 Distribution of proportion of deaths in the first year post-transition to ESRD and between 10/1/2007-8/1/2015 attributed to cardiovascular causes among 18,492 incident ESRD veterans across the United States 10/1/2007-3/31/2015



Data source: VHA, CMS, and USRDS ESRD Databases. Abbreviation: ESRD, end-stage renal disease.

Over the 7.5 year period between 10/1/2007 and 3/31/2015, the proportion of deaths in the first year post-ESRD transition attributed to cardiovascular causes decreased in most of the United States, but increased in Vermont, Oregon, Idaho, Colorado, North Dakota, Illinois, Ohio, Maryland, Hawaii, Virginia, Georgia, District of Columbia, and Alabama (Figure 9.19).

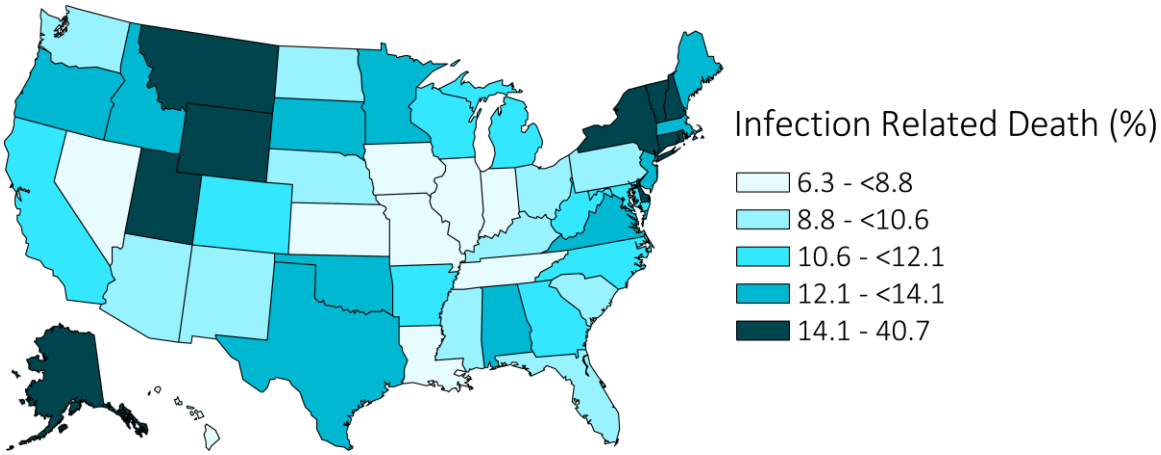
vol 1 Figure 9.19 Secular trends in the proportion of deaths in the first year post-transition to ESRD attributed to cardiovascular causes among 18,492 incident ESRD veterans who died between 10/1/2007-8/1/2015 and transitioned to ESRD across the United States, 10/1/2007-3/31/2015



Data source: VHA, CMS, and USRDS ESRD Databases. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (% per year). Abbreviation: ESRD, end-stage renal disease.

Deaths in veterans within the first year of ESRD transition attributed to infection-related causes (Figure 9.20) were highest in the District of Columbia (41%), Wyoming (22%), and Rhode Island (18%). Other Northern states including Montana, Alaska, Delaware, New York, Connecticut, Vermont, New Hampshire, and Rhode Island, also had higher proportions of infection-related deaths. The lowest proportions of infection-related deaths were seen in Kansas (6%), Hawaii (6%), and Iowa (8%). Indiana, Nevada, Illinois, Tennessee, and Louisiana also had lower proportions of infection-related deaths in the first year post-ESRD transition.

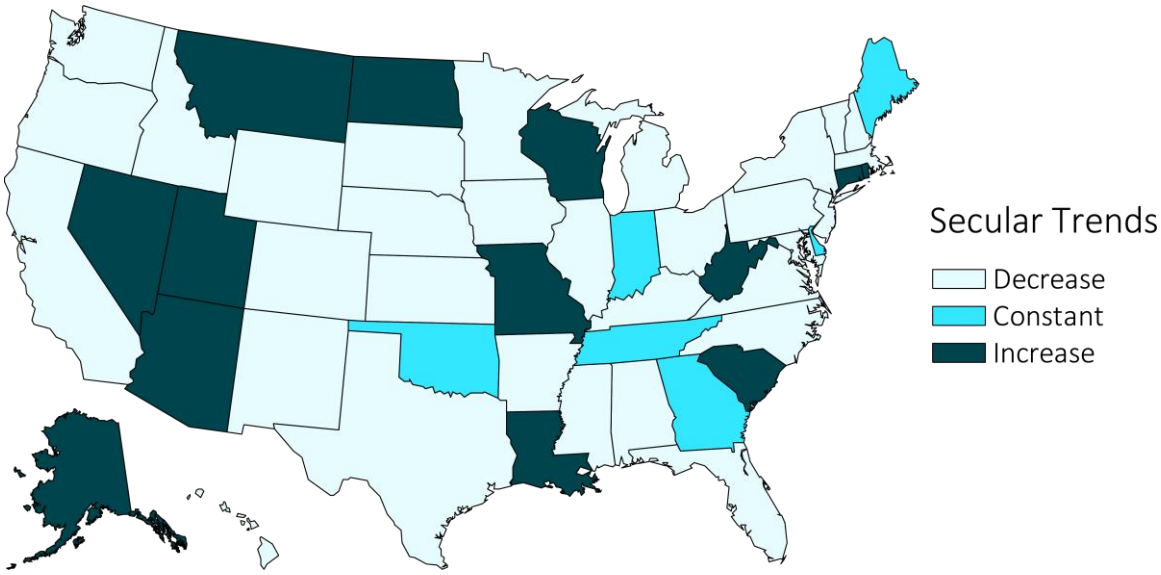
vol 1 Figure 9.20 Distribution of proportion of deaths in the first year post-ESRD transition attributed to infection-related causes among 18,492 incident ESRD veterans who died between 10/1/2007-8/1/2015 and transitioned to ESRD across the United States, 10/1/2007-3/31/2015



Data source: VHA, CMS, and USRDS ESRD Databases. Abbreviation: ESRD, end-stage renal disease.

For most of the United States, the proportion of deaths in the first year post-ESRD transition attributed to infection-related causes decreased or remained constant, but increased in Alaska, Nevada, Arizona, Connecticut, North Dakota, Utah, Montana, Louisiana, Missouri, Rhode Island, Wisconsin, West Virginia, and South Carolina (Figure 9.21).

vol 1 Figure 9.21 Secular trends in the proportion of deaths in the first year post-ESRD transition attributed to infection-related causes among 18,492 incident ESRD veterans who died between 10/1/2007-8/1/2015 and transitioned to ESRD across the United States, 10/1/2007-3/31/2015

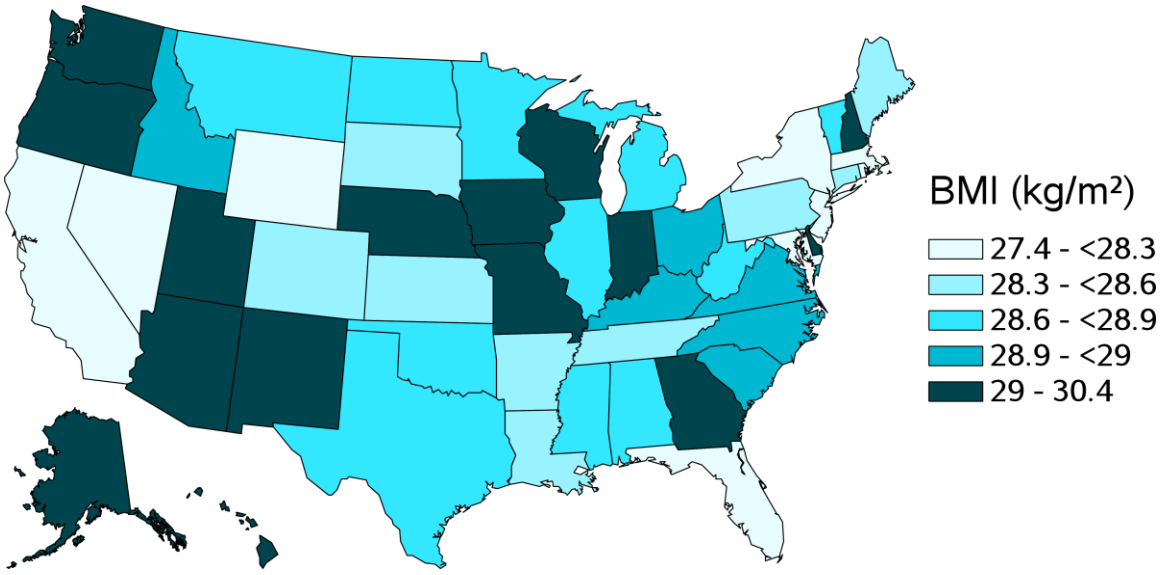


Data source: VHA, CMS, and USRDS ESRD Databases. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (% per year). Abbreviation: ESRD, end-stage renal disease.

BODY MASS INDEX AMONG VETERANS WHO TRANSITIONED TO ESRD

As the obesity epidemic continually increases across the United States, and as obesity is a leading risk factor for diabetes, which is also the leading cause of ESRD, we sought to characterize body mass index (BMI) in U.S. veterans transitioning to ESRD. As noted in Table 9.1 above, the mean BMI for veterans transitioning to ESRD is slightly lower than in the total USRDS population transitioning to ESRD between 10/1/2007 and 3/31/2015. Across the United States, we found that the U.S. veterans with highest mean BMI levels at transition (Figure 9.22) were in Alaska (30.4 kg/m^2), Nebraska (29.8 kg/m^2), and New Hampshire (29.7 kg/m^2), while the District of Columbia (27.4 kg/m^2), New York (27.5 kg/m^2), and Massachusetts (27.7 kg/m^2) had the lowest mean BMI at transition.

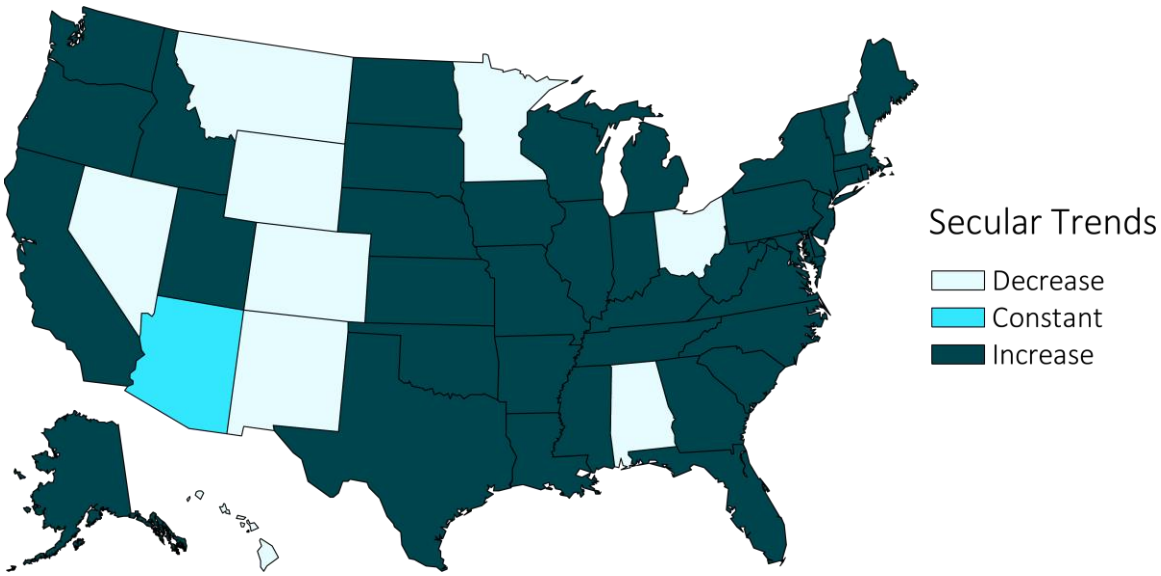
vol 1 Figure 9.22 Distribution of mean body mass index (BMI) levels at transition to ESRD among 98,701 incident ESRD veterans across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; BMI, body mass index; kg, kilogram; m, meter.

Over the 7.5 year period between 10/1/2007 and 3/31/2015, the mean BMI at transition to ESRD for most U.S. veterans has increased. However, mean BMI has remained constant in Arizona, but has decreased in Western states, including Nevada, Montana, Wyoming, Colorado, and New Mexico, as well as New Hampshire, Hawaii, Alabama, Ohio, and Minnesota (Figure 9.23).

vol 1 Figure 9.23 Secular trends in the mean body mass index (BMI) level among 98,701 incident ESRD veterans across the United States, 10/1/2007-3/31/2015 (For decomposition by racial/ethnic categories, see Figures 9.25, 9.27, and 9.29)



Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (kg/m² per year). Abbreviations: ESRD, end-stage renal disease; BMI, body mass index; kg, kilogram; m, meter.

As shown in Figure 9.24, mean BMI levels have gradually increased between 10/1/2007 and 3/31/2015 for (a) all racial/ethnic groups in the total USRDS transitioning population, and (b) in U.S. veterans. In the USRDS population, differences across racial/ethnic groups were maintained as mean BMI levels increased, whereas Non-Hispanic Black patients had persistently higher BMI levels at transition, followed by Non-Hispanic White patients, and Hispanics. However, less of a distinction across racial/ethnic groups is apparent in the veteran population, where BMI levels at transition are also on the rise over the 7.5 year period, but there is substantial overlap in the racial/ethnic groups with the highest and lowest BMI levels at transition.

vol 1 Figure 9.24 Secular trends in mean body mass index (BMI) across racial/ethnic groups in 98,704 veterans and 838,511 total USRDS patients transitioning to ESRD, 10/1/2007-3/31/2015

(a) USRDS cohort

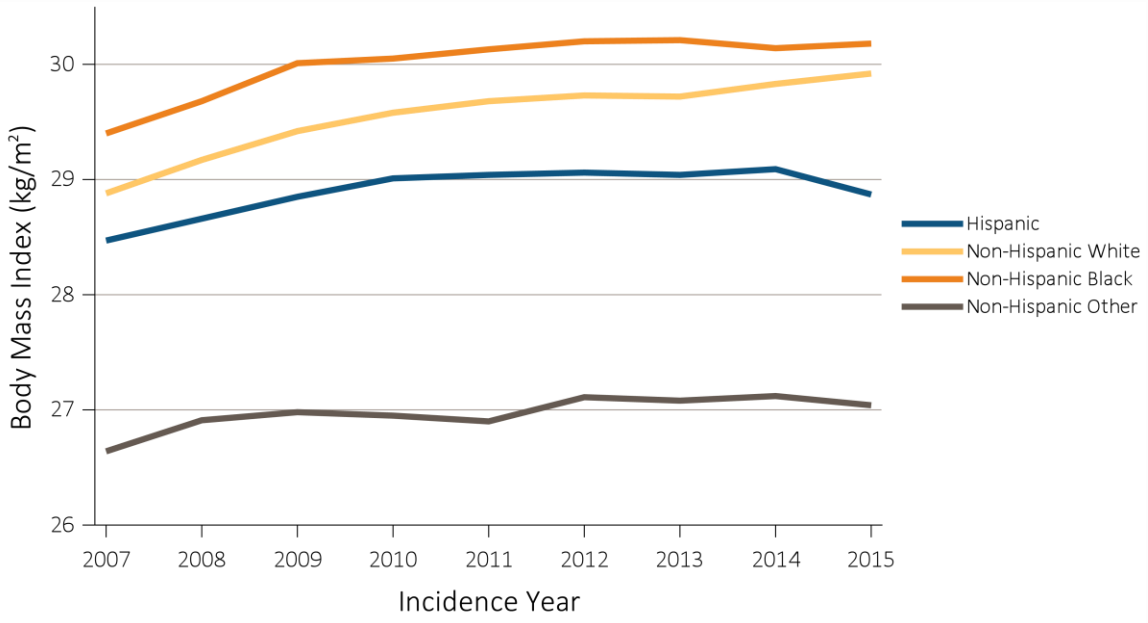
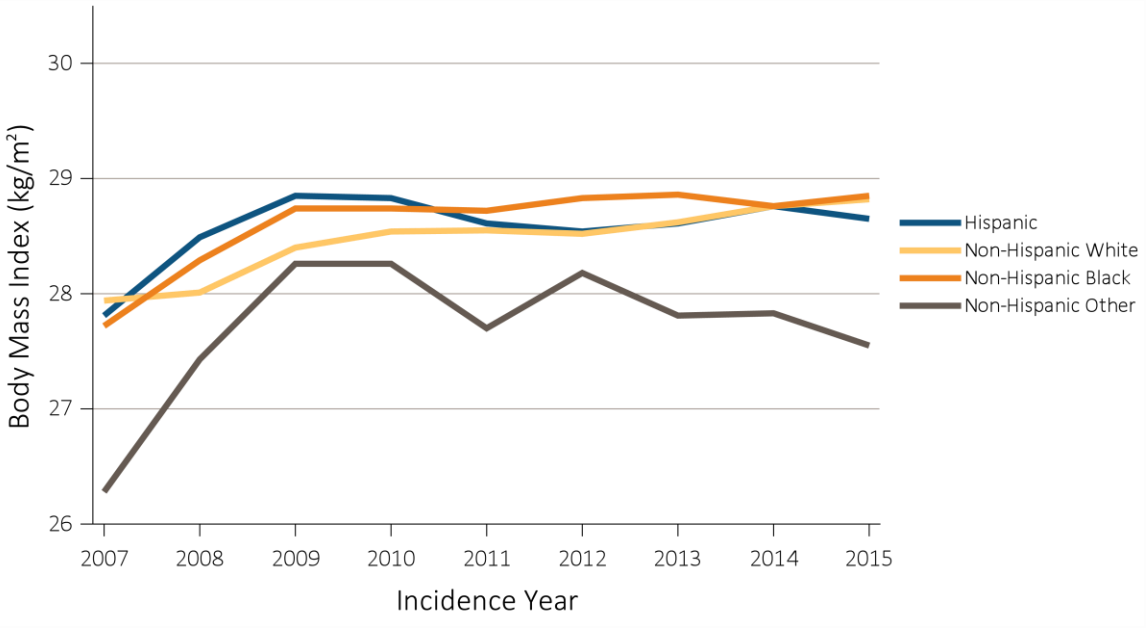


Figure 9.24 continued on next page.

vol 1 Figure 9.24 Secular trends in mean body mass index (BMI) across racial/ethnic groups in 98,704 veterans and 838,511 total USRDS patients transitioning to ESRD, 10/1/2007-3/31/2015 (continued)

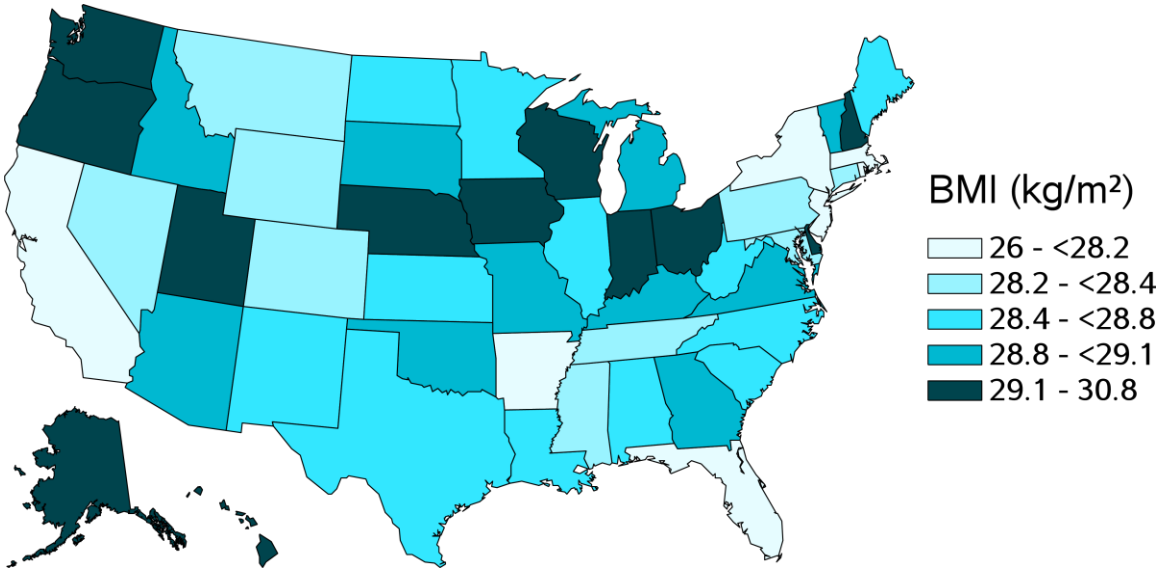
(b) TC-CKD cohort



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; kg, kilogram; m, meter.

The mean BMI level in 64,289 non-Hispanic White veterans, who transitioned to ESRD between 10/1/2007 and 3/31/2015 was 28.5 kg/m². Similar to mean BMI levels for the entire TC-CKD veteran population, higher levels of mean BMI levels for non-Hispanic White veterans (Figure 9.25), were seen in Hawaii (30.8 kg/m²), Alaska (30.0 kg/m²), and Nebraska (30.0 kg/m²), while the District of Columbia (26.0 kg/m²), New Jersey (27.5 kg/m²), and New York (27.6 kg/m²) had the lowest mean BMI levels at transition. Oregon, Washington, Utah, Wisconsin, Iowa, Indiana, Ohio, and New Hampshire also had higher levels of BMI at transition, while Florida, Rhode Island, Massachusetts, Arkansas, and California had lower levels of BMI for non-Hispanic White veterans transitioning to ESRD.

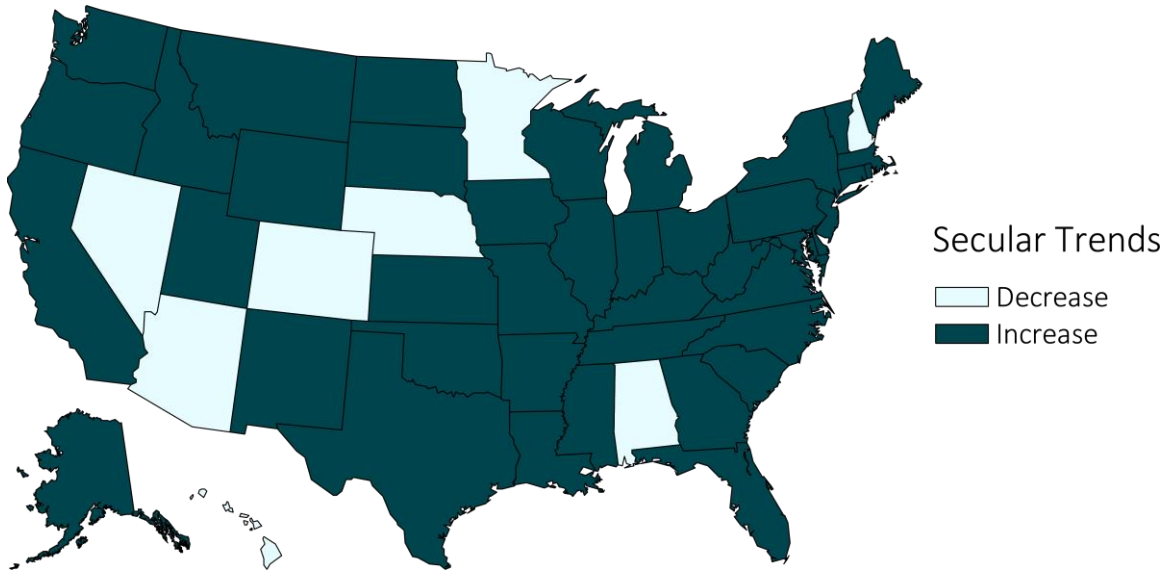
vol 1 Figure 9.25 Distribution of mean body mass index (BMI) levels at transition to ESRD among 64,289 Non-Hispanic White incident ESRD veterans across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; BMI, body mass index; kg, kilogram; m, meter.

For Non-Hispanic Whites, the mean BMI level at transition increased from 27.9 kg/m² in 2007 to 28.8 kg/m² in 2015. For most of the United States, the mean BMI at transition increased between 10/1/2007-3/31/2015 (Figure 9.26) in U.S. veterans transitioning to ESRD, with the exception of Nevada, Arizona, New Hampshire, Colorado, Nebraska, Hawaii, Alabama, and Minnesota, where mean BMI at transition decreased over time.

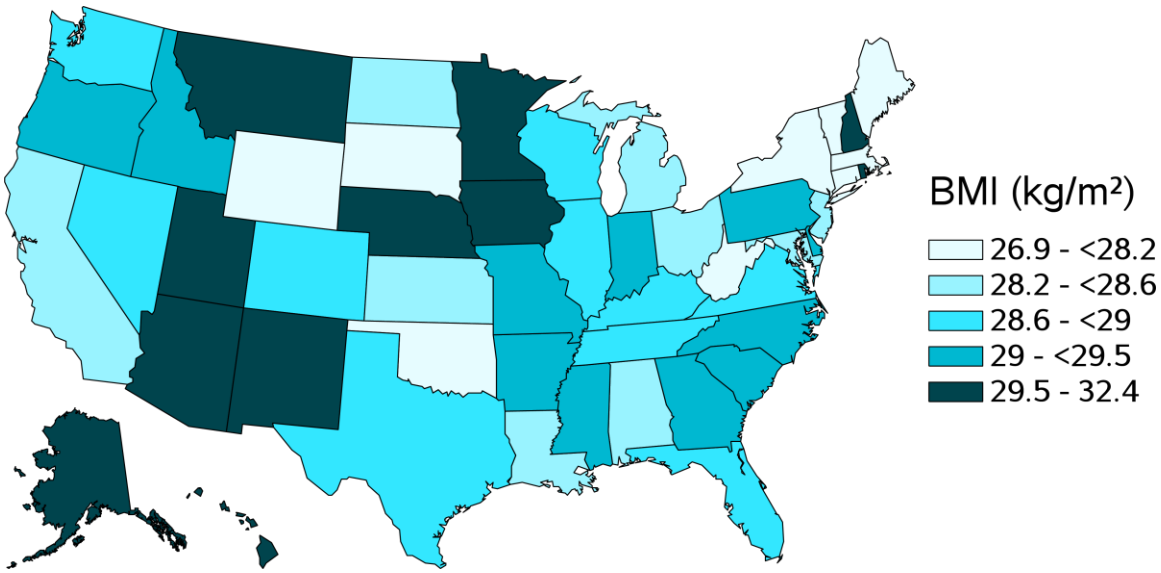
vol 1 Figure 9.26 Secular trends in the mean body mass index (BMI) level among 64,289 Non-Hispanic White incident ESRD veterans across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (kg/m² per year). Abbreviations: ESRD, end-stage renal disease; BMI, body mass index; kg, kilogram; m, meter.

Non-Hispanic Black veterans on average had a higher BMI at transition, which was 28.7 kg/m² for 24,543 Non-Hispanic Black veterans who transitioned to ESRD between 10/1/2007 and 3/31/2015. Higher levels of mean BMI for non-Hispanic Black veterans (Figure 9.27) were seen in Alaska (32.4 kg/m²), Montana (31.7 kg/m²), and Rhode Island (31.6 kg/m²), as well as in Nebraska, Minnesota, Iowa, Utah, Arizona, New Mexico, Hawaii, and New Hampshire, while lower BMI levels for non-Hispanic Black veterans transitioning to ESRD were observed in Massachusetts (26.9 kg/m²), Wyoming (27.3 kg/m²), and West Virginia (27.4 kg/m²), as well as in South Dakota, Oklahoma, Maine, New York, Vermont, and the District of Columbia.

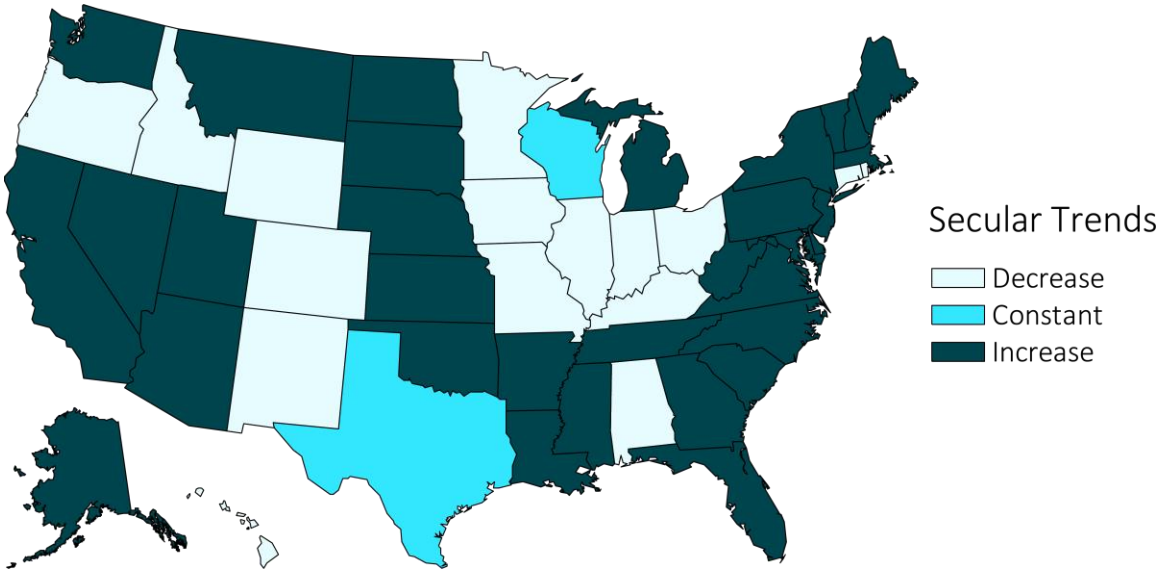
vol 1 Figure 9.27 Distribution of mean body mass index (BMI) levels at transition to ESRD among 24,543 Non-Hispanic Black incident ESRD veterans across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; BMI, body mass index; kg, kilogram; m, meter.

Secular trends in mean BMI level for Non-Hispanic Black veterans across the U.S. were less consistent (Figure 9.28). Although the mean BMI at transition for Non-Hispanic Black veterans in the majority of the U.S. increased between 10/1/2007 and 3/31/2015, there were states that remained constant (Texas and Wisconsin) and pockets that decreased, such as in the Midwest and in the West, as well as in Alabama.

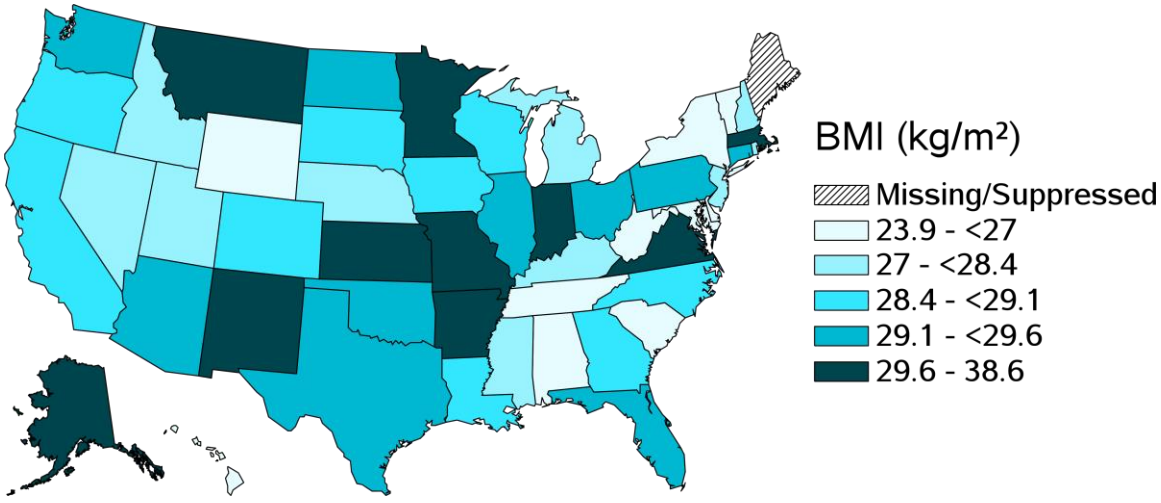
vol 1 Figure 9.28 Secular trends in the mean body mass index (BMI) level among 24,543 Non-Hispanic Black incident ESRD veterans across the United States, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (kg/m² per year). Abbreviations: ESRD, end-stage renal disease; BMI, body mass index; kg, kilogram; m, meter.

Hispanic veterans comprised only 6% of veterans transitioning to ESRD between 10/1/2007 and 3/31/2015, but of the 6,412 who had data on mean BMI level at transition, the mean was 28.6 kg/m². Higher levels of mean BMI for Hispanic veterans (Figure 9.29) were seen in Alaska (38.6 kg/m²), Indiana (31.6 kg/m²), and Montana (30.8 kg/m²), as well as in New Mexico, Minnesota, Kansas, Missouri, Arkansas, Virginia, and Massachusetts. Lower BMI levels for Hispanic veterans transitioning to ESRD were observed in Vermont (23.9 kg/m²), Delaware (24.9 kg/m²), and Alabama (25.7 kg/m²), as well as in Hawaii, Wyoming, West Virginia, Tennessee, South Carolina, and Maryland. No information on mean BMI for Hispanic veterans was available for veterans in Maine.

vol 1 Figure 9.29 Distribution of mean body mass index (BMI) levels at transition to ESRD among 6,412 Hispanic incident ESRD veterans across the United States, 10/1/2007-3/31/2015

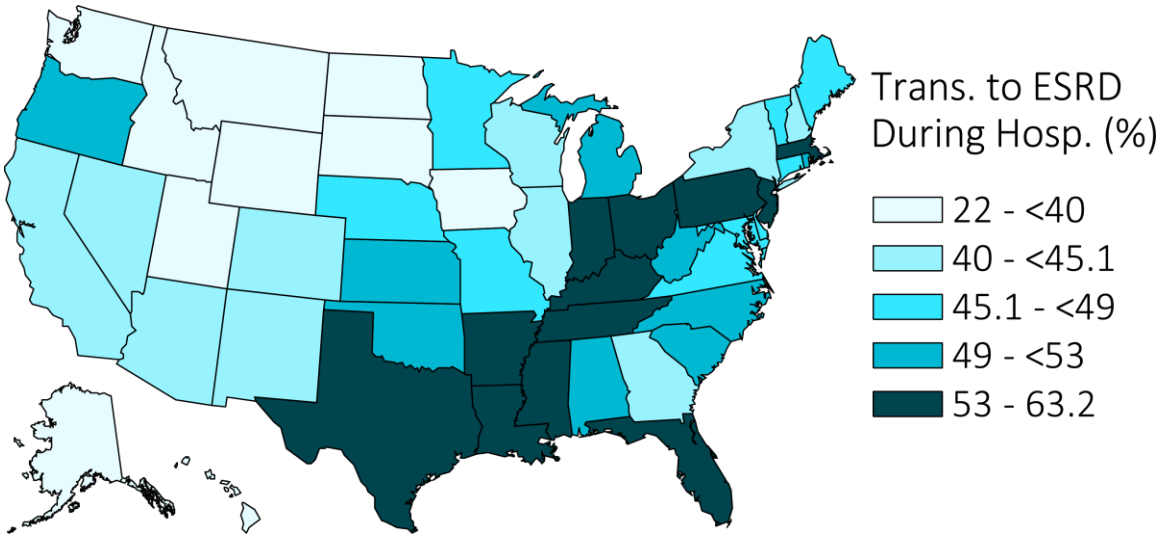


Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; BMI, body mass index; kg, kilogram; m, meter.

HOSPITALIZATIONS DURING TRANSITION, INITIAL ACCESS TYPE AND ACUTE KIDNEY INJURIES IN THE YEAR PRIOR TO TRANSITION AMONG VETERANS WHO TRANSITIONED TO ESRD

In the 2017 ADR, we showed that 50% (n=50,786) of the 102,477 U.S. veterans who transitioned to ESRD between 10/1/2007 and 3/31/2015 transitioned to ESRD during a hospitalization admission. This year, we show the proportion of veterans per state who transitioned to ESRD during a hospitalization admission (Figure 9.30). There were higher proportions of transition during hospitalization in states in the South and the East, including Florida (63%), Louisiana (60%), Massachusetts (60%), Texas, Arkansas, Mississippi, Tennessee, Kentucky, Indiana, Ohio, Pennsylvania, and New Jersey. States in the North had lower proportions of patients transitioning to ESRD during a hospitalization. States with the lowest proportions of veterans transitioning to ESRD during a hospitalization admission included Utah (22%), Alaska (27%), Idaho (29%), Hawaii, Washington, Wyoming, Montana, North and South Dakota, and Iowa.

vol 1 Figure 9.30. Distribution of proportion of veterans transitioning to ESRD during a Hospitalization Admission among 102,477 incident ESRD veterans across the United States, 10/1/2007-3/31/2015

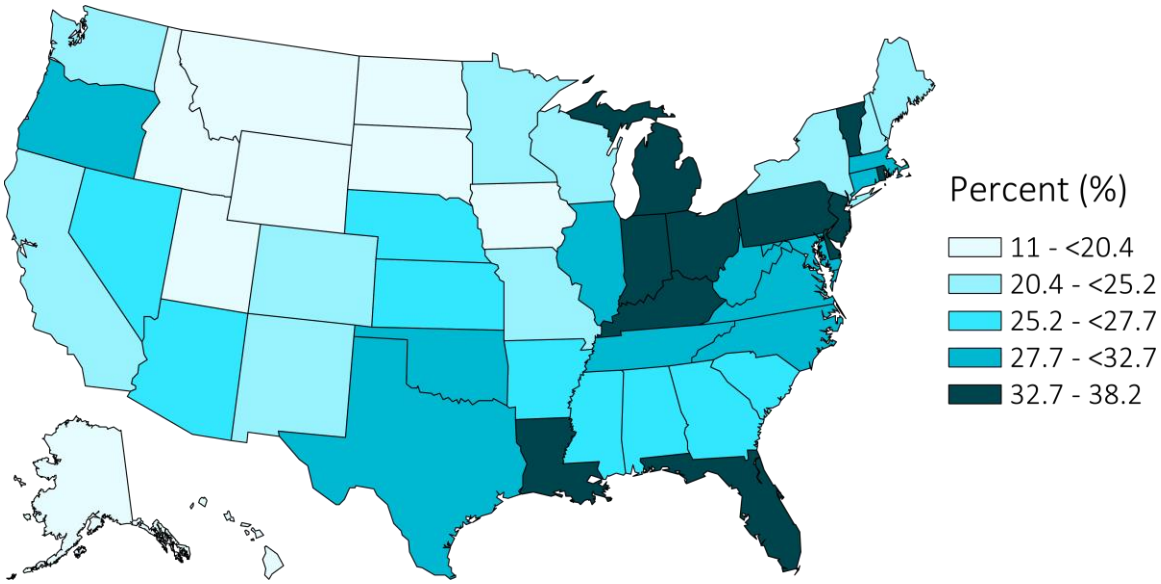


Data source: VHA, CMS, and USRDS ESRD Databases. Abbreviations: ESRD, end-stage renal disease; Trans., transition; Hosp., hospitalization.

Secular trends in the proportion of veterans transitioning to ESRD during a hospitalization appeared to decrease for most states, although Washington, DC, increased and Wyoming remained constant over the 7.5 year period (map not shown).

In the 2017 ADR, we showed that the most commonly listed cause of hospital admission for patients that were hospitalized during transition to ESRD was acute kidney injury (AKI). We found that of the 84,799 U.S. veterans in the year prior to ESRD, there were 24,500 (29%) U.S. veterans who had at least one hospitalization for AKI in the year prior to transition. Across the United States, higher proportions of patients with an AKI hospitalization in the year prior to ESRD transition were seen in the East, including Florida (38%), Rhode Island (37%), Vermont (36%), Ohio, New Jersey, Michigan, Kentucky, Indiana, Pennsylvania, and Louisiana , while lower proportions were seen in Utah (11%), Alaska (13%), and Idaho (16%), as well as Hawaii, and some northern states including North Dakota, Montana, South Dakota, Iowa, and Wyoming (Figure 9.31).

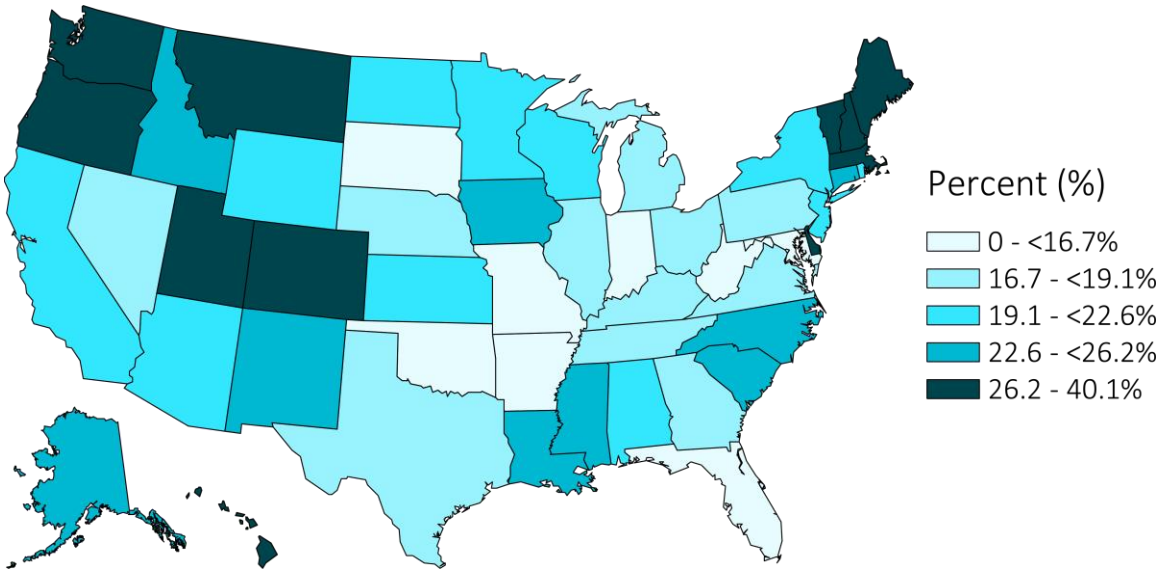
vol 1 Figure 9.31 Distribution of proportion of veterans with a hospitalization for acute kidney injury in the year prior to transition across the United States among 84,799 incident ESRD veterans with information in the year prior to transition, 10/1/2007-3/31/2015



Data source: VHA, CMS, and USRDS ESRD Databases. Abbreviation: ESRD, end-stage renal disease.

Information on initial access type at transition can shed light on U.S. veteran patient pre-transition care and preparation for transition to ESRD. As shown in Table 9.1, 20% (n=18,122) of U.S. veterans transitioned to ESRD between 10/1/2007 and 3/31/2015 with an AV fistula as an initial access type, which was a greater percentage than for the total USRDS population (15%) (Table 9.1). The percentage of TC-CKD U.S. veterans with AV graft as an initial access type is similar to that of the USRDS population, but the percentage of U.S. veterans with central venous catheter (CVC) as an initial access type is lower. New Hampshire (40%), Maine (30%), and Hawaii (30%) had the highest proportion of patients with AV fistula as an initial access type. Higher proportions were also seen in Oregon, Washington, Delaware, Montana, Colorado, Utah, Vermont, and Massachusetts. The lowest proportions were in the District of Columbia (9%), Arkansas (13%), and South Dakota (14%) (Figure 9.32).

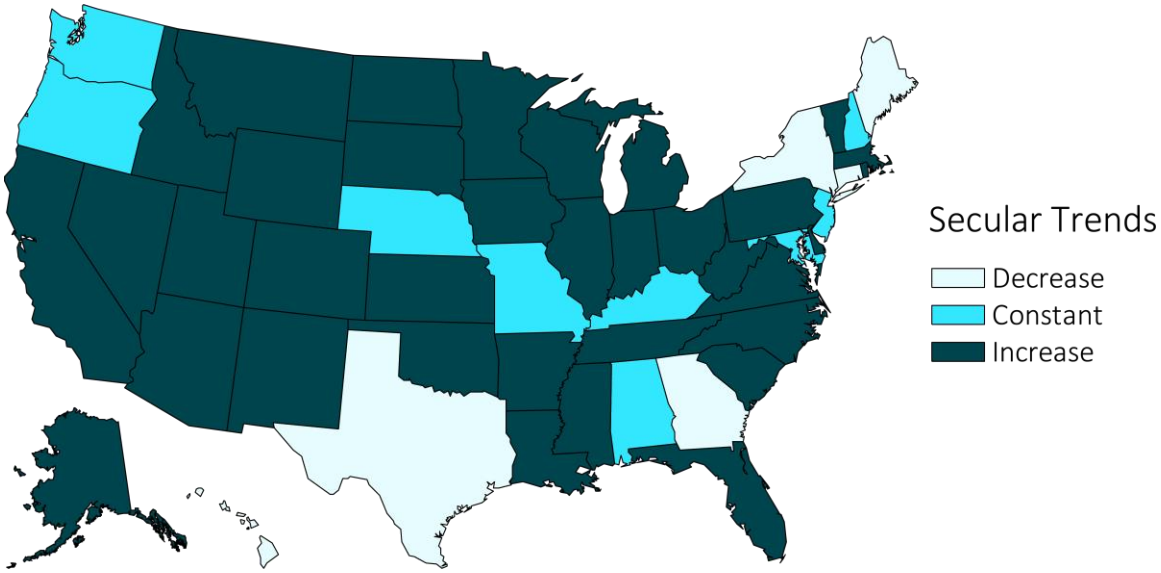
vol 1 Figure 9.32 Distribution of proportion of veterans with an AV fistula as initial access type across the United States among 102,477 incident ESRD veterans, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous.

Between 10/1/2007 and 3/31/2015, most states saw an increase in the proportion of patients with AV fistula as an initial access type, with a few states that remained constant, but New York, Connecticut, Hawaii, Texas, Georgia, and Maine had a decrease over time (Figure 9.33).

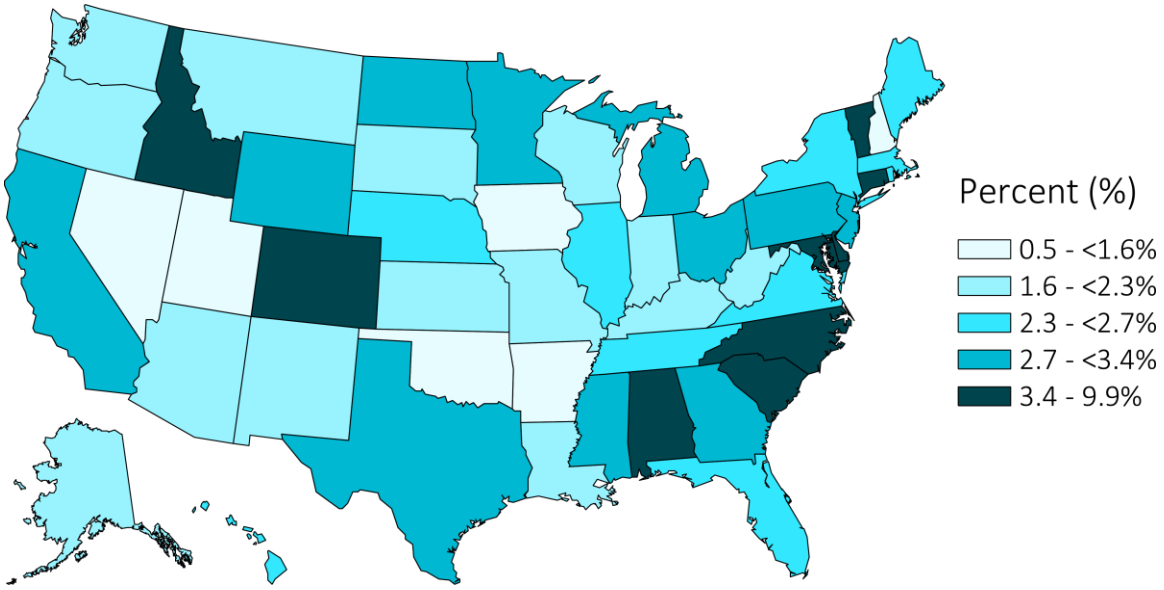
vol 1 Figure 9.33 Secular trends in the proportion of veterans with an AV fistula as initial access type across the United States among 102,477 incident ESRD veterans, between 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (% per year). Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous.

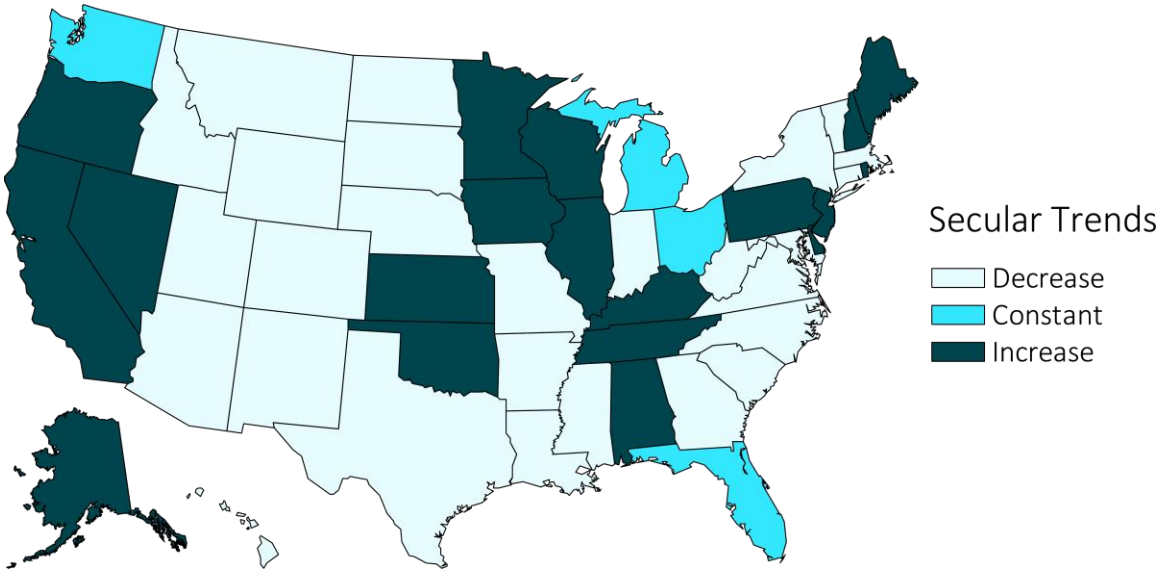
Only 3% of U.S. veterans transitioning to ESRD between 10/1/2007 and 3/31/2015 had an AV graft as initial access type. However, some states across the U.S. showed higher proportions of patients with an AV graft as the initial access type. These included the District of Columbia (10%), Alabama (6%), and Maryland (4%). Idaho, Colorado, Vermont, North Carolina, South Carolina, and Connecticut were also among the states with the higher proportions of veterans with an AV graft as the initial access type (Figure 9.34). Across the years, pockets including, California, Nevada, Alaska, and Oregon, Minnesota, Iowa, Illinois, and Wisconsin, as well as Oklahoma and Kansas, Kentucky, Tennessee, and Alabama, and Pennsylvania, Rhode Island, Delaware, New Jersey, and New Hampshire, and Maine, showed an increase in the proportion of U.S. veterans transitioning to ESRD with an AV graft as the initial access type (Figure 9.35).

vol 1 Figure 9.34 Distribution of proportion of veterans with an AV graft as initial access type across the United States among 102,477 incident ESRD veterans, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous.

vol 1 Figure 9.35 Secular trends in the proportion of veterans with an AV graft as initial access type across the United States among 102,477 incident ESRD veterans, between 10/1/2007-3/31/2015



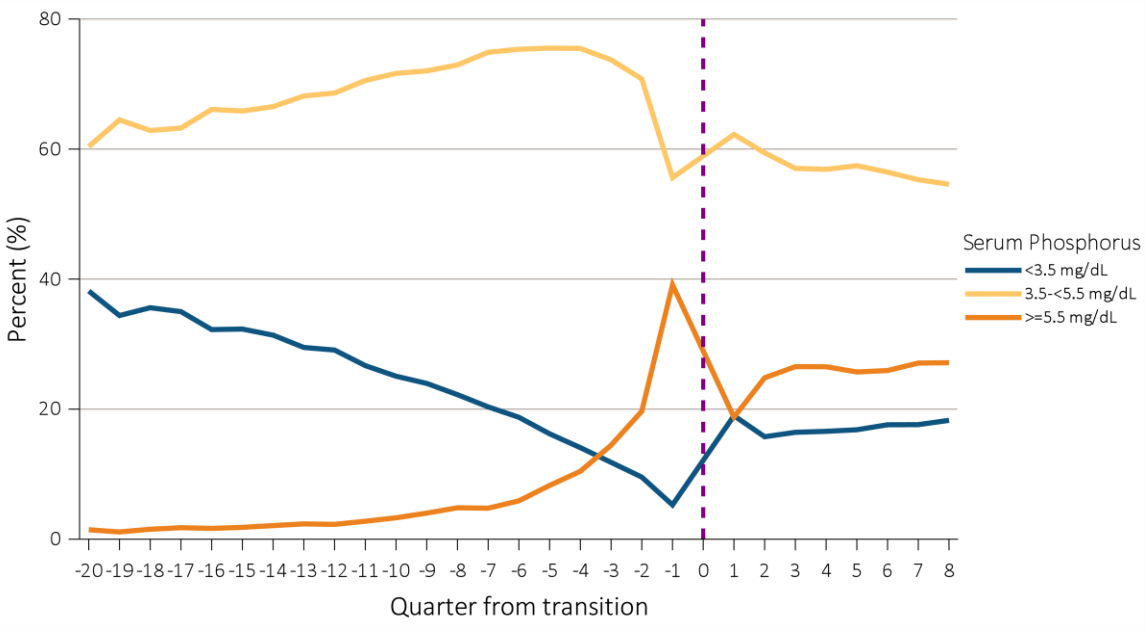
Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (% per year). Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous.

COMPARING LABORATORY TRENDS DURING PRELUDE (PRIOR TO ESRD TRANSITION) AND VINTAGE PERIODS (AFTER ESRD TRANSITION)

The significance of changes in clinical and laboratory values when a patient with non-dialysis dependent (NDD) CKD transitions to renal replacement therapy is still unclear. In the previous ADR 2017, we showed averaged laboratory measurements for up to 5 years (20 quarters) prior and 2 years post-ESRD transition. In this year's ADR, we sought to examine the change over time in the proportion of patients within ranges of laboratory measures. It can be useful to see how patients' laboratory values fall within and out of target ranges across the period before and after ESRD transition.

In the previous ADR (2017), we showed that the mean phosphorous level increased over 36 months from 4 to above 5.5 mg/dL immediately prior to transition to ESRD. Figure 9.36 shows the trend in serum phosphorus categories in 36,621 veterans. In all measurements and throughout the entire time period, the majority of patients achieved the target range of serum phosphorous between 3.5-<5.5 mg/dL. As patients moved closer to transition, the proportion of patients with lower serum phosphorous (<3.5 mg/dL) and serum phosphorus within target range decreased, while the proportion of patients with higher serum phosphorous (≥5.5 mg/dL) gradually increased. In the quarter immediately prior to transition, there was a sharp increase in the proportion of patients with serum phosphorous ≥5.5 mg/dL; however, by the first quarter post-ESRD transition the proportion of patients with a phosphorous level in target range or lower increased again and remained relatively stable after the 3rd quarter post-transition.

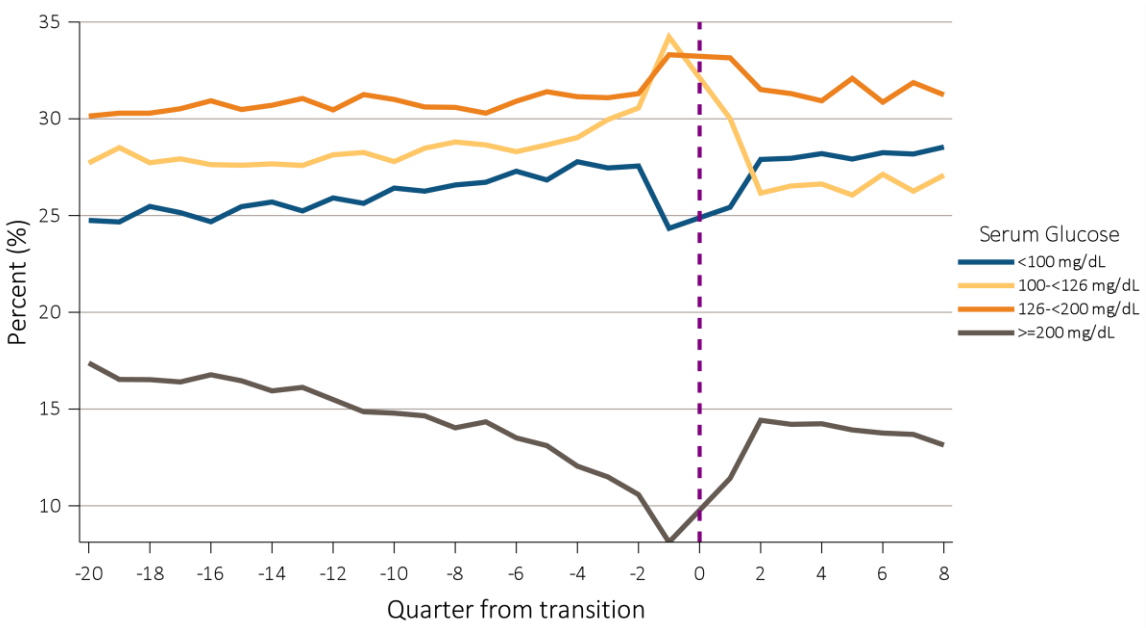
vol 1 Figure 9.36 Trend in serum phosphorus level categories up to 5 years prior and 2 years post-transition in 36,621 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; mg/dL, milligrams per deciliter.

Figure 9.37 shows the trends in serum glucose across ESRD transition in 61,730 veterans. For most measurements and throughout most of the time period, the majority of patients had serum glucose between 126-200 mg/dL. The proportion of patients with elevated glucose ≥200 mg/dL decreased over the prelude period, with the largest drop in the quarter prior to transition; however, this proportion increased after the first two quarters of transition to ESRD. The other middle range groups, including those with glucose 100-<126 and 126-<200 mg/dL are relatively stable for most of the period prior to transition, but increased in proportion in the quarter prior to ESRD, and then declined after transition. While the proportion of patients with low serum glucose of <100 mg/dL gradually increased over the time prior to ESRD transition, the proportion dipped lower in the two quarters surrounding transition, but recovered and remained stable throughout the post-transition period. From the previous ADR, we have learned that large drops in serum glucose level prior to transition in this veteran population is mostly seen in patients with diabetes as the primary cause of ESRD.

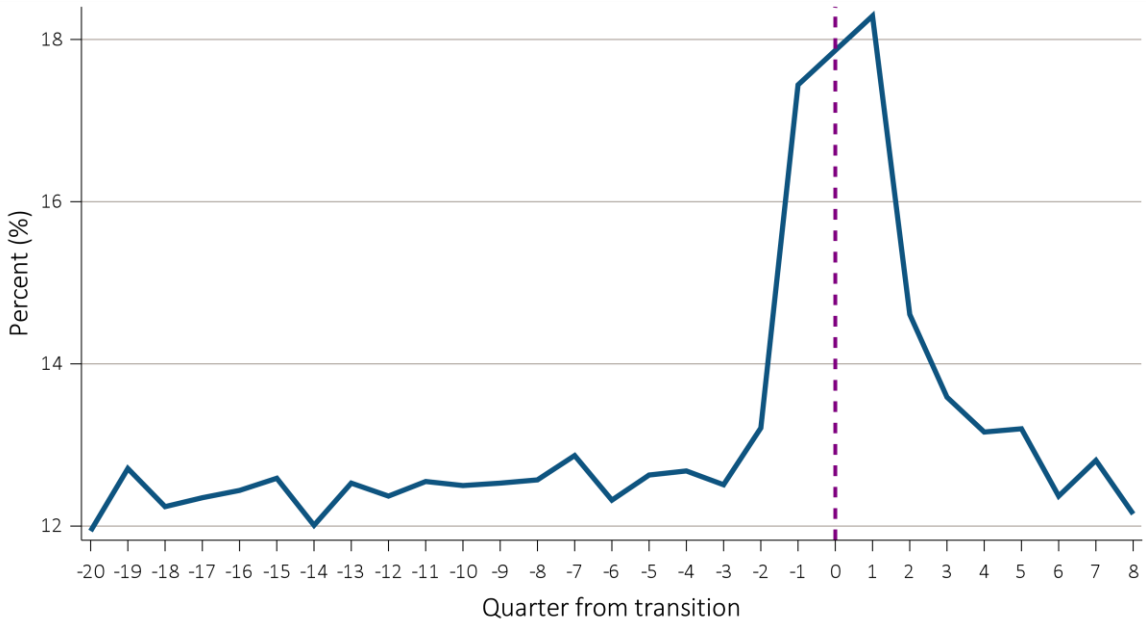
vol 1 Figure 9.37 Trend in serum glucose level categories up to 5 years prior and 2 years post-transition in 61,730 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; mg/dL, milligrams per deciliter.

For most of the period prior to ESRD transition, approximately 12% of patients in each quarter had an elevated white blood cell count >10 x10^3/µL. In the previous ADR, we showed that mean white blood cell levels remained steady at 7.5 x10^3/µL in the earlier pre-transition period. However, from this year's results, in the quarter before and lasting until the quarter after transition, the proportion of patients with an elevated white blood cell count swelled to 18%. Yet, by the 2nd quarter post-transition, this proportion began to decline and leveled to pre-ESRD levels at the 6th quarter post-transition (Figure 9.38).

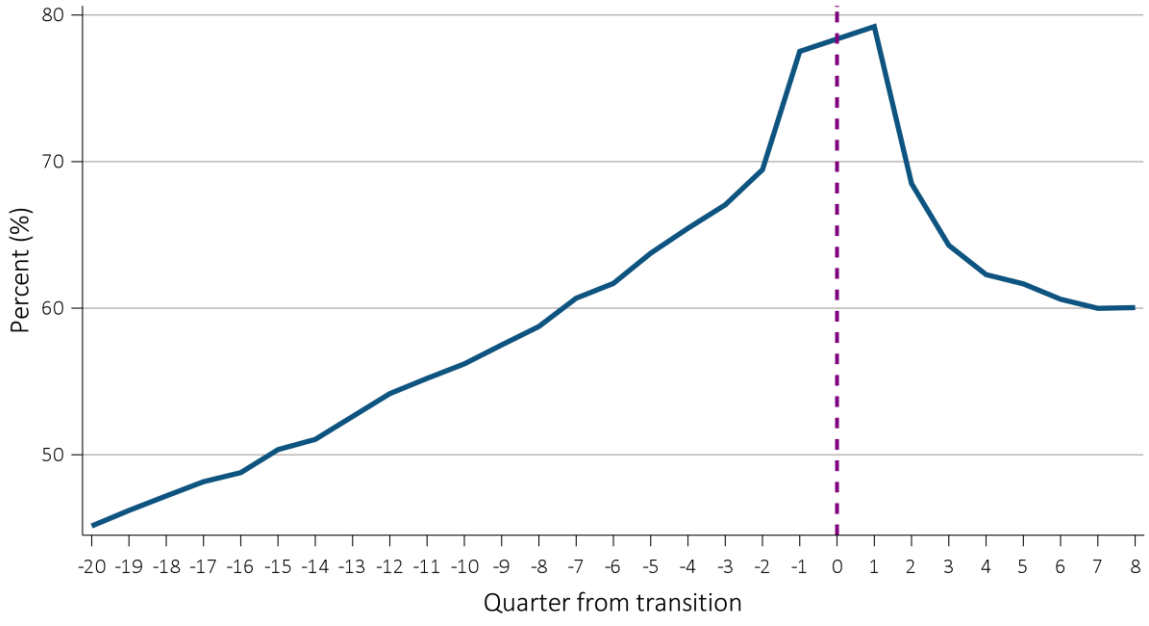
vol 1 Figure 9.38 Trend in proportion of U.S. veteran patients with serum white blood cell count >10 x 10^3/µL up to 5 years prior and 2 years post-transition in 60,036 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; µL, microliter.

Conversely, the proportion of patients with lower serum albumin <3.8 g/dL gradually increased from 45% to nearly 80% through the period prior to ESRD transition (Figure 9.39) Higher proportions of patients had lower serum albumin up to the quarter following ESRD transition, and then abruptly declined over the 3rd and 4th quarters following transition. Thereafter, approximately 60% of patients had lower serum albumin levels <3.8 g/dL for the remainder of the post-transition period. In the previous ADR, we showed that the mean albumin levels declined from 3.8 g/dL to less than 3.4 g/dL over the prelude period (-20 quarters), and then increased to almost 3.6 g/dL in the vintage period (+4 quarters).

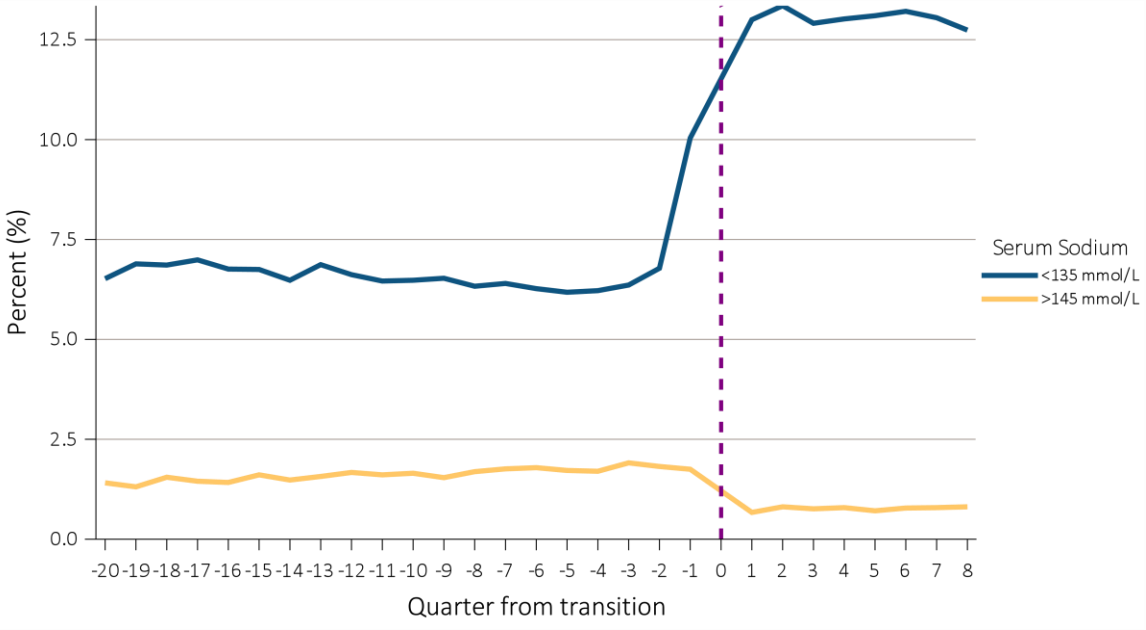
vol 1 Figure 9.39 Trend in proportion of U.S. veteran patients with serum albumin <3.8 g/dL up to 5 years prior and 2 years post-transition in 58,854 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; g/dL, grams per deciliter.

Figure 9.40 shows the pre- and post-ESRD trends in the proportion of patients across serum sodium categories (<135, 135-145, >145 mEq/L) among veterans who transitioned to ESRD during 10/1/2007-3/31/2015 (figure only shows serum sodium <135 and >145 mEq/L). Less than 7% of patients had a serum sodium <135 mEq/L during the time prior to ESRD transition. However, in the quarter prior to ESRD transition, the proportion of patients with low sodium rose to 10%, and then rose even higher to 13% in the quarter after transition. Thereafter, the proportion of patients with lower serum sodium remains higher at 13% throughout the rest of the post-transition period. Conversely, the proportion of patients with serum sodium >145 mEq/L gradually rose between 1.5 to 2% of patients throughout the pre-ESRD period, but this proportion dropped to 0.7% after ESRD transition and remained low thereafter. The proportion of patients in the target range of 135-145 mEq/L was relatively stable throughout the prelude period, but begins to drop two quarters prior to transition and then continues to drop after transition to ESRD. In the previous ADR, we showed that the mean sodium levels remained relatively steady at around 139 g/dL over the prelude period (-20 quarters), and then dropped to 138 g/dL in the vintage period (+4 quarters).

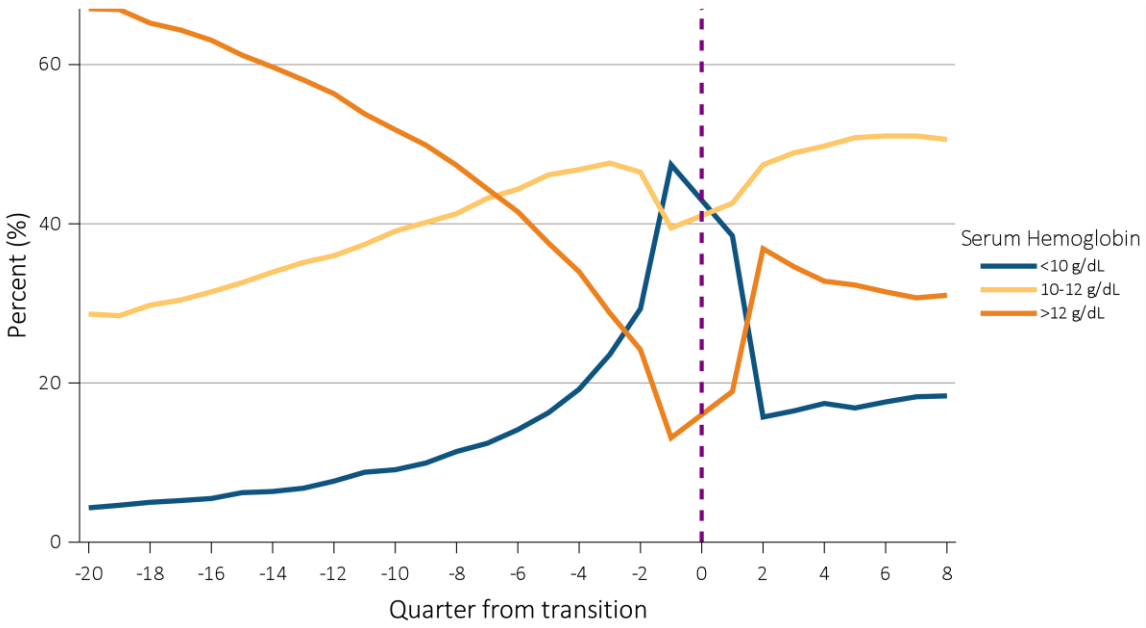
vol 1 Figure 9.40 Trend in serum sodium categories up to 5 years prior and 2 years post-transition in 61,990 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; mmol/L, millimoles per liter.

Figure 9.41 shows the pre- and post-ESRD trends in the proportion of patients across a range of hemoglobin categories among U.S. veterans who transitioned to ESRD during 10/1/2007-3/31/2015. Early in the prelude period, most patients (approximately 67%) had a hemoglobin >12 g/dL. However, as CKD progressed toward ESRD transition, the proportion of patients with higher hemoglobin declined rapidly to 12% in the quarter prior to transition. After transition to ESRD, the proportion of patients with higher hemoglobin >12 g/dL increased to 37%, and modestly declined in the next few quarters, but remained stable at approximately 30% of patients thereafter. Conversely, the proportion of patients with hemoglobin <10 g/dL was below 5% in patients with lab measures five years prior to ESRD transition; however, that proportion rapidly rose to 46% in the quarter prior to transition and quickly dropped, but only to above 15% in the 2nd quarter post-transition. Thereafter, it slightly increased but remained below 16% throughout the remainder of the 2 year post-transition period. The proportion of patients in the target range of 10-12 g/dL steadily increased from 29% prior to transition to 51% in quarter 4 post-transition. In the previous ADR, we showed that mean blood hemoglobin dropped from 13 g/dL to almost 10 g/dL over the prelude period (-20 quarters), then increased from above 10 g/dL to less than 12 g/dL over the vintage period (+4 quarters).

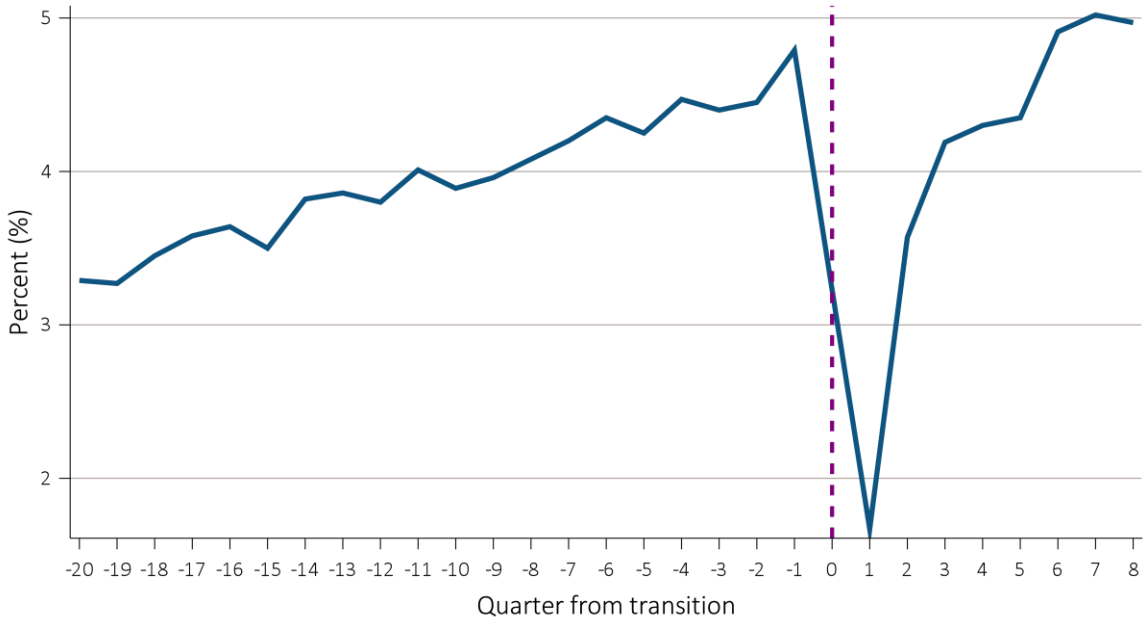
vol 1 Figure 9.41 Trend in serum hemoglobin categories up to 5 years prior and 2 years post-transition in 59,946 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; g/dL, grams per deciliter.

In this year's ADR chapter, we also wanted to examine the proportion of patients with hyperkalemia (serum potassium ≥5.5 mEq/L) throughout transition, in pre- and post-ESRD periods (Figure 9.42). Over the course of the pre-transition period, the proportion of patients with higher serum potassium (≥5.5 mEq/L) rose from 3.2% to a peak of 4.8% in the quarter prior to ESRD transition. After transition to ESRD, that proportion sharply declined to less than 2% in the first post-transition quarter, but then rose to above 4% by the 4th quarter and rose to 5% in the 7th and 8th quarters after transition to ESRD.

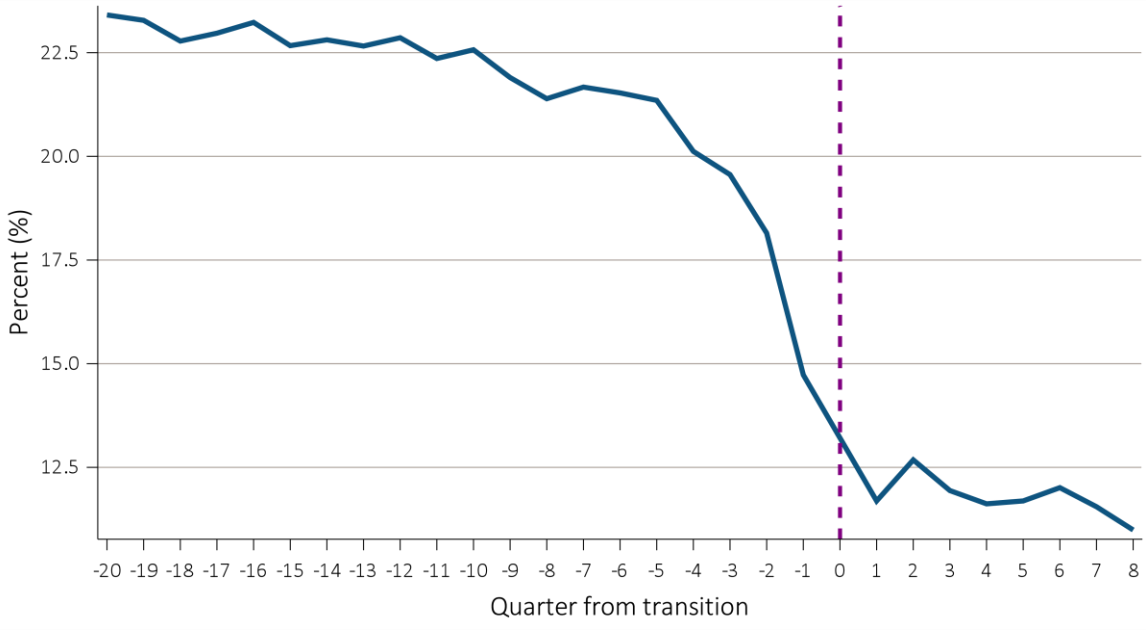
vol 1 Figure 9.42 Trend in proportion of U.S. veteran patients with serum potassium ≥5.5 mEq/L for up to 5 years prior and 2 years post-transition in 61,934 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; mEq/L, milliequivalent per liter.

In patients with available serum cholesterol measurements 20 quarters prior to ESRD transition, more than 23% had a cholesterol level of ≥200 mg/dL (Figure 9.43). However, over the next 16 quarters, that proportion dropped gradually to 20% of patients. Thereafter, the proportion of patients with elevated cholesterol sharply declined over the next year and until the quarter following ESRD transition. Although there was a slight increase in the 2nd quarter after transition to ESRD, the proportion of patients with elevated cholesterol remained low (around 12%) for the remainder of the two-year post-ESRD transition period.

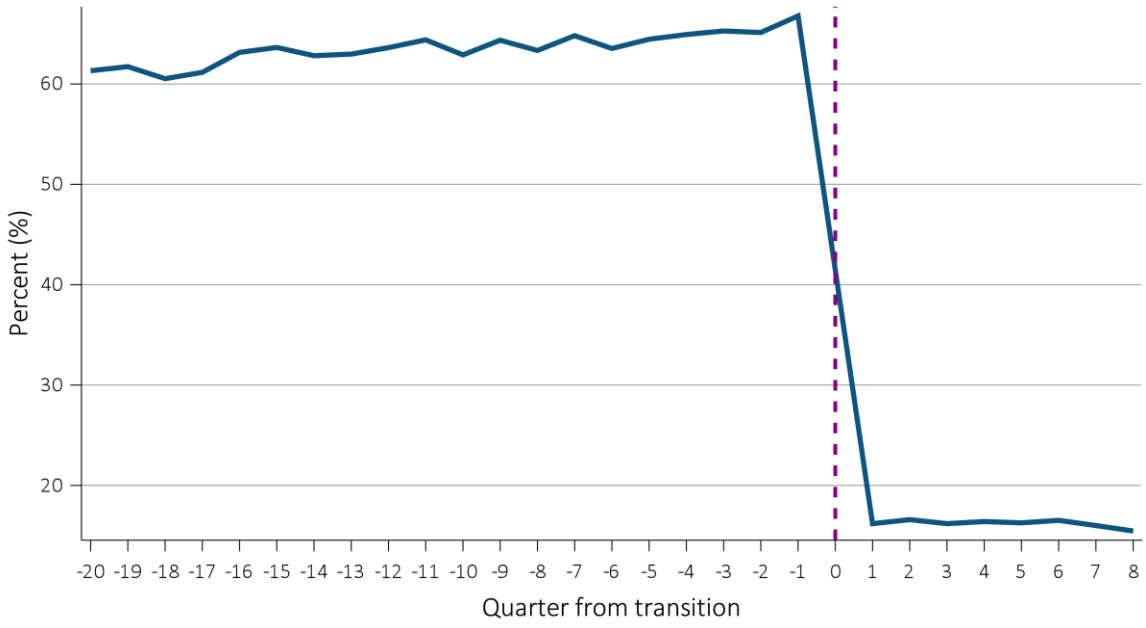
vol 1 Figure 9.43 Trend in proportion of U.S. veteran patients with serum cholesterol ≥200 mg/dL for up to 5 years prior and 2 years post-transition in 59,562 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; mg/dL, milligrams per deciliter.

Throughout the period of NDD-CKD and over the 20 quarters prior to ESRD transition, between 61 and 65% of patients had a uric acid level >7 mg/dL, with a peak of 67% in the quarter prior to ESRD transition (Figure 9.44). In the quarter after ESRD transition, that percentage dropped to 16% of patients. However, there was a very slight increase in the 2nd quarter. For the remainder of the two-year post-ESRD transition, the proportion of patients with higher uric acid remained low at approximately 17%.

vol 1 Figure 9.44 Trend in proportion of U.S. veteran patients with uric acid >7 mg/dL for up to 5 years prior and 2 years post-transition in 31,276 veterans who transitioned to ESRD during 10/1/2007-3/31/2015

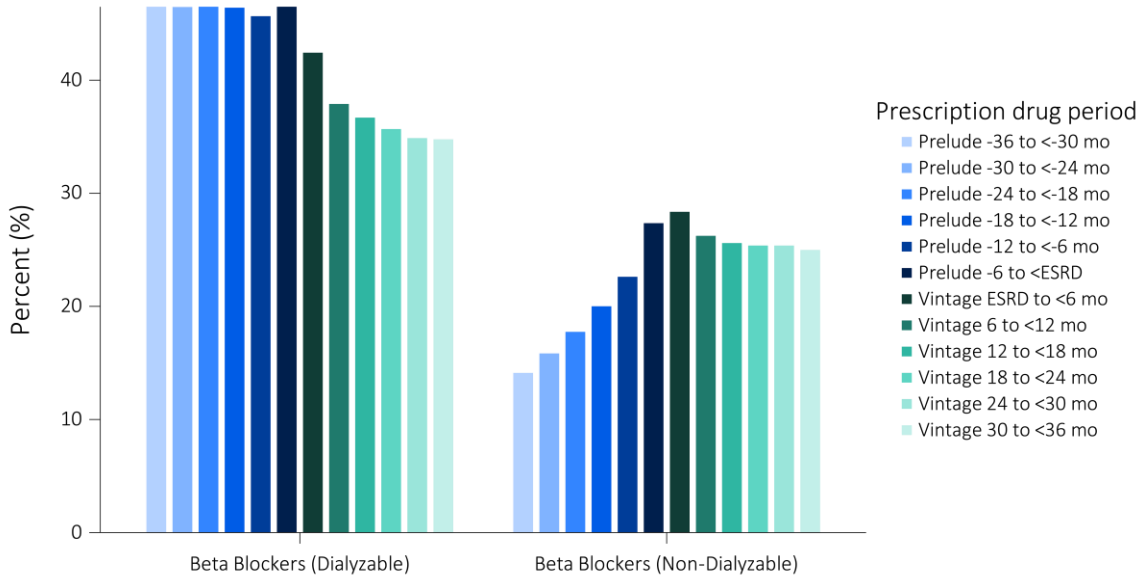


Data source: VHA data. Abbreviations: ESRD, end-stage renal disease; mg/dL, milligrams per deciliter.

Beta Blocker Use during Prelude (prior to ESRD Transition) and Vintage Periods (after ESRD Transition)

In the previous year's ADR chapter, we characterized the proportion of patients using various medications before and after ESRD transition. Beta blocker use gradually increased from 60% of patients to 65% over the course of the prelude period, and then began to decline to below 60% over the post-ESRD or vintage period. In this year's ADR, we sought to further characterize the use of beta blockers across transition to ESRD, by dialyzable versus non-dialyzable beta blockers (Figure 9.45). In this more granular examination, we see that increases in beta blocker prescriptions prior to ESRD were mostly attributed to increases in prescriptions for non-dialyzable beta blockers, while prescriptions for dialyzable beta blockers remained consistently higher at approximately 45% of patients throughout the prelude period. Post-transition, declines in beta blocker prescriptions appear to be attributed to the decline in prescriptions of dialyzable beta blockers, as the proportion of patients prescribed non-dialyzable beta blockers remained relatively stable at approximately 25% throughout the vintage period.

vol 1 Figure 9.45 Prescribed dialyzable (a) and non-dialyzable (b) beta blockers to incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2015, with data up to -36 months prior to transition (prelude) and up to +36 months after transition (vintage) (data were abstracted from 84,004 veterans)

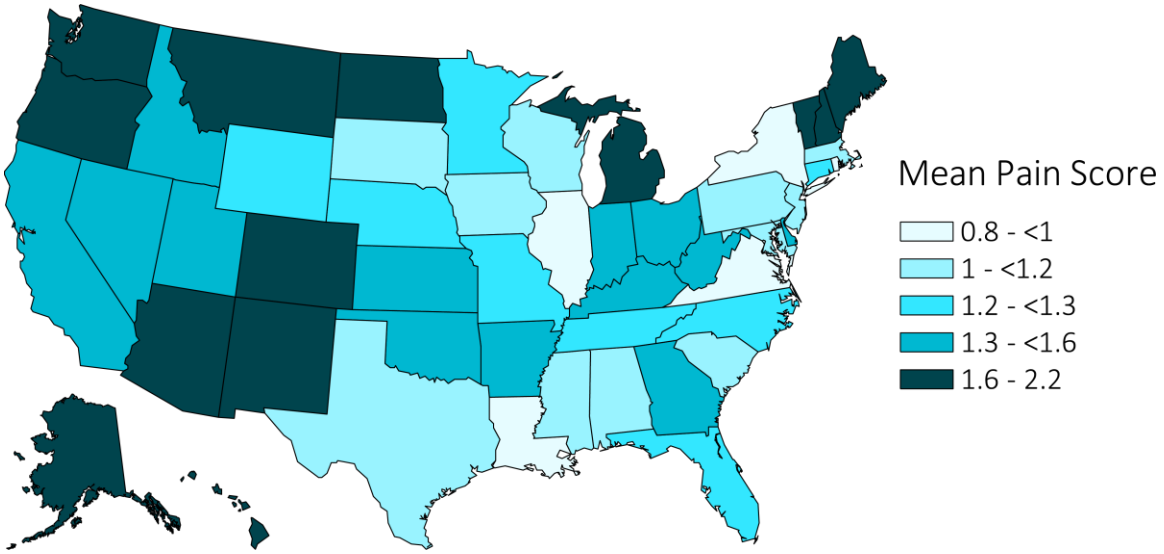


Data source: VHA data, CMS Medicare Inpatient and Outpatient data. Abbreviations: ESRD, end-stage renal disease; mo, months.

PAIN AND OPIOID USE IN U.S. VETERANS TRANSITIONING TO ESRD

CKD patients often report having pain as their disease progresses and while on dialysis. In this year's ADR, we wanted to further characterize pain scores and use of opioids in U.S. veterans transitioning to ESRD. U.S. veterans are asked to provide a pain score between 1 and 10 during any clinical encounter. In the 44,903 U.S. veterans who transitioned to ESRD between 10/1/2007-3/31/2015, and had a pain score available in the 6 months prior to ESRD, the mean ± standard deviation pain score was 1.2±2.3 out of 10. The highest mean reported pain score per state was in Colorado (2.2) (Figure 9.46). Other higher reported mean pain scores per state were more likely to be in the northern states such as Alaska (2.0), Oregon (2.0), Washington, Montana, North Dakota, Michigan, Vermont, New Hampshire, and Maine, as well as Arizona, New Mexico, and Hawaii; while Rhode Island (0.76), Illinois (0.82), Louisiana (0.85), and Virginia (0.89) had the lowest mean pain scores per state.

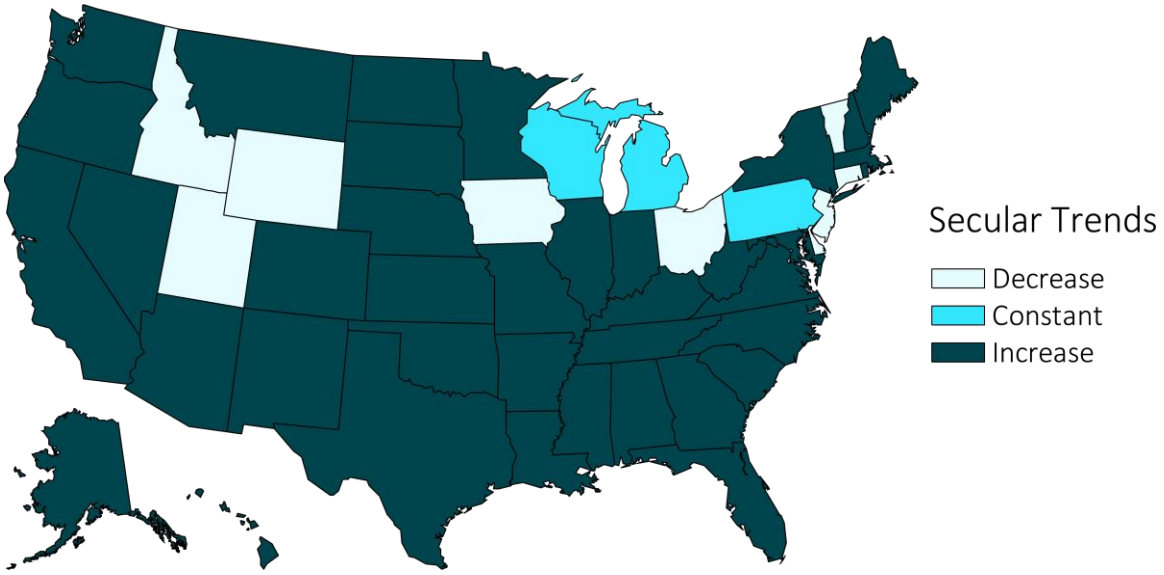
vol 1 Figure 9.46 Distribution in the mean pain score across the United States among 44,903 incident ESRD veterans, 10/1/2007-3/31/2015



Data source: VHA data. Abbreviation: ESRD, end-stage renal disease.

Over the 7.5 year period studied, the mean score reported for patients in the 6 months prior to transition increased from 1.0 in 2007 to 1.4 in 2015. There were 3% of patients reporting a pain score of >7 (severe pain) in the 6 months prior to ESRD transition in 2007, and 4% in 2015. Most states had an increase in mean pain score between 10/1/2007-3/31/2015 (Figure 9.47). While mean pain scores decreased in Connecticut, Delaware, Iowa, Idaho, New Jersey, Ohio, Vermont, Wyoming, and Utah, they remained constant in Pennsylvania, Michigan, District of Columbia, and Wisconsin.

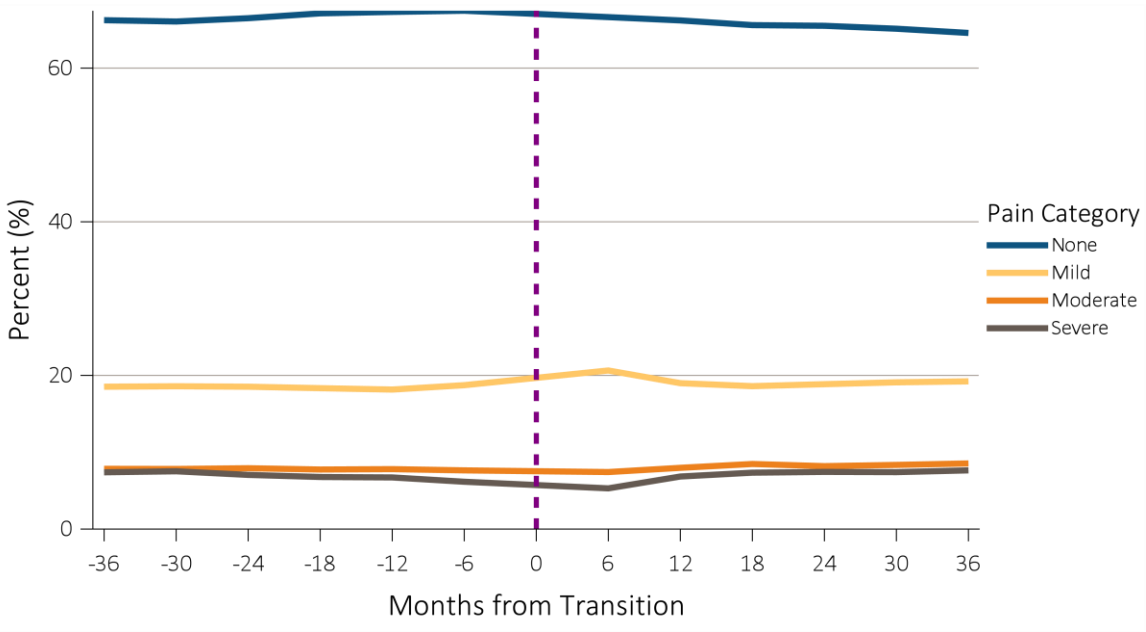
vol 1 Figure 9.47 Secular trends in the mean pain score across the United States among 44,903 incident ESRD veterans, 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (score per year). Abbreviation: ESRD, end-stage renal disease.

Proportion of patients in pain score categories did not vary widely across quarters before and after transition (Figure 9.48) in 66,042 patients who transitioned to ESRD between 10/1/2007-3/31/2015. There was a very slight increase in mild pain reported starting in the 6 months prior to transition and lasting to 6 months post-ESRD transition, but then declines and stabilizes thereafter.

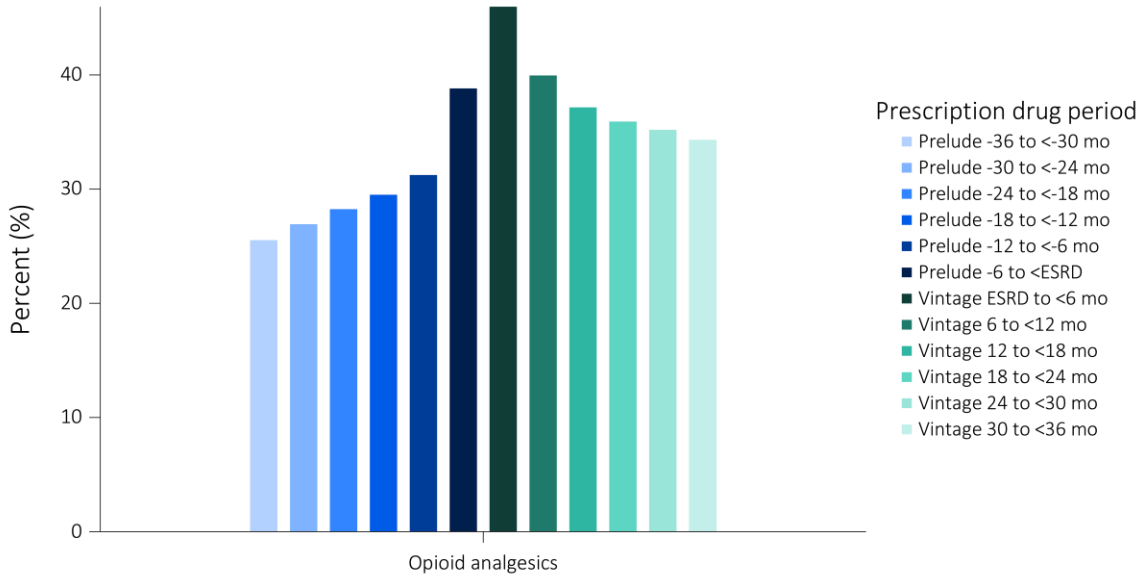
vol 1 Figure 9.48 Trend in proportion of patients in pain score categories with data up to -36 months prior to transition (prelude) and up to +36 months after transition (vintage) in 66,042 veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data. Abbreviation: ESRD, end-stage renal disease.

Conversely, prescriptions of opioid in U.S. veterans varied more markedly across periods surrounding transition to ESRD. In the prelude (pre-ESRD) period, the proportion of patients ever prescribed an opioid rose from 25% in the 30-36 month prelude period, up to 39% in the 6 months prior to ESRD transition (Figure 9.49). Immediately after ESRD transition, in the first 6 months vintage, over 46% of patients were prescribed an opioid. That proportion dropped to less than 40% in the following 6 months and slowly declined but remained higher than 34% through the 30-36 month vintage period.

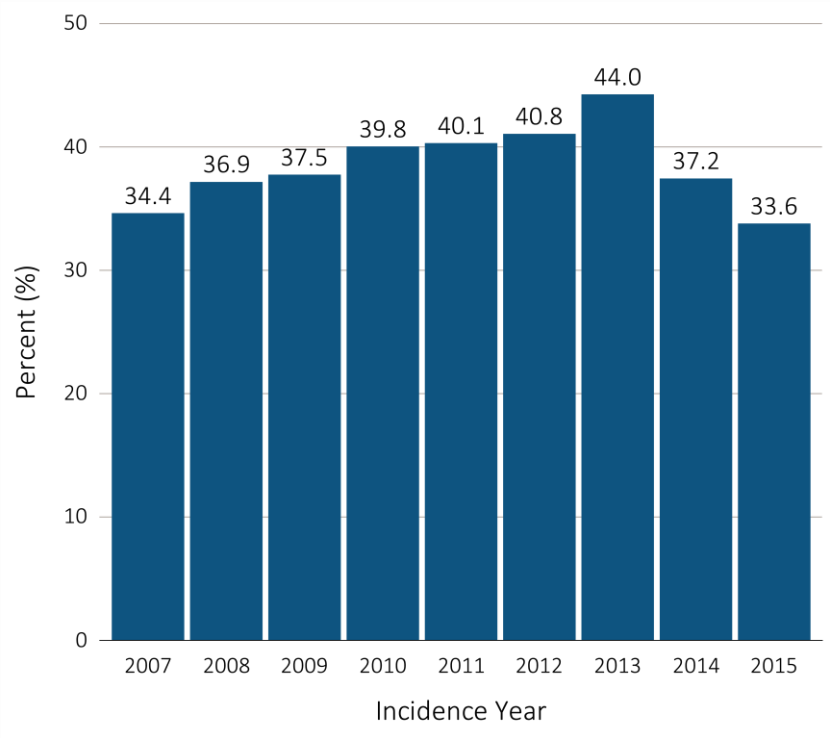
vol 1 Figure 9.49 Prescribed opioids in incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2015, with data up to -36 months prior to transition (prelude) and up to +36 months after transition (vintage) (data were abstracted from 84,004 veterans)



Data source: VHA data, CMS Medicare Inpatient and Outpatient data. Abbreviations: ESRD, end-stage renal disease; mo, months.

Between 2007 and 2013, the proportion of patients with an opioid prescription within 6 months prior to transition increased from 34% to 44% (Figure 9.50). However, in 2014 that proportion declined to 37% of patients and then further declined to 34% in the following year.

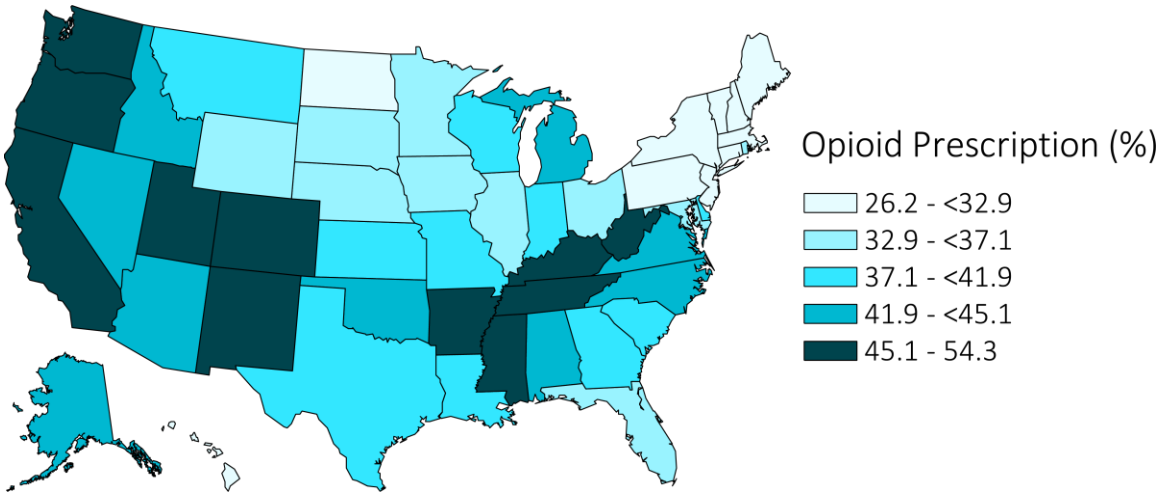
vol 1 Figure 9.50 Secular trends in proportion of patients with an opioid prescription in the 6 months prior to ESRD transition in incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: CMS and VHA ESRD Databases. Abbreviation: ESRD, end-stage renal disease.

The proportion of patients with an opioid prescription in the 6 months prior to ESRD varied across states (Figure 9.51). The highest proportions of opioid prescriptions were in Utah (54%), Oregon (54%), and West Virginia (50%). Other states within the highest quintile of proportion of veteran patients prescribed an opioid within 6 months prior to ESRD were in California, Washington, Colorado, New Mexico, as well as in Mississippi, Kentucky, Tennessee, and Arkansas. The states with the lowest proportion of veterans receiving an opioid within 6 months prior to ESRD transition were in the upper East of the United States, including New Jersey (26%), Connecticut (29%), and New Hampshire (30%), Massachusetts, Vermont, Maine, New York, Pennsylvania, as well as Hawaii and North Dakota.

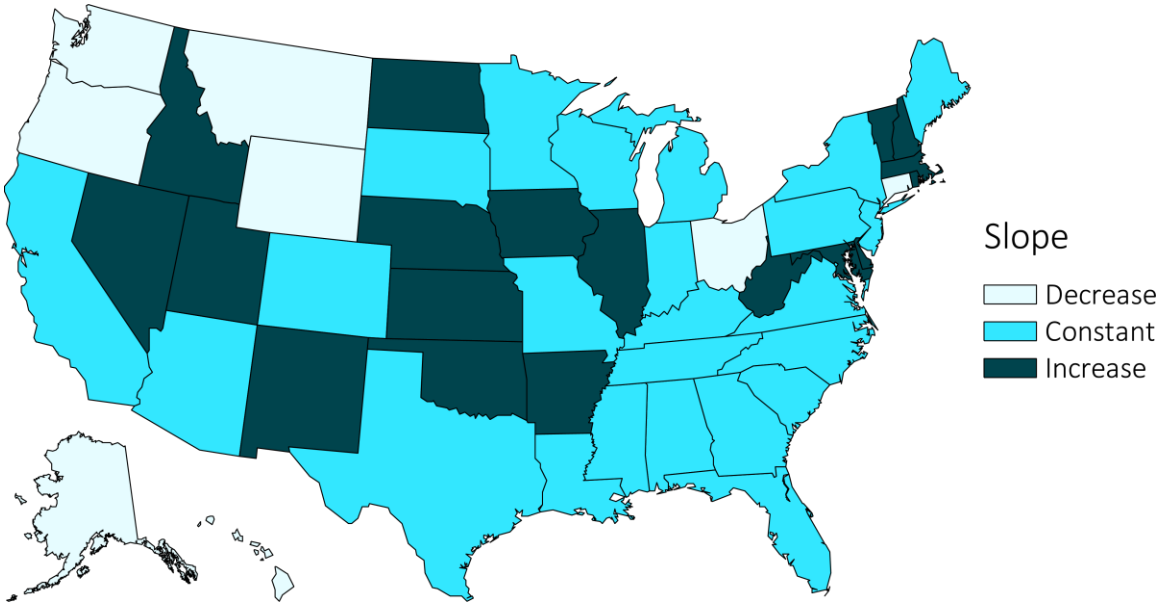
vol 1 Figure 9.51 Proportion of patients with an opioid prescription in the 6 months prior to ESRD transition across the United States in incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: VHA data, CMS Medicare Inpatient and Outpatient data. Abbreviation: ESRD, end-stage renal disease.

Most states had an increase or remained constant with regard to the proportion of patients with a prescription for opioids in the 6 months prior to transition over the 7.5 year period for patients transitioning to ESRD between 10/1/2007-3/31/2015 (Figure 9.52). However, Washington, Oregon, Montana, Wyoming, Alaska, Hawaii, Ohio, and Connecticut showed a decline over this time span.

vol 1 Figure 9.52 Secular trends in the proportion of patients with an opioid prescription in the 6 months prior to ESRD transition across the United States in incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2015



Data source: USRDS ESRD Database. Decrease: ≤-0.01; Constant: <-0.01 to ≤0.01; Increase: >0.01 (% per year). Abbreviation: ESRD, end-stage renal disease.

Data from Kaiser Permanente Southern California

California is the most populous (39.8 million) and racially/ethnically diverse U.S. state. Southern California is the most populous mega-region of California with almost 23 million people (58% of California's population), and bears two of the top 10 most populated cities in the nation (Los Angeles and San Diego). It encompasses the Los Angeles Metropolitan region, including the >17 million people in Los Angeles, San Diego, and Orange Counties combined, and is the fifteenth largest economy in the world. In addition to substantial socioeconomic diversity, Southern California has remarkable racial/ethnic diversity that is reflected among the Kaiser Permanente Southern California member population.

Kaiser Permanente Southern California (KP-SC), the largest Kaiser Permanente region, is an integrated health care system that provides comprehensive health services for over 4.4 million members. Table 9.6 displays demographic characteristics of the KP-SC member population compared to the 2010 U.S. census and California populations. The KP-SC member population, like the California-specific total population, has greater racial/ethnic diversity as compared to the nation. The proportion of Hispanic members at KP-SC matches that of the California-specific total population. KP-SC also has a larger proportion of non-Hispanic Black, and a smaller proportion of non-Hispanic Asian members than the California-specific total population. The proportion of males to females and distribution by age is similar to both the U.S. census and California populations.

vol 1 Table 9.6 Demographic characteristics of the Kaiser Permanente Southern California member population compared to the 2010 U.S. census and California populations

	KPSC (%)	U.S. census 2010 (%)	California 2010 (%)
Sex			
Male	48.2	49.2	49.7
Female	51.8	50.8	50.3
Age			
Under 5 years	5.8	6.5	6.8
5-17 years	19.1	17.5	18.6
18 to 24 years	8.7	9.9	10.5
25 to 44 years	26.1	26.6	28.2
45 to 64 years	28.2	26.4	24.9
65 years and over	12.1	13.0	11.4
Ethnicity			
Hispanic	37.6	16.3	37.6
Non-Hispanic	53.0	83.7	62.4
Unknown	9.4	^	^
Race			
White	47.7	76.2	40.1
Black/African American	9.8	14.6	5.8
American Indian/Alaska Native	0.4	0.9	0.4
Asian	9.1	5.6	12.8
Native Hawaiian/Pacific Islander	1.0	0.2	0.3
Other/Multirace	5.1	2.5	2.8
Unknown	26.3	^	^

Data source: Kaiser Permanente Southern California Electronic Health Records, U.S. Census Bureau. Active KPSC Members (all medical centers) on June 30, 2010. Abbreviation: KPSC, Kaiser Permanente Southern California. ^Data not available.

TRANSITION TO ESRD IN KAISER PERMANENTE SOUTHERN CALIFORNIA

The Kaiser Permanente transition to ESRD (TC-CKD) database is maintained by the KP-SC Renal Business Group, in which all members undergoing dialysis or transplantation are tracked through the health system's Renal Program, and regularly reconciled with internal dialysis unit census and outside claims. Patients' demographic information—including race, ethnicity, sex, and zip code—are linked to the KP-SC Membership and Benefit Research Data Warehouse created by the Research and Evaluation (R&E) Department. This mainly relies on four KP systems: the Operational Data Store (ODS), HealthConnect (HC), the Enhanced Prenatal Services System (PSS), and the Membership Extract Enrollment Management (MXEM) files. Other data such as socioeconomic information (education and household income) are collected from the KP-SC Geocoding database created by the R&E Department, in which three sources, including the U.S. Census, Claritas (i.e. Nielsen), and American Community Survey (ACS) five-year summary are combined.

Mortality data of the ESRD population were obtained from the KP-SC Mortality database, which combines multiple data sources, including the California State Death Master Files, California State Multiple Cause of Death Master Files (MCOD), Social Security Administration (SSA) Death Master Files, KP-SC Hospital and Emergency Room (ER) records, KP-SC Membership System, Perinatal Data Mart (PDM), and Outside Claims Processing System (OCPS).

Over the 10 years between 01/1/2007 and 12/31/2016, 12,242 KP-SC members transitioned to ESRD, i.e. dialysis and transplant patients. Crude and adjusted incidence rates are shown in Table 9.7. KP-SC incidence rates were lower than the U.S. general population, likely due to several different factors. These include an earlier and more standardized comprehensive delivery of care for the CKD population, and a population that may have been comprised of a larger proportion of people who were healthier and employed. KP-SC members were 62.5 ± 14.7 years old (mean ± SD) and included 7,116 (58.1%) men and 5,126 (41.9%) women. Race/ethnic groups included non-Hispanic Whites (3,567, 29.1%), Blacks (2,467, 20.2%), Asians (1,290, 10.6%), Hispanics (4,555, 37.2%), American Indians or Alaska Natives (27, 0.2%), Native Hawaiians or Pacific Islanders (173, 1.4%), and those of other race/ethnicity or unknown (109, 0.9%). According to KP-SC Renal Program records, the primary causes of ESRD were diabetes in 6,276 (51.3%) patients and hypertension in 2,142 (17.5%).

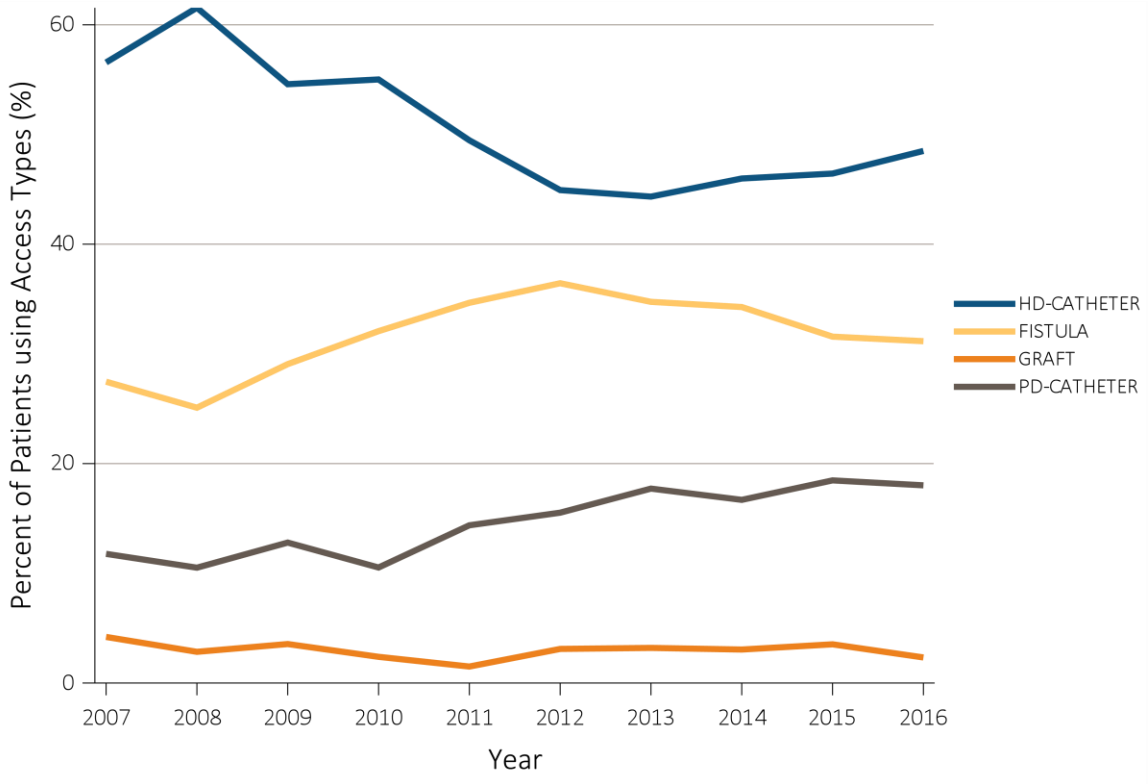
vol 1 Table 9.7 Crude and age- and sex-adjusted incidence rates among Kaiser Permanente Southern California members who transitioned to ESRD between 1/1/2007 and 12/31/2016

Incidence Year	Number of incident ESRD patients	Number of KP-SC members	Crude incidence/ 1,000,000 person years	Age-, Sex-adjusted incidence/1,000,000 person years
2007	1,144	3,183,804	359.3	386.1
2008	1,109	3,200,101	346.6	364.8
2009	1,253	3,216,209	389.6	404.8
2010	1,255	3,247,766	386.4	393.6
2011	1,168	3,387,552	344.8	349.2
2012	1,125	3,485,161	322.8	320.9
2013	1,188	3,551,617	334.5	324.2
2014	1,276	3,667,316	347.9	331.6
2015	1,359	3,908,399	347.7	331.2
2016	1,365	4,080,091	334.6	315.4

Data source: Kaiser Permanente Southern California Electronic Health Records, U.S. Census Bureau. The 2010 U.S. Census was used as the standard population. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California.

Of the 12,242 patients who transitioned to ESRD, 10,196 (83.3%) started on hemodialysis (HD), 1,731 (14.1%) started on peritoneal dialysis (PD) (continuous ambulatory PD and continuous cycling PD), and 315 (2.6%) underwent preemptive transplant. Among the 11,927 incident dialysis patients, 5,991 (50.2%) used HD-catheters, 1,750 (14.7%) used PD-catheters, 3,755 (31.5%) used arteriovenous (AV)fistulas, and 351 (2.9%) used AV grafts for initial dialysis access. Figure 9.53 displays the trend for access type among the incident dialysis patients. There was a marked decrease in the use of HD-catheters and an increase in the use of AV fistulas and PD-catheters between 2010 and 2012. HD-catheter was the most common access type of dialysis over time; while AV grafts remained the least common access type.

vol 1 Figure 9.53 Trend of initial dialysis access type used among the 11,927 KP-SC incident dialysis patients who transitioned to ESRD during 1/1/2007-12/31/2016

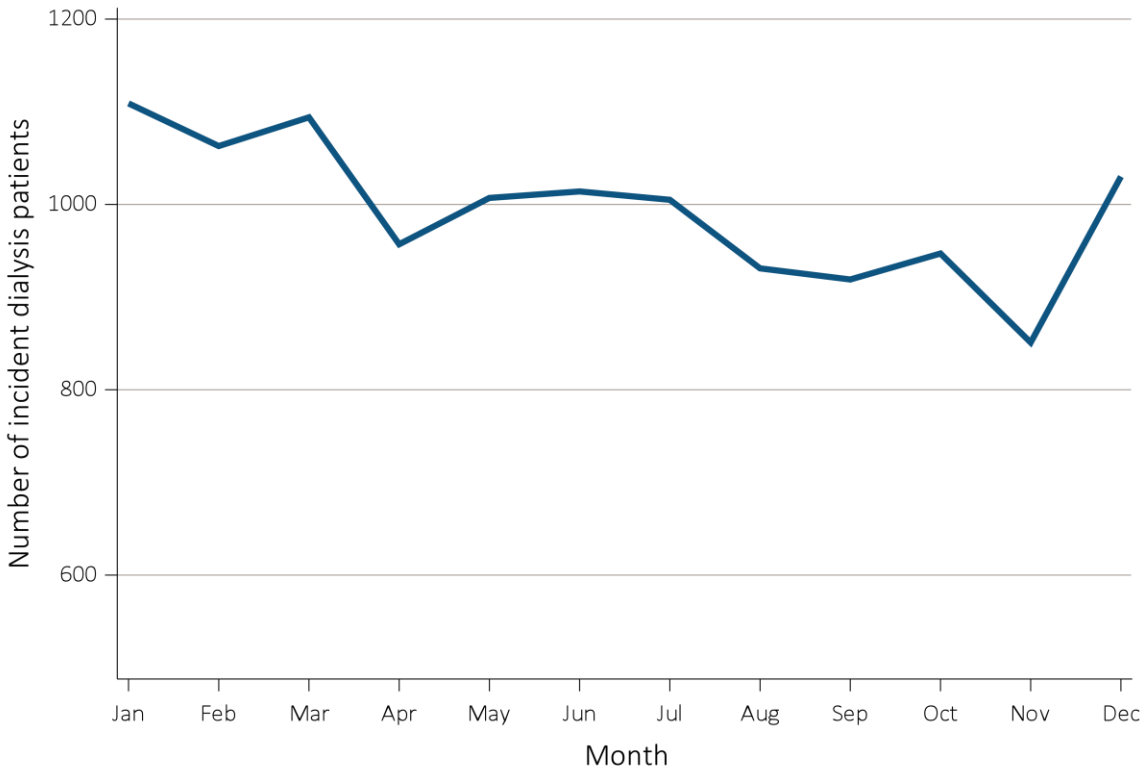


Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: KP-SC, Kaiser Permanente Southern California; ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

SEASONAL TREND AMONG KAISER PERMANENTE SOUTHERN CALIFORNIA INCIDENT DIALYSIS PATIENTS WHO TRANSITIONED TO ESRD

The seasonal trend of the 11,927 incident dialysis patients who transitioned to ESRD is shown in Figure 9.54. A greater number of patients transitioned to ESRD in the winter months of January, February, and March, compared to the rest of the year. The fewest incident dialysis patients, less than 900, transitioned to ESRD in the month of November.

vol 1 Figure 9.54 Seasonal trend among 11,927 KP-SC incident dialysis patients who transitioned to ESRD during 1/1/2007-12/31/2016

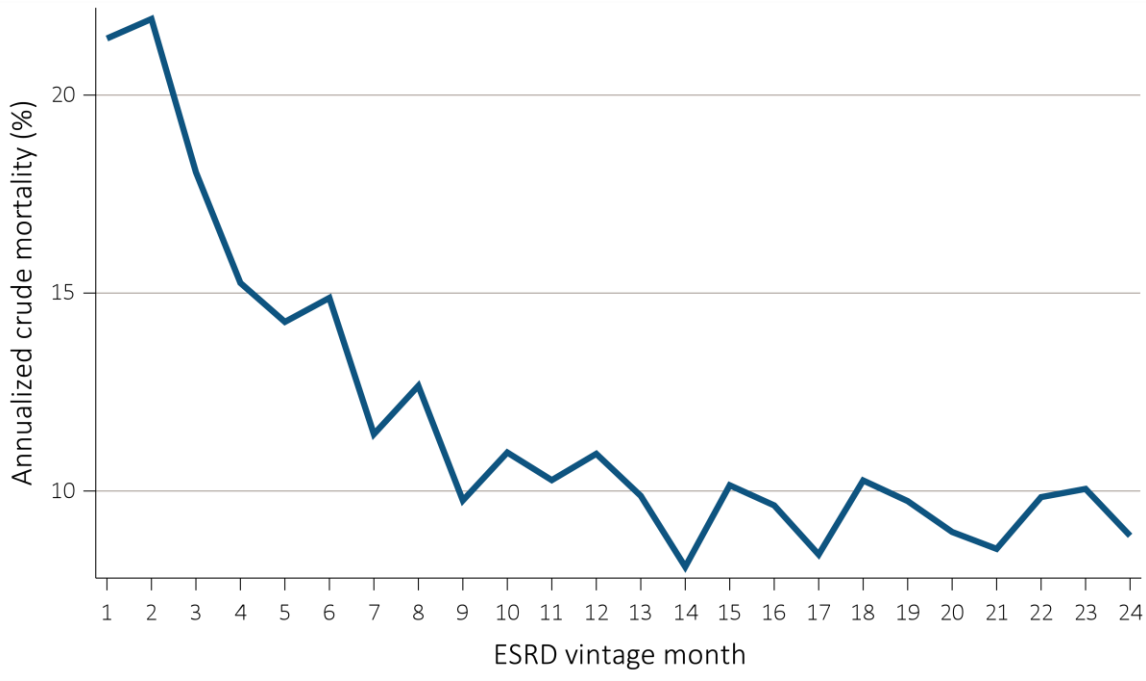


Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: KP-SC, Kaiser Permanente Southern California; ESRD, end-stage renal disease; Jan, January; Feb, February; Mar, March; Apr, April; Jun, June; Jul, July; Aug, August; Sep, September; Oct, October; Nov, November; Dec, December.

MORTALITY IN 24 MONTHS AND UTILIZATION COMPARISON AMONG KAISER PERMANENTE SOUTHERN CALIFORNIA INCIDENT DIALYSIS PATIENTS WHO TRANSITIONED TO ESRD

Annualized mortality rates among 11,927 KP-SC incident dialysis patients over the first 24 months of the vintage period are depicted in Figure 9.55. The higher mortality rates in the first several months bear resemblance to rates observed among veterans with incident ESRD, and the U.S. ESRD population overall. During the first three months, 600 (5.0%) of incident dialysis patients died.

vol 1 Figure 9.55 Annualized unadjusted mortality of the 11,927 KP-SC incident dialysis patients who transitioned to ESRD during 1/1/2007-12/31/2016 and were followed for up to 24 months



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California.

Table 9.8 displays the number of incident dialysis patients who were hospitalized during pre-transition and post-transition. Of the 8,019 incident dialysis patients who were hospitalized prior to ESRD transition, 4,956 (61.8%) were hospitalized post-transition. Of the 3,908 who were not hospitalized pre-transition, over a third (35.6%) were hospitalized post-transition. Table 9.9 compares hospitalizations for heart failure (HF) and acute kidney injury (AKI) and early mortality. Among patients dying two months after ESRD transition, 38.6% were hospitalized for AKI six months prior to ESRD transition, compared to 19.4% who survived at least 12 months. Congestive heart failure was a primary cause of hospitalization six months prior to ESRD transition among the 28.6% of patients who died at two months compared to 11.1% who were alive more than 12 months.

vol 1 Table 9.8 Number of hospitalizations pre- and post-transition among the 11,927 KP-SC incident dialysis patients during 1/1/2007-12/31/2016

Hospitalization pre-transition	Hospitalization post-transition
Yes N=8,019 (73.1%)	Yes N=4,956 (61.8%)
	No N=3,063 (38.2%)
No N=3,908 (26.9%)	Yes N=1,391 (35.6%)
	No N=2,517 (64.4%)

Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviation: KP-SC, Kaiser Permanente Southern California.

vol 1 Table 9.9 Comparison of hospitalizations for heart failure and acute kidney injury for KP-SC incident dialysis patients who died at two months vs. alive more than 12 months after ESRD transition

	Patients died at two months (N=427)	Patients died between 2 months and 12 months (N=1,174)	Patients survived more than 12 months (N=10,326)
	N (%)	N (%)	N (%)
Hospitalization in 6 months prior to ESRD transition	382 (89.5)	1,006 (85.7)	6,013 (58.2)
Primary cause of hospitalization in 6 months prior to ESRD transition			
Heart failure	122 (28.6)	275 (23.4)	1,142 (11.1)
Acute kidney injury	165 (38.6)	380 (32.4)	2,004 (19.4)
Hospitalization related diagnosis in 6 months prior to ESRD transition			
Heart failure	235 (55.0)	589 (50.2)	2,724 (26.4)
Acute kidney injury	327 (76.6)	802 (68.3)	4,019 (38.9)

Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: KP-SC, Kaiser Permanente Southern California; ESRD, end-stage renal disease.

TC-CKD COMORBIDITY DATA PRIOR TO ESRD TRANSITION AT KAISER PERMANENTE SOUTHERN CALIFORNIA

The comorbidity data for the prelude period were created from the KP-SC utilization database, which stores comprehensive patient diagnosis and procedure information from 1981 to the present. Pre-existing co-morbidities were determined by ICD-9-CM documentation in records from inpatient or outpatient settings in the three years prior to transition to ESRD. Among the top five comorbid conditions seen in Figure 9.56.a, more than 70% of the 11,927 incident dialysis patients at KP-SC had DM with or without complications; over a third of the ESRD patients had myocardial infarction, and 22% had cancer.

A macro originally developed at Manitoba Centre for Health Policy (MCHP) website was used to estimate Charlson Comorbidity Index (CCI) scores as shown in Figure 9.56.b. A revised, weighted CCI score that excluded renal disease was calculated according to the formula below:

CCI = 1* Myocardial Infarction + 1* Heart Failure + 1* Peripheral Vascular Disease + 1* Cerebrovascular Disease + 1* Dementia + 1* Chronic Pulmonary Disease + 1* Rheumatic Disease + 1* Peptic Ulcer Disease + 1* Mild Liver Disease + 1* Diabetes without chronic complications

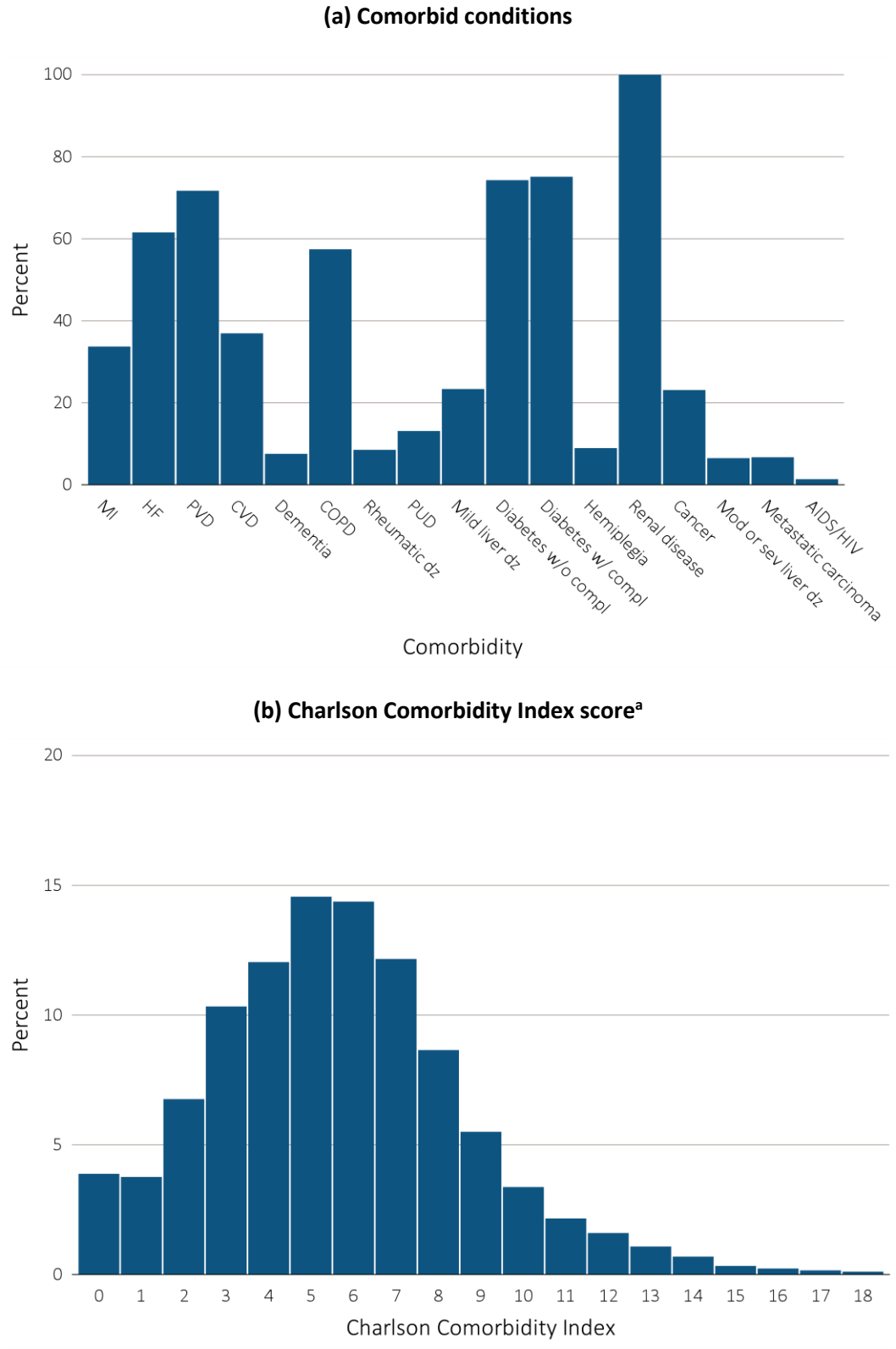
+ 2* Diabetes with chronic complications + 2* Paraplegia or Hemiplegia + 2* Any Cancer

+ 3* Moderate or Severe Liver Disease

+ 6* Metastatic Carcinoma + 6*AIDS/HIV

The mean CCI, excluding renal disease, was 4.2 ± 2.1, and 0.3% had a CCI of 10 or greater. The mean weighted CCI was slightly greater, 5.6 ± 2.9, and 8.9% of the persons with weighted CCI had a CCI of 10 or greater.

vol 1 Figure 9.56 Selected (a) comorbid conditions for calculation of the (b) Charlson Comorbidity Index, prior to transition to ESRD in 11,927 KP-SC incident dialysis patients during 1/1/2007-12/31/2016

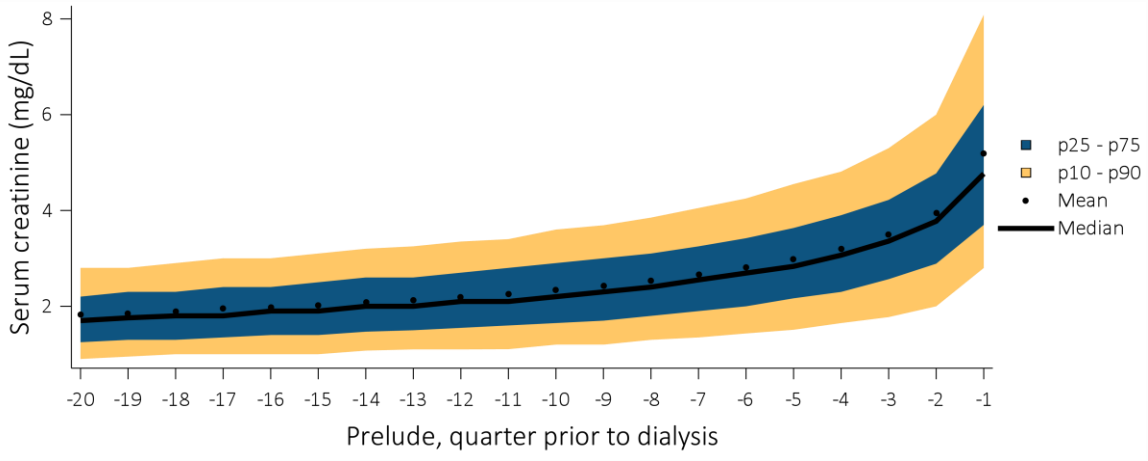


Data source: Kaiser Permanente Southern California Electronic Health Records. [a]Excludes renal disease (not ESRD). Abbreviations: AIDS, acquired immunodeficiency virus; compl, complications; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; dz, disease; ESRD, end-stage renal disease; HF, heart failure; HIV, human immunodeficiency virus; Kaiser Permanente Southern California; MI, myocardial infarction; Mod, moderate; PVD, peripheral vascular disease; PUD, peptic ulcer disease; sev, severe.

PRELUDE AND VINTAGE LABORATORY TRENDS OF TC-CKD DATA IN KAISER PERMANENTE SOUTHERN CALIFORNIA

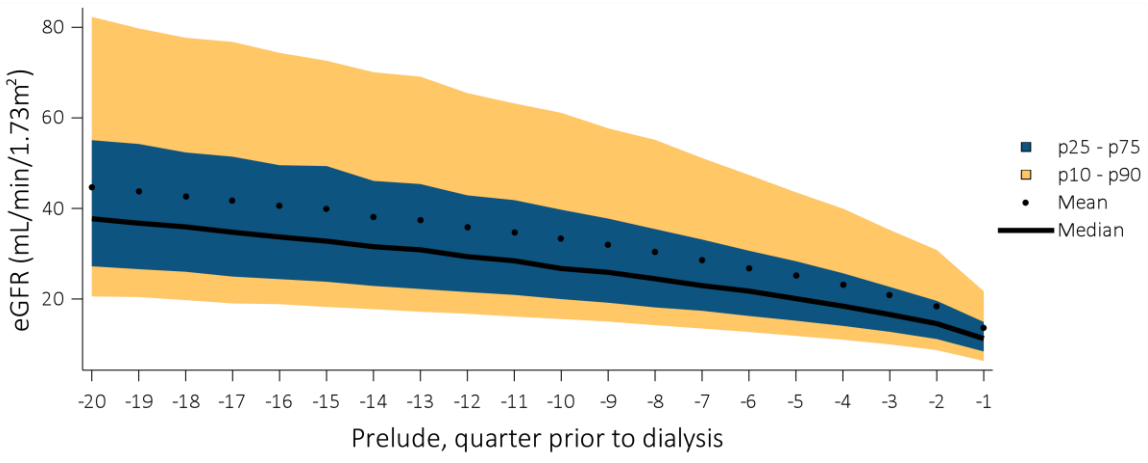
Data spanning over 20 years were extracted from the KP-SC Laboratory database that tracks inpatient and outpatient laboratory orders and results. Figures 9.57 and 9.58 show prelude variables (including serum creatinine and eGFR) averaged by 91-day quarters (n=20 quarters) among the 11,927 patients who transitioned to dialysis. In the 90 days immediately prior to transition, serum creatinine levels remarkably increased and eGFR levels decreased. Furthermore, the age-stratified eGFR trend over 20 quarters shows that older CKD patients had a slower progression rate than younger patients (Figure 9.59). Examining the eGFR trend by cause of ESRD in Figure 9.60, we find that those with diabetes had a faster progression rate than those with hypertension or other causes for most of the prelude quarters.

vol 1 Figure 9.57 Trend in serum creatinine level during the prelude (pre-ESRD) period over 20 quarters among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016



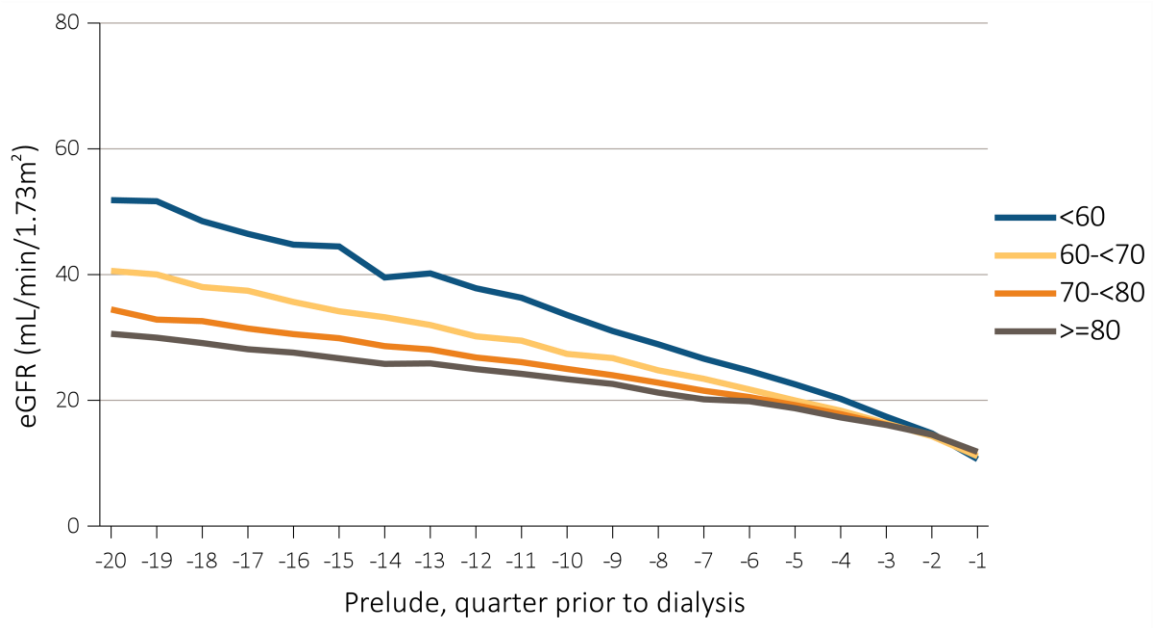
Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; mg/dL, milligrams per deciliter; p, percentile.

vol 1 Figure 9.58 Trend in eGFR during the prelude (pre-ESRD) period over 20 quarters among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016



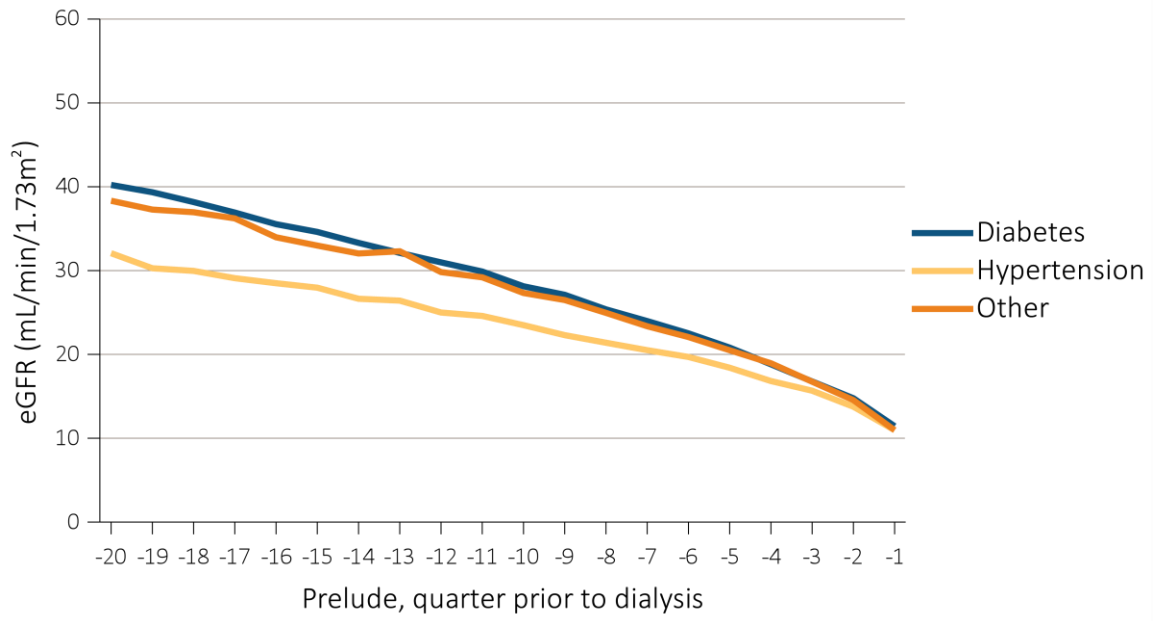
Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: eGFR; estimated glomerular filtration rate; ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; mL/min/1.73m², milliliter per minute per 1.73 meters squared; p, percentile.

vol 1 Figure 9.59 Trends in eGFR[a] during the prelude (pre-ESRD) period over 20 quarters among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016, stratified by age-at-incidence



Data source: Kaiser Permanente Southern California Electronic Health Records. [a]Median eGFR. Abbreviations: eGFR; estimated glomerular filtration rate; ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; mL/min/1.73m², milliliter per minute per 1.73 meters squared.

vol 1 Figure 9.60 Trends in eGFR[a] during the prelude (pre-ESRD) period over 20 quarters among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016, stratified by cause of ESRD

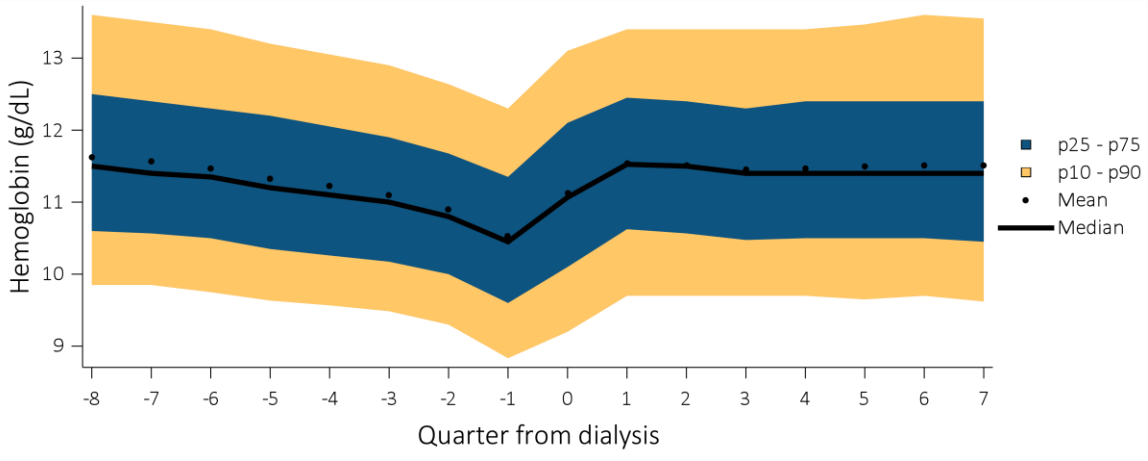


Data source: Kaiser Permanente Southern California Electronic Health Records. [a]Median eGFR. Abbreviations: eGFR; estimated glomerular filtration rate; ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; mL/min/1.73m², milliliter per minute per 1.73 meters squared.

For the 11,927 patients who transitioned to ESRD, we show selected KP-SC laboratory data for hemoglobin, hemoglobin A1C, phosphorus, parathyroid hormone, and albumin levels over eight prelude (quarters -8 to -1) and eight vintage (quarters 0 to +7) quarters (Figures 9.61, 9.62, 9.63, 9.64, and 9.65).

Mean hemoglobin levels gradually decreased from 11.6 g/dL to a nadir of 10.5 g/dL in the prelude period of progression from CKD to ESRD. Immediately after transition to ESRD, a slight increase in mean hemoglobin to 11.1 g/dL was observed in the first quarter (quarter 0), followed by a rise to a peak of 11.5 g/dL in the second quarter (quarter 1). Subsequent mean hemoglobin levels decreased in vintage quarter 3 and later stabilized (Figure 9.61).

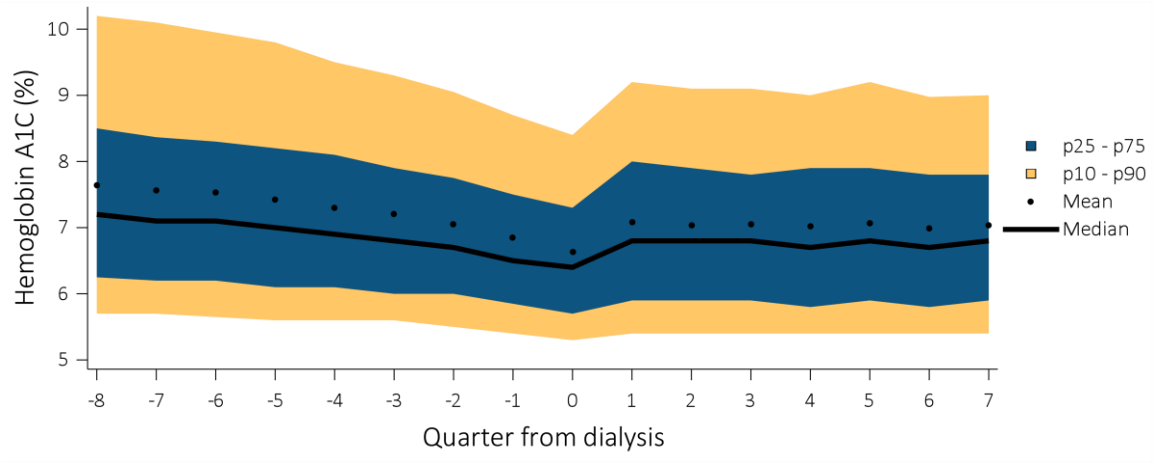
vol 1 Figure 9.61 Trend in hemoglobin levels (g/dL) over 8 quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; HGB, hemoglobin; g/dL, grams per deciliter; p, percentile.

In Figure 9.62, mean hemoglobin A1C levels dropped from 7.6% to 6.8% in the prelude period, then slightly decreased even further to 6.6% immediately after transition to ESRD. In the second quarter, post-transition (quarter 1), mean hemoglobin A1C levels rose to 7.1% and remained stable afterwards in the vintage period.

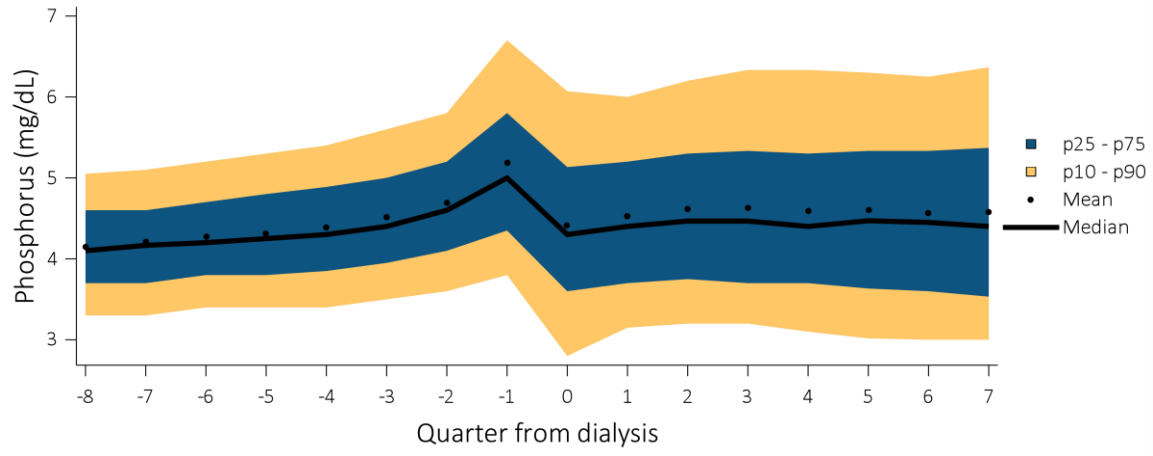
vol 1 Figure 9.62 Trend in hemoglobin A1C levels (%) over 8 quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; Hgb, hemoglobin; p, percentile.

Mean phosphorus levels increased in the prelude period from 4.2 mg/dL to 5.2 mg/dL (Figure 9.63). Immediately after transition to ESRD, mean phosphorus decreased to 4.4 mg/dL. In the third quarter post-transition (quarter 2), mean phosphorus increased to 4.6 mg/dL and remained stable in the vintage period.

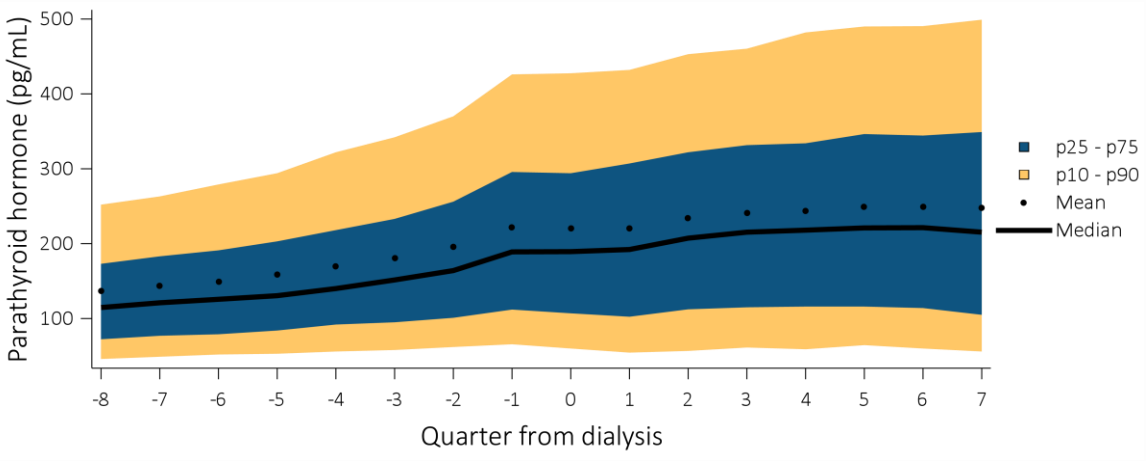
vol 1 Figure 9.63 Trend in phosphorus levels (mg/dL) over 8 quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; mg/dL, milligrams per deciliter; p, percentile.

Figure 9.64 shows mean parathyroid hormone levels steadily increasing over the prelude and vintage periods from 136.2 pg/mL to 248.0 pg/mL. Transition to ESRD did not appear to modify the trajectory of increasing parathyroid hormone levels over time.

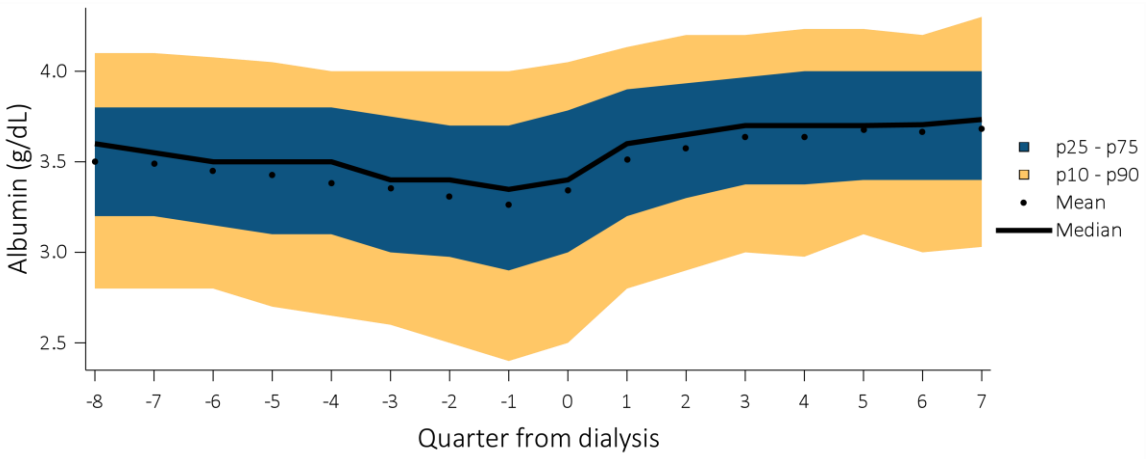
vol 1 Figure 9.64 Trend in parathyroid hormone levels (pg/mL) over 8 quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; PTH, parathyroid hormone; pg/dL, picograms per deciliter; p, percentile.

Mean albumin levels dropped from 3.5 g/dL to 3.3 g/dL over the prelude period. Immediately after transition to ESRD, mean albumin increased to 3.4 g/dL in the first quarter to 3.7 g/dL in the fourth quarter (quarter 3) of the vintage period, and subsequently remained stable (Figure 9.65).

vol 1 Figure 9.65 Trend in albumin levels (g/dL) over 8 quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 11,927 KP-SC patients who transitioned to dialysis during 1/1/2007-12/31/2016



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California; g/dL, grams per deciliter; p, percentile.

References

1. Arif FM, Sumida K, Molnar MZ, Potukuchi PK, Lu JL, Hassan F, Thomas F, Siddiqui OA, Gyamlani GG, Kalantar-Zadeh K and Kovesdy CP. Early Mortality Associated with Inpatient versus Outpatient Hemodialysis Initiation in a Large Cohort of US Veterans with Incident End-Stage Renal Disease. Nephron. 2017;137:15-22.https://www.ncbi.nlm.nih.gov/pubmed/28445893
2. Gaipov A, Molnar MZ, Potukuchi PK, Sumida K, Szabo Z, Akbilgic O, Streja E, Rhee CM, Koshy SKG, Canada RB, Kalantar-Zadeh K and Kovesdy CP. Acute kidney injury following coronary revascularization procedures in patients with advanced CKD. *Nephrol Dial Transplant*. 2018 [epub]. https://www.ncbi.nlm.nih.gov/pubmed/29986054
3. Kalantar-Zadeh K, Crowley ST, Beddhu S, Chen JLT, Daugirdas JT, Goldfarb DS, Jin A, Kovesdy CP, Leehey DJ, Moradi H, Navaneethan SD, Norris KC, Obi Y, O'Hare A, Shafi T, Streja E, Unruh ML, Vachharajani TJ, Weisbord S and Rhee CM. Renal Replacement Therapy and Incremental Hemodialysis for Veterans with Advanced Chronic Kidney Disease. *Semin Dial*. 2017;30:251-261. https://www.ncbi.nlm.nih.gov/pubmed/28421638
4. Kalantar-Zadeh K, Kovesdy CP, Streja E, Rhee CM, Soohoo M, Chen JLT, Molnar MZ, Obi Y, Gillen D, Nguyen DV, Norris KC, Sim JJ and Jacobsen SS. Transition of care from pre-dialysis prelude to renal replacement therapy: the blueprints of emerging research in advanced chronic kidney disease. *Nephrol Dial Transplant*. 2017;32:ii91-ii98. https://www.ncbi.nlm.nih.gov/pubmed/28201698
5. Kleine CE, Soohoo M, Ranasinghe ON, Park C, Marroquin MV, Obi Y, Rhee CM, Moradi H, Kovesdy CP, Kalantar-Zadeh K and Streja E. Association of Pre-End-Stage Renal Disease Hemoglobin with Early Dialysis Outcomes. *Am J Nephrol*. 2018;47:333-342. https://www.ncbi.nlm.nih.gov/pubmed/29779027
6. Kovesdy CP, Naseer A, Sumida K, Molnar MZ, Potukuchi PK, Thomas F, Streja E, Heung M, Abbott KC, Saran R and Kalantar-Zadeh K. Abrupt Decline in Kidney Function Precipitating Initiation of Chronic Renal Replacement Therapy. *Kidney Int Rep*. 2018;3:602-609. https://www.ncbi.nlm.nih.gov/pubmed/29854967
7. Lu JL, Molnar MZ, Sumida K, Diskin CD, Streja E, Siddiqui OA, Kalantar-Zadeh K and Kovesdy CP. Association of the frequency of pre-end-stage renal disease medical care with post-end-stage renal disease mortality and hospitalization. *Nephrol Dial Transplant*. 2018;33:789-795. https://www.ncbi.nlm.nih.gov/pubmed/29106625
8. Molnar MZ, Eason JD, Gaipov A, Talwar M, Potukuchi PK, Joglekar K, Remport A, Mathe Z, Mucsi I, Novak M, Kalantar-Zadeh K and Kovesdy CP. History of psychosis and mania, and outcomes after kidney transplantation - a retrospective study. *Transpl Int*. 2018;31:554-565. https://www.ncbi.nlm.nih.gov/pubmed/29405487
9. Molnar MZ, Gosmanova EO, Sumida K, Potukuchi PK, Lu JL, Jing J, Ravel VA, Soohoo M, Rhee CM, Streja E, Kalantar-Zadeh K and Kovesdy CP. Predialysis Cardiovascular Disease Medication Adherence and Mortality After Transition to Dialysis. *Am J Kidney Dis*. 2016;68:609-18. http://www.ncbi.nlm.nih.gov/pubmed/27084246
10. Molnar MZ, Streja E, Sumida K, Soohoo M, Ravel VA, Gaipov A, Potukuchi PK, Thomas F, Rhee CM, Lu JL, Kalantar-Zadeh K and Kovesdy CP. Pre-ESRD Depression and Post-ESRD Mortality in Patients with Advanced CKD Transitioning to Dialysis. *Clin J Am Soc Nephrol*. 2017;12:1428-1437. https://www.ncbi.nlm.nih.gov/pubmed/28679562
11. Molnar MZ, Sumida K, Gaipov A, Potukuchi PK, Fulop T, Joglekar K, Lu JL, Streja E, Kalantar-Zadeh K and Kovesdy CP. Pre-ESRD Dementia and Post-ESRD Mortality in a Large Cohort of Incident Dialysis Patients. *Dement Geriatr Cogn Disord*. 2017;43:281-293. https://www.ncbi.nlm.nih.gov/pubmed/28448971

12. Obi Y, Kalantar-Zadeh K, Streja E, Rhee CM, Reddy UG, Soohoo M, Wang Y, Ravel V, You AS, Jing J, Sim JJ, Nguyen DV, Gillen DL, Saran R, Robinson B and Kovesdy CP. Seasonal variations in transition, mortality and kidney transplantation among patients with end-stage renal disease in the USA. *Nephrol Dial Transplant*. 2017;32:ii99-ii105. https://www.ncbi.nlm.nih.gov/pubmed/28201764

13. Obi Y, Nguyen DV, Zhou H, Soohoo M, Zhang L, Chen Y, Streja E, Sim JJ, Molnar MZ, Rhee CM, Abbott KC, Jacobsen SJ, Kovesdy CP and Kalantar-Zadeh K. Development and Validation of Prediction Scores for Early Mortality at Transition to Dialysis. *Mayo Clin Proc*. 2018 [epub]. https://www.ncbi.nlm.nih.gov/pubmed/30104041

14. Obi Y, Park C, Soohoo M, Sumida K, Hamano T, Rhee CM, Kovesdy CP, Kalantar-Zadeh K and Streja E. Association of Pre-ESRD Serum Calcium With Post-ESRD Mortality Among Incident ESRD Patients: A Cohort Study. *J Bone Miner Res*. 2018;33:1027-1036. https://www.ncbi.nlm.nih.gov/pubmed/29342320

15. Rhee CM, Kovesdy CP, Ravel VA, Streja E, Brunelli SM, Soohoo M, Sumida K, Molnar MZ, Brent GA, Nguyen DV and Kalantar-Zadeh K. Association of Glycemic Status During Progression of Chronic Kidney Disease With Early Dialysis Mortality in Patients With Diabetes. *Diabetes Care*. 2017;40:1050-1057. https://www.ncbi.nlm.nih.gov/pubmed/28592525

16. Rhee CM, Kovesdy CP, You AS, Sim JJ, Soohoo M, Streja E, Molnar MZ, Amin AN, Abbott K, Nguyen DV and Kalantar-Zadeh K. Hypoglycemia-Related Hospitalizations and Mortality Among Patients With Diabetes Transitioning to Dialysis. *Am J Kidney Dis*. 2018 [epub]. https://www.ncbi.nlm.nih.gov/pubmed/30037725

17. Saleh T, Sumida K, Molnar MZ, Potukuchi PK, Thomas F, Lu JL, Gyamlani GG, Streja E, Kalantar-Zadeh K and Kovesdy CP. Effect of Age on the Association of Vascular Access Type with Mortality in a Cohort of Incident End-Stage Renal Disease Patients. *Nephron*. 2017;137:57-63. https://www.ncbi.nlm.nih.gov/pubmed/28514785

18. Soohoo M, Streja E, Obi Y, Rhee CM, Gillen DL, Sumida K, Nguyen DV, Kovesdy CP and Kalantar-Zadeh K. Predialysis Kidney Function and Its Rate of Decline Predict Mortality and Hospitalizations After Starting Dialysis. *Mayo Clin Proc*. 2018;93:1074-1085. https://www.ncbi.nlm.nih.gov/pubmed/30078411

19. Streja E, Kovesdy CP, Soohoo M, Obi Y, Rhee CM, Park C, Chen JLT, Nakata T, Nguyen DV, Amin AN, Jacobsen SJ, Sim JJ and Kalantar-Zadeh K. Dialysis Provider and Outcomes among United States Veterans Who Transition to Dialysis. *Clin J Am Soc Nephrol*. 2018;13:1055-1062. https://www.ncbi.nlm.nih.gov/pubmed/29903898

20. Sumida K, Diskin CD, Molnar MZ, Potukuchi PK, Thomas F, Lu JL, Rhee CM, Streja E, Yamagata K, Kalantar-Zadeh K and Kovesdy CP. Pre-End-Stage Renal Disease Hemoglobin Variability Predicts Post-End-Stage Renal Disease Mortality in Patients Transitioning to Dialysis. *Am J Nephrol*. 2017;46:397-407. https://www.ncbi.nlm.nih.gov/pubmed/29130991

21. Sumida K, Molnar MZ, Potukuchi PK, Thomas F, Lu JL, Jing J, Ravel VA, Soohoo M, Rhee CM, Streja E, Kalantar-Zadeh K and Kovesdy CP. Association of Slopes of Estimated Glomerular Filtration Rate With Post-End-Stage Renal Disease Mortality in Patients With Advanced Chronic Kidney Disease Transitioning to Dialysis. *Mayo Clin Proc*. 2016;91:196-207. http://www.ncbi.nlm.nih.gov/pubmed/26848002

22. Sumida K, Molnar MZ, Potukuchi PK, Thomas F, Lu JL, Obi Y, Rhee CM, Streja E, Yamagata K, Kalantar-Zadeh K and Kovesdy CP. Prognostic significance of pre-end-stage renal disease serum alkaline phosphatase for post-end-stage renal disease mortality in late-stage chronic kidney disease patients transitioning to dialysis. *Nephrol Dial Transplant*. 2018;33:264-273. https://www.ncbi.nlm.nih.gov/pubmed/28064159

23. Sumida K, Molnar MZ, Potukuchi PK, Thomas F, Lu JL, Ravel VA, Soohoo M, Rhee CM, Streja E,

Sim JJ, Yamagata K, Kalantar-Zadeh K and Kovesdy CP. Blood Pressure Before Initiation of Maintenance Dialysis and Subsequent Mortality. *Am J Kidney Dis*. 2017;70:207-217. https://www.ncbi.nlm.nih.gov/pubmed/28291617

24. Sumida K, Molnar MZ, Potukuchi PK, Thomas F, Lu JL, Ravel VA, Soohoo M, Rhee CM, Streja E, Yamagata K, Kalantar-Zadeh K and Kovesdy CP. Association between vascular access creation and deceleration of estimated glomerular filtration rate decline in late-stage chronic kidney disease patients transitioning to end-stage renal disease. *Nephrol Dial Transplant*. 2017;32:1330-1337. https://www.ncbi.nlm.nih.gov/pubmed/27242372

25. Sumida K, Molnar MZ, Potukuchi PK, Thomas F, Lu JL, Yamagata K, Kalantar-Zadeh K and Kovesdy CP. Pre-end-stage renal disease visit-to-visit systolic blood pressure variability and post-end-stage renal disease mortality in incident dialysis patients. *J Hypertens*. 2017;35:1816-1824. https://www.ncbi.nlm.nih.gov/pubmed/28399042

26. You AS, Sim JJ, Kovesdy CP, Streja E, Soohoo M, Nguyen DV, Brent G, Kalantar-Zadeh K and Rhee CM. Association of Thyroid Status prior to Transition to End-Stage Renal Disease with Early Dialysis Mortality. *Nephrol Dial Transplant*. 2018 [in press];

27. Wong ES, Wang V, Liu CF, Hebert PL and Maciejewski ML. Do Veterans Health Administration Enrollees Generalize to Other Populations? *Med Care Res Rev*. 2016;73:493-507. http://www.ncbi.nlm.nih.gov/pubmed/26589675

28. Street AE, Vogt D and Dutra L. A new generation of women veterans: stressors faced by women deployed to Iraq and Afghanistan. *Clin Psychol Rev*. 2009;29:685-94. https://www.ncbi.nlm.nih.gov/pubmed/19766368

29. Kovesdy CP, Norris KC, Boulware LE, Lu JL, Ma JZ, Streja E, Molnar MZ and Kalantar-Zadeh K. Association of Race With Mortality and Cardiovascular Events in a Large Cohort of US Veterans. *Circulation*. 2015;132:1538-48. http://www.ncbi.nlm.nih.gov/pubmed/26384521

30. Affairs DoV. National center for veterans analysis and statistics. 2012.

31. Sim JJ, Zhou H, Shi J, Shaw SF, Henry SL, Kovesdy CP, Kalantar-Zadeh K and Jacobsen SJ. Disparities in early mortality among chronic kidney disease patients who transition to peritoneal dialysis and hemodialysis with and without catheters. *Int Urol Nephrol*. 2018;50:963-971. https://www.ncbi.nlm.nih.gov/pubmed/29532308