Chapter 8: Transition of Care in Chronic Kidney Disease

- Over 20% of all 85,505 United States (U.S.) veterans who transitioned to end-stage renal disease (ESRD) over a 6.5-year period (10/2007-3/2014) received antidepressant medications prior to transition, or during the "prelude" period. After transition to ESRD ("vintage" period) the antidepressant prescription rate increased to almost 30%.
- Phosphorus binders (lanthanum, sevelamer, and calcium acetate) were rarely prescribed during the prelude period prior to ESRD transition, while a major surge was observed in the final six months of the prelude, followed by a substantial rise during the dialysis vintage period.
- Among the comorbid conditions of 74,382 veterans who transitioned to ESRD with at least one identified comorbidity, congestive heart failure (CHF), diabetes mellitus (DM), and chronic obstructive pulmonary disease (COPD) were each present in over half of the sample. Over a quarter of all veteran patients had a diagnosis of cancer (CA), and 32% had a prior myocardial infarction (MI).
- Among the 74,382 veterans who had at least one hospitalization event during their transition to ESRD, the most common causes of admission included acute kidney injury (AKI,), hypertension (HTN), congestive heart failure (CHF), and chronic kidney disease (CKD). Septicemia-related hospital admissions increased dramatically after ESRD transition.
- CHF and AKI were the most common reasons for hospital admission prior to ESRD transition (prelude period), whereas dialysis access complications were the most common cause after ESRD transition (vintage period).
- AKI was the leading cause for hospitalizations that included the transition to ESRD event, i.e., the first hemodialysis treatment.
- Prelude trend analyses provided important information about changes in clinical and laboratory measures over time during the several years prior to transition to ESRD, including measured serum phosphorus in 20 quarters (five years) prelude in the 24,765 veterans who eventually transitioned to ESRD; values gradually increased from 4.0 mg/dL to above 5.5 mg/dL immediately prior to transition.

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 non-dialysis dependent (NDD) CKD. These are often people with an estimated glomerular filtration rate (eGFR) <25 ml/min/1.73 m^2. The primary databases used in these analyses were created from the linkage between the national USRDS data and two large longitudinal databases of NDD-CKD patients—the national Veterans Affairs (VA) database and the regional (Southern California) Kaiser Permanente (KP-SC) database. These linkages allowed us to identify all VA and all KP-SC patients who have transitioned to ESRD from the index point in time onwards. Each of these linked databases includes thousands of NDD-CKD patients who have transitioned to ESRD each year, in whom historical data for up to -5 (minus five) years prior to ESRD (the so-called "prelude" period) and up to +2 (plus two) years after ESRD transition (the so-called early "vintage" period) were examined.

In the first phase of this Special Study operation, we examined the recent national VA and KP-SC cohorts of incident ESRD patients. We provided pre-ESRD (prelude) data on all available ESRD transitions since 10/1/2007 among veterans, and since 1/1/2007 among KP-SC patients. Analyses that examined preliminary, 4- year pre- and post-ESRD data of approximately 52,000 incident ESRD veterans who transitioned to ESRD between 10/1/2007 and 9/30/2011 were presented in our 2014 and 2015 Annual Data Report (ADR) chapters. In this 2016 ADR, we present 6.5-year pre- and post-ESRD data on approximately 85,000 incident ESRD veterans who transitioned between 10/1/2007 and 3/31/2014. For these incident patients we also include additional data from the first two years of the post-ESRD (vintage) period and the -5-year prelude (pre-ESRD) data, along with additional data from the USRDS. Similar analyses are also presented for the KP-SC patient cohort.

As stated in the original goals of this Special Study Center, we continue to test the hypotheses that a pre-ESRD (prelude) data-driven individualized 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 the CKD progression rate, comorbid conditions during prelude period, and demographics. In subsequent years we also plan to develop and validate scoring systems 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.

The Veterans Health Administration

There are approximately 22 million veterans in the U.S.; nine million are enrolled in the Veterans Health Administration (VHA), including almost six million who receive their healthcare in one of the VHA facilities. During the 2013 fiscal year there were 86.4 million outpatient visits and 694,700 inpatient admissions at Veterans Affairs (VA) healthcare facilities.[1]

Whereas currently some 90% of the U.S. veteran population is male, it is estimated that by 2040 approximately 18% will be female. Minority veterans comprised about 22% of the total veterans' population in 2014. Most minority veterans were those of Black or African American race (12% of all veterans), and Hispanics or Latinos of any race comprised approximately 7% of all veterans[2]

The VHA facility network consists of 150 hospitals, along with 820 community-based outpatient clinics, 300 veterans' centers, and some 70 dialysis centers that are primarily hospital based[3]. Services provided by the VA department and VHA facilities include comprehensive medical care, life insurance, disability compensation, home loans, educational benefits, pensions, and vocational rehabilitation training.

Management of ESRD in the VHA

The VHA provides comprehensive medical care for patients with kidney disease, including acute kidney injury (AKI) and all stages of CKD. Management of kidney disease that does not require dialysis or transplantation is typically provided by VA personnel at one of the nationwide VHA facilities, or outsourced to local private providers in cases where the VHA cannot provide adequate care, for reasons such as prohibitive distance or lack of adequate resources.

Any veteran who develops ESRD is eligible to receive kidney replacement therapy from the VHA. Dialysis care is a covered benefit under VA's Medical Benefits Package for veterans enrolled in the VA, irrespective of their service connectedness[4]. For patients requiring in-center dialysis treatment, the VHA provides dialysis both through units maintained and operated by individual VA facilities, (hence usually hospital based dialysis centers), or by outsourcing dialysis services to private dialysis providers. This may happen in cases where the distance from a VA facility is prohibitive for thrice-weekly dialysis, when there is a lack of home dialysis resources or expertise, or when the capacity of the VA facility-operated dialysis unit is exceeded. There are currently 71 VA facilities nationwide that maintain and operate a primarily in-house (in-center) dialysis center[5]. Most of the hospital-based dialysis units provide both chronic outpatient and acute inpatient dialysis treatments in the same location. In the USRDS ADR census these were usually classified under the category of "hospital based" facilities.

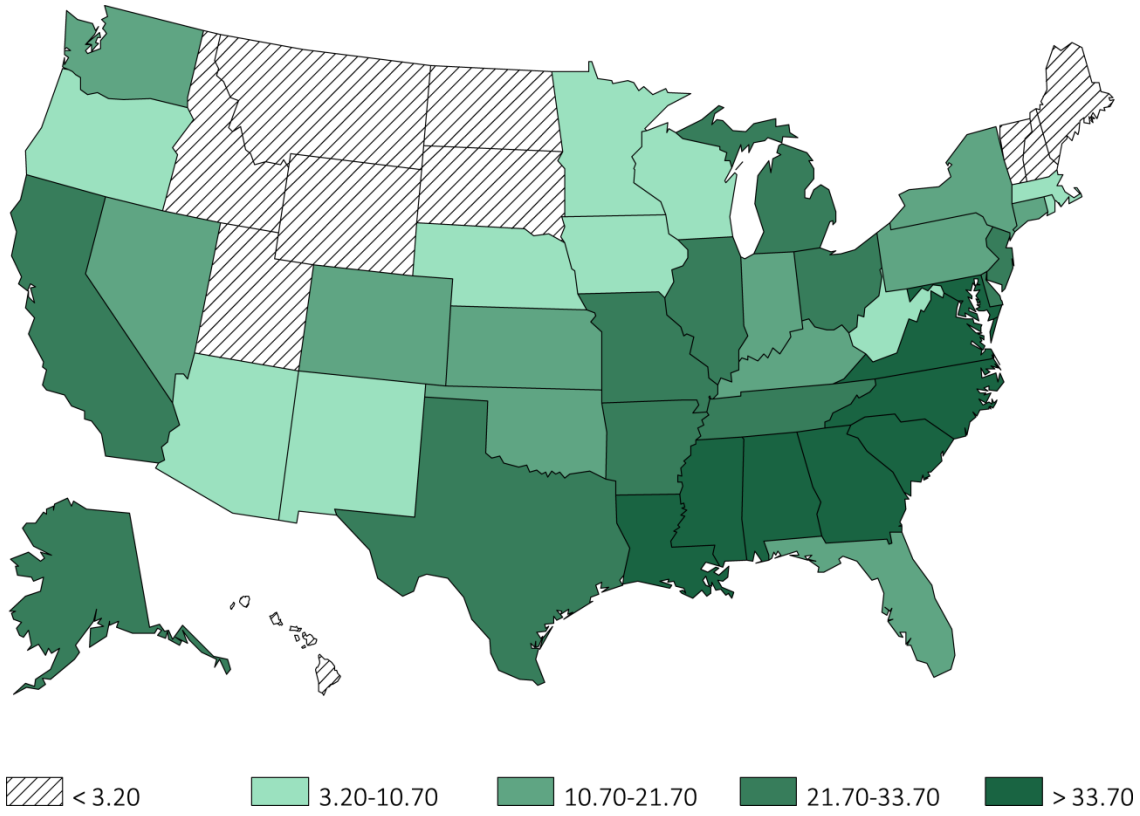
Although approximately 90% of the ESRD veterans receive dialysis treatment in non-VHA facilities, including large dialysis chains, the transition data of these and other outsourced dialysis veterans and in particular their prelude and early vintage analyses and other data are also included in this chapter (see below). Hence, our transition-of-care data for veterans with ESRD are exceptionally inclusive and comprehensive.

HIGHLIGHTS OF THE INCIDENT ESRD VETERANS POPULATION BETWEEN 10/1/2007 AND 3/31/2014

Between 10/1/2007 and 3/31/2014 (over 6.5 fiscal years) 85,505 veterans transitioned to ESRD. The mean ±SD age was 70.1 ±12.0 years, and included 25% patients of Black race and 6% of Hispanic ethnicity. The main causes of ESRD were DM (42%) or HTN (31%).

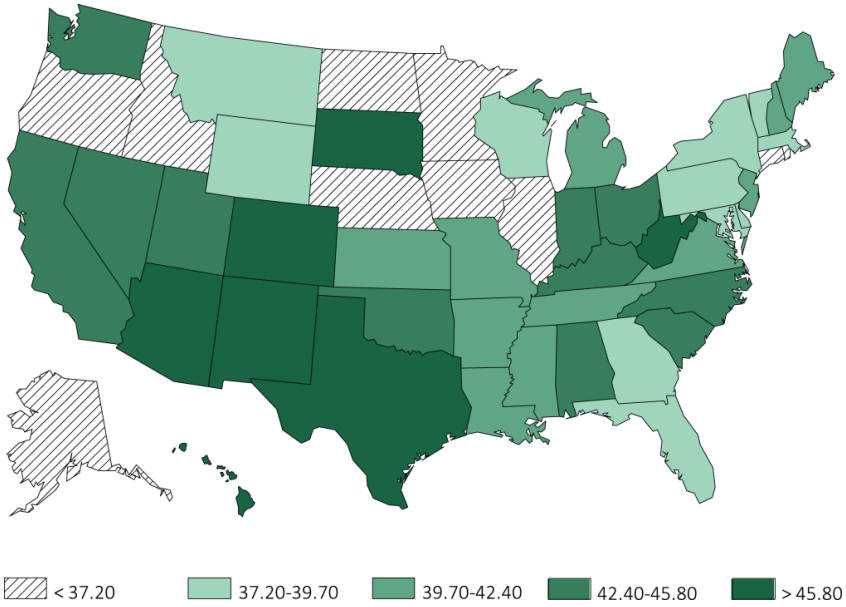
Across the nation, the proportion of Black incident ESRD veterans varied by state and region. Southern states such as Alabama, Georgia, Louisiana, Mississippi, and Washington D.C. had the highest proportion of Black veterans who transitioned to ESRD. Northeastern and northwestern states had lower proportions of Black veterans transitioning to ESRD (Figure 8.1). Furthermore, the distribution of patients with ESRD due to DM varied across the nation. Primarily, southwestern states, such as Texas, New Mexico, and Arizona had a higher proportion of patients with ESRD due to DM, while northern states such as Alaska, Oregon, Idaho, and North Dakota had lower proportions of ESRD due to DM (Figure 8.2).

vol 1 Figure 8.1 Distribution of Black incident ESRD veterans (%) among 85,505 incident ESRD veterans across states and territories of the United States, 10/1/2007-3/31/2014



Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. States and territories of the United States of America.

vol 1 Figure 8.2 Distribution of diabetes (%) as the cause of ESRD among 85,505 incident ESRD veterans across states and territories of the United States, 10/1/2007-3/31/2014

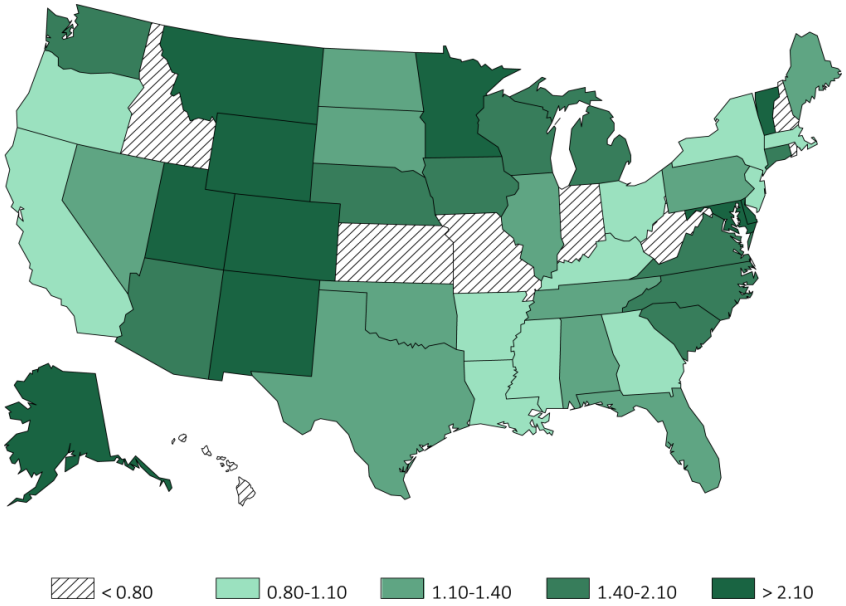


Data source: VHA Administrative data, USRDS ESRD Database. States and territories of the United States of America.

PREEMPTIVE KIDNEY TRANSPLANTATION AMONG VETERANS ACROSS THE NATION

Figure 8.3 shows the proportions of preemptive kidney transplantation in each state and territory of the U.S. The rates were calculated based on the number of preemptive transplants divided by the total number of the incident ESRD veterans in that state or territory (n=1133 preemptive transplantations over 6.5 years in the entire nation). The states with the highest preemptive kidney transplant rates among veterans (>2.1%) were Alaska, Colorado, Delaware, Maryland, Minnesota, Montana, New Mexico, Utah, Vermont, and Wyoming.

vol 1 Figure 8.3 Distribution of preemptive kidney transplant rates among 85,505 incident ESRD veterans across states and territories of the United States, 10/1/2007-3/31/2014



Data source: VHA Administrative data, USRDS ESRD Database. States and territories of the United States of America.

ESRD RATES AMONG VETERANS

As reported in previous ADR chapters on Transition of Care in CKD, during each year of the 6.5-year observation period, approximately 13,000 veterans transitioned to ESRD, with an average rate of ESRD transition of 1,096 veterans per month across the entire nation. In this report we have calculated the ESRD incident rates for veterans in each calendar year (Jan 1-Dec 31), instead of fiscal year (Oct 1-Sep 30). The U.S. Census data were accessed to obtain the Veteran population data using the Census Fact Finder site[6].

We then calculated counts of all veterans in each year and per age strata. The USRDS incidence rates for ESRD among U.S. adults were obtained from the 2015 Standard Analysis Files (SAFs) databases for comparison. For the six calendar years between 2008 and 2013, the crude ESRD incident rates among veterans were 603.3, 633.4, 616.9, 594.5, 606.2, and 635.3 per million veterans, respectively. Given the ESRD incident rates of 488.0, 499.3, 498.3, 484.7, 488.1, and 485.9 per million per the USRDS population, the calculated crude rate ratio of ESRD incidence among veterans compared to the U.S. general population is 1.24, 1.27, 1.24, 1.23, 1.24, and 1.31 for calendar years 2008 through 2013, respectively, suggesting that the ESRD is 23% to 31% more likely to occur among veterans than the general U.S. population.

However, the VA population is considerably older than the general U.S. population. Indeed, on an age specific and age adjusted basis, the VA rate of ESRD is 25 to 40 percent lower than the U.S. rate of ESRD. This lower-than-expected adjusted risk occurs despite the fact that the VA population is predominantly male. The remarkably low adjusted rate of ESRD among VA patients, despite higher crude ESRD incidence rates, is vastly unexplained. Is it because the VA provides an integrated health care system with better care to CKD patients, including Blacks in whom higher CKD burden is well known? Is it because there is a selection bias of persons into military service, in that healthier subjects were selected to serve? Further research may shed some light on this issue.

vol 1 Table 8.1. Rates and ratio of incident ESRD veterans among the veteran population and the U.S. adult population for calendar years 2008-2013 across 5 age strata of 18-34, 35-54, 55-64, 65-74, and 75+ years

(a) Age Strata: 18-34 years

Calendar Year	2008	2009	2010	2011	2012	2013
Incident ESRD veterans	77	73	75	74	56	69
All veterans	1,714,845	1,670,511	1,748,592	1,769,261	1,818,258	1,627,662
ESRD rate in veterans, PM	45	44	43	42	31	42
Incident ESRD in U.S.	5,523	5,745	5,556	5,484	5,611	5,462
U.S. Population	71,037,035	71,579,121	71,065,713	71,959,476	72,729,412	73,376,887
ESRD rate in the U.S., PM	78	80	78	76	77	74
ESRD rate ratio (Vet: US)*	0.58	0.54	0.55	0.55	0.40	0.57

(b) Age Strata: 35-45 years

Calendar Year	2008	2009	2010	2011	2012	2013
Incident ESRD veterans	1,374	1,378	1,227	1,124	1,163	987
All veterans	5,934,593	5,723,322	5,569,185	5,388,915	5,268,038	4,717,736
ESRD rate in veterans, PM	232	241	220	209	221	209
Incident ESRD in U.S.	25,998	26,659	26,023	25,784	25,938	25,836
U.S. Population	87,002,075	86,590,351	85,649,162	85,058,778	84,466,794	83,909,036
ESRD rate in the U.S., PM	299	308	304	303	307	308
ESRD rate ratio (Vet: US)*	0.77	0.78	0.73	0.69	0.72	0.68

(continued on next page)

vol 1 Table 8.1 Rates and ratio of incident ESRD veterans among the veteran population and the U.S. adult population for calendar years 2008-2013 across 5 age strata of 18-34, 35-54, 55-64, 65-74, and 75+ years *(continued)*

(c) Age Strata: 55-64 years

Calendar Year	2008	2009	2010	2011	2012	2013
Incident ESRD veterans	3,214	3,413	3,256	3,152	2,977	2,633
All veterans	5,717,733	5,448,504	5,345,088	5,084,023	4,573,643	3,974,914
ESRD rate in veterans, PM	562	626	609	620	651	662
Incident ESRD in U.S.	26,034	27,140	27,652	27,601	28,701	28,478
U.S. Population	33,669,357	34,868,475	36,779,047	38,074,477	38,586,011	39,311,771
ESRD rate in the U.S., PM	773	778	752	725	744	724
ESRD rate ratio (Vet: US)*	0.73	0.80	0.81	0.86	0.88	0.91

(d) Age Strata: 65-74 years

Calendar Year	2008	2009	2010	2011	2012	2013
Incident ESRD veterans	3,091	3,283	3,187	3,205	3,599	3,889
All veterans	4,148,773	4,152,473	4,299,538	4,418,566	4,787,653	4,715,285
ESRD rate in veterans, PM	745	791	741	725	752	825
Incident ESRD in U.S.	26,074	27,245	27,874	27,147	28,372	29,714
U.S. Population	20,098,221	20,781,497	21,856,930	22,488,128	23,998,113	25,216,766
ESRD rate in the U.S., PM	1,297	1,311	1,275	1,207	1,182	1,178
ESRD rate ratio (Vet: US)*	0.57	0.60	0.58	0.60	0.64	0.70

(e) Age Strata: 75+ years

Calendar Year	2008	2009	2010	2011	2012	2013
Incident ESRD veterans	5,773	5,695	5,703	5,200	5,074	4,865
All veterans	4,908,768	4,859,564	4,835,674	4,797,662	4,783,273	4,552,989
ESRD rate in veterans, PM	1,176	1,172	1,179	1,084	1,061	1,069
Incident ESRD in U.S.	28,854	29,389	29,475	28,597	27,993	27,757
U.S. Population	18,671,803	18,846,651	18,620,282	18,881,385	19,145,631	19,487,308
ESRD rate in the U.S., PM	1,545	1,559	1,583	1,515	1,462	1,424
ESRD rate ratio (Vet: US)*	0.76	0.75	0.75	0.72	0.73	0.75

*Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data, U.S. Census Bureau; data derived from U.S. veteran incident dialysis patients. *Veterans to U.S. rate ratios. Abbreviations: ESRD, end-stage renal disease; PM; per million.*

FIRST THREE MONTHS AFTER TRANSITION TO ESRD

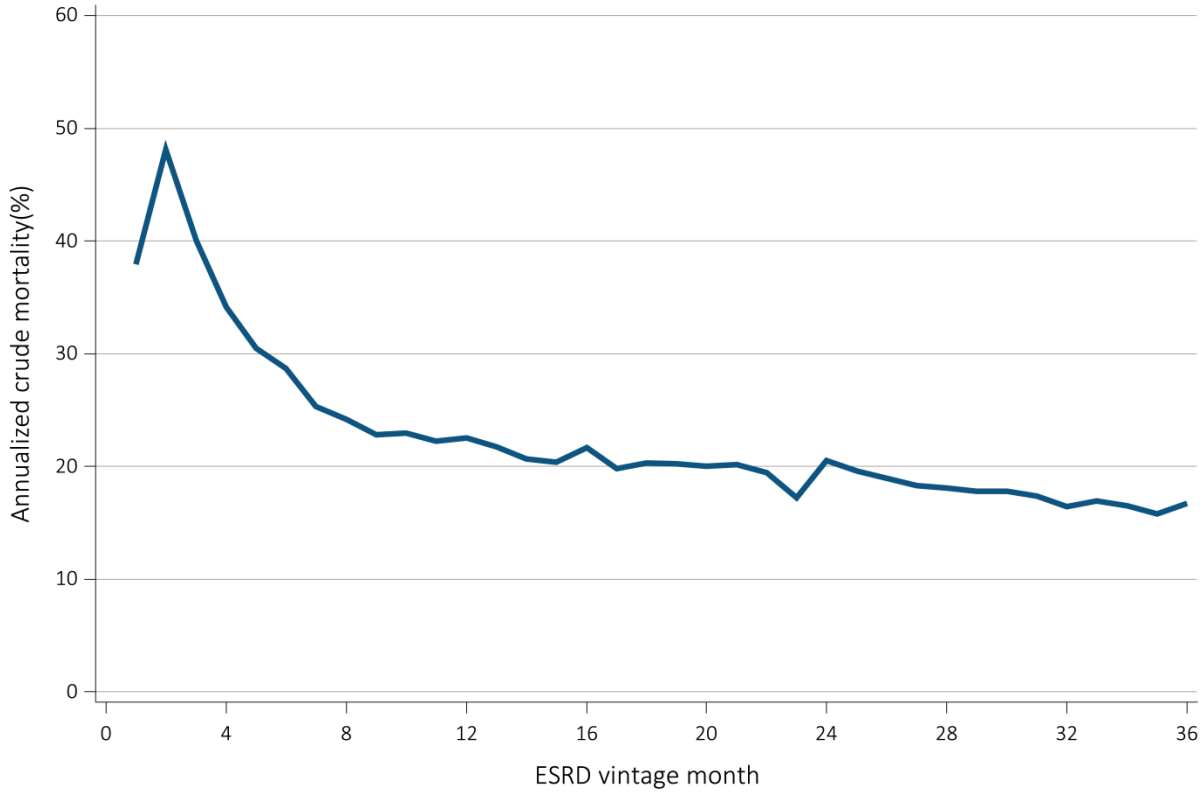
The status of incident ESRD veterans during the first three months upon transition to ESRD (10/1/2007-3/31/2014) is shown in Table 8.2. At ESRD service initiation, 81.4% and 6.1% of 85,505 veterans received in–center hemodialysis or peritoneal dialysis, respectively. After 90 days of ESRD service, 91.0% and 7.7% of all veterans receiving any dialysis treatment utilized in-center hemodialysis or peritoneal dialysis (n=72,128 veterans). There were 1.3 % (n=1133) registered preemptive kidney transplant recipients at ESRD service initiation. During the first three months of the transition to ESRD, 10.0% (n=8,562) died, 1.5% (n=1272) received a kidney transplant, and 3.6% (n=3,064) recovered from ESRD and stopped dialysis therapy. As shown in Figure 8.4, the crude annualized mortality rate among incident ESRD veterans was exceptionally high during the initial months after ESRD transition, and reflects the similar early excess mortality that is seen in the general ESRD population.

vol 1 Table 8.2. Status of 85,505 incident ESRD veterans on Day 1 and Day 90 after transition to ESRD, 10/1/2007-3/31/2014

	Day 1		Day 90	
Modality	**Frequency**	**%**	**Frequency**	**%**
Hemodialysis	69,625	81.4	65,636	76.8
Home Hemodialysis	571	0.7	587	0.7
Peritoneal Dialysis	5,187	6.1	5,562	6.5
Uncertain Dialysis	8,989	10.5	343	0.4
Transplant	1,133	1.3	1,272	1.5
Discontinued Dialysis			388	0.5
Death			8562	10.0
Lost to Follow-up			81	0.1
Recovered kidney Function			3,074	3.6
Total	85,505	100	85,505	100

*Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data . *Uncertain groups have no known dialysis modality,**n for outcomes is cumulative for subsequent periods after Day 1.*

vol 1 Figure 8.4 Annualized unadjusted mortality of incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2014 and who were followed for up to 36 months (N=85,505)



Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Abbreviations: ESRD, end-stage renal disease.

PRESCRIBED MEDICATIONS UPON TRANSITION TO ESRD

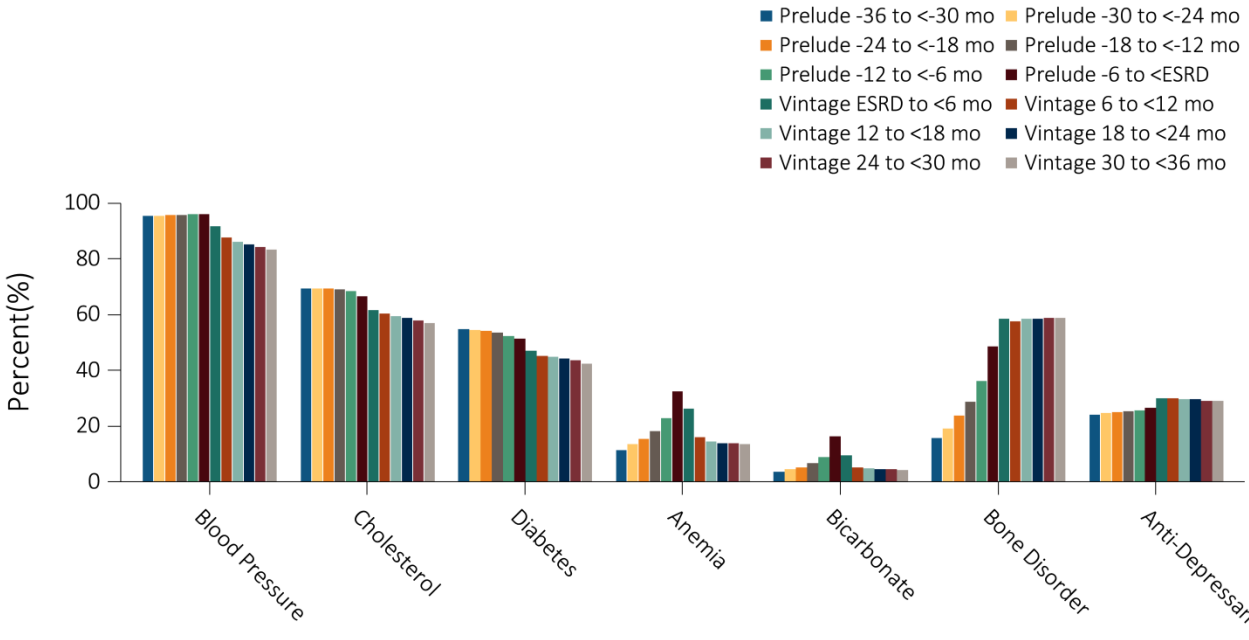
The veteran ESRD population utilizes a number of medications, and the patterns of medication use vary before (prelude), during, and after (vintage) transition to ESRD. Both VA prescription records and CMS Medicare Part D prescription records were used to describe medication use in 6-month intervals before (up to -3 years prelude), during, and after (up to +3 years vintage) ESRD transition. Seven groups of medications were analyzed, including (1) medication used for blood pressure management (alpha blockers, beta blockers, calcium channel blockers, potassium sparing diuretics, loop diuretics, RAAS inhibitors, thiazide diuretics, vasodilators, and central alpha agonists); (2) cholesterol lowering medications (statins and non-statin lipid lowering drugs); (3) diabetes medications (insulin and oral hypoglycemics); (4) anemia medications (erythropoietin stimulating agents [EPO] and iron); (5) mineral and bone disorder medications (native vitamin D, active vitamin D, calcium acetate, cinacalcet, lanthanum, sevelamer); (6) bicarbonate medication; and (7) antidepressants. As shown in Figure 8.5, over 90% of patients were prescribed blood pressure lowering medications in the last three years of the prelude period prior to ESRD transition, and this persisted at a slightly lower rate during and throughout the post-transition or vintage period. More granular data on trends in blood pressure medication type are presented in Figure 8.6a, where it is shown that RAAS inhibitors and loop diuretics were prescribed to over two-thirds of veterans during the prelude time, while the use of thiazides and potassium sparing and loop diuretics dropped dramatically after transition to ESRD.

Similarly decreasing trends in the post-transition period were seen for cholesterol lowering drugs and diabetic medications (Figure 8.5). The decrease in diabetic medication prescriptions appears to be driven by a drop in prescribing oral hypoglycemics in the

post transition period (Figure 8.6b). Mineral and bone disorder medications (including phosphorous binders) were prescribed at a low rate during the prelude to ESRD, but a major surge was observed in the final prelude months immediately prior to transition to ESRD, followed by a substantial rise during the vintage period. More granular data on trends in mineral and bone disorder medication type are presented in Figure 8.6c, which shows large surges in prescription of lanthanum and sevelamer after transition to ESRD, and that the calcimimetic agent cinacalcet was mostly prescribed in the vintage but not prelude period.

Both anemia (EPO and iron) and bicarbonate medications had a modest surge in prescription during ESRD transition and then rapidly declined post-transition (Figures 8.5 and 8.6b). However, it should be noted that data on EPO, iron, and active vitamin D medication use in the vintage period after the transition to ESRD were affected by these medications being administered in commercial dialysis clinics, and were therefore probably not well-captured by either the CMS or VA databases. Finally, approximately 22% of veterans received an antidepressant prescription during the prelude period. Antidepressant prescriptions slightly increased as patients approached ESRD transition, while rates increased approximately 3-5% to almost 30% of all veterans in the post-transition period.

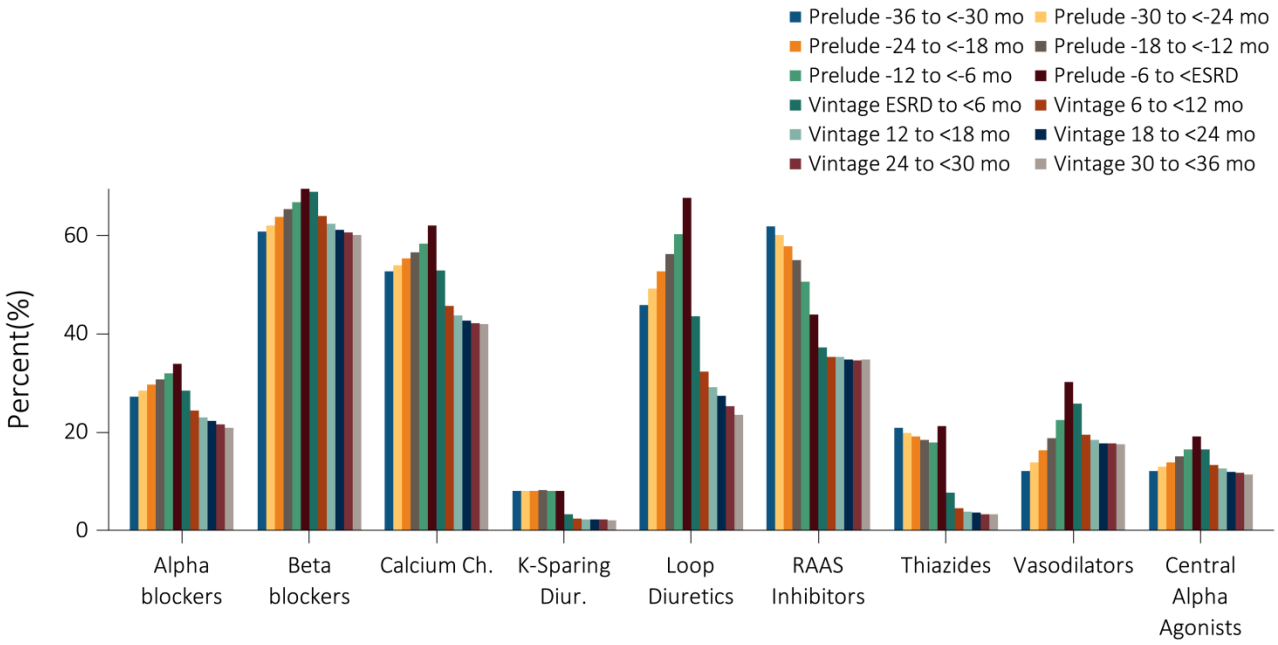
vol 1 Figure 8.5 Prescribed medication to incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2014, with data up to -36 months prior to transition (prelude) and up to +36 months after transition (vintage) (data were abstracted from 68,435 veterans)



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

vol 1 Figure 8.6 Granular Prescribed Medication Data for incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2014, with data up to -36 months prior to transition (prelude) and up to +36 months after transition (vintage) (data were abstracted from 68,435 veterans)

(a) Medications 1-9



(b) Medications 10-15

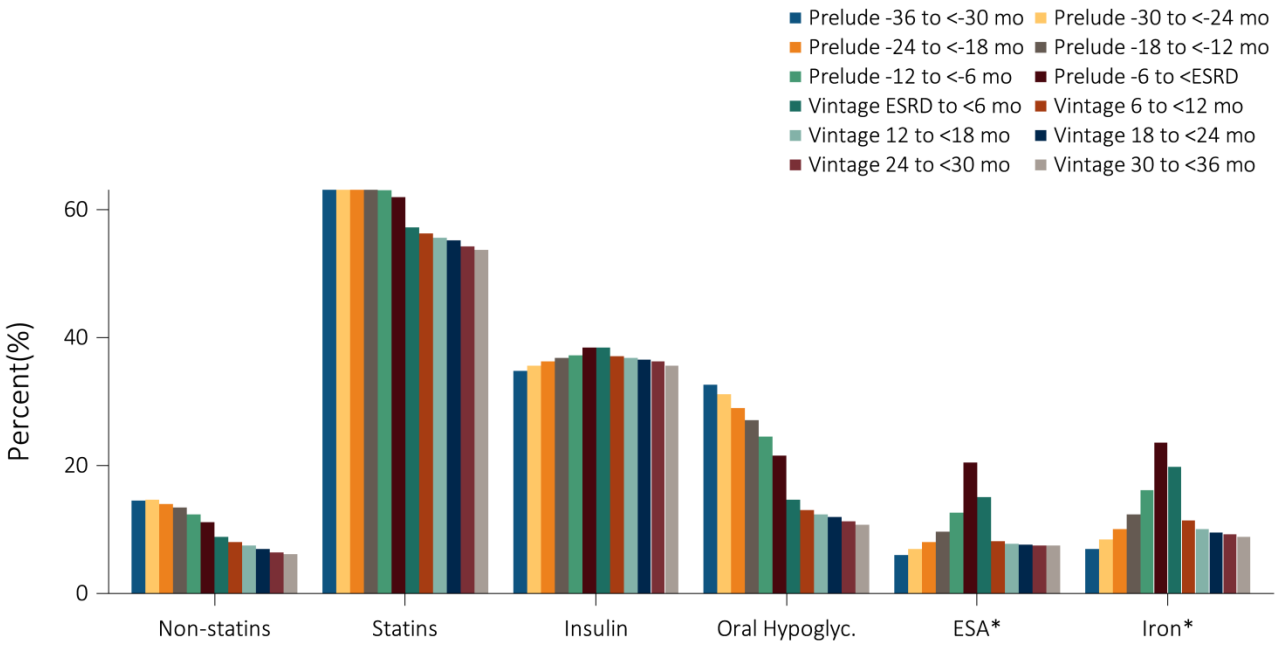
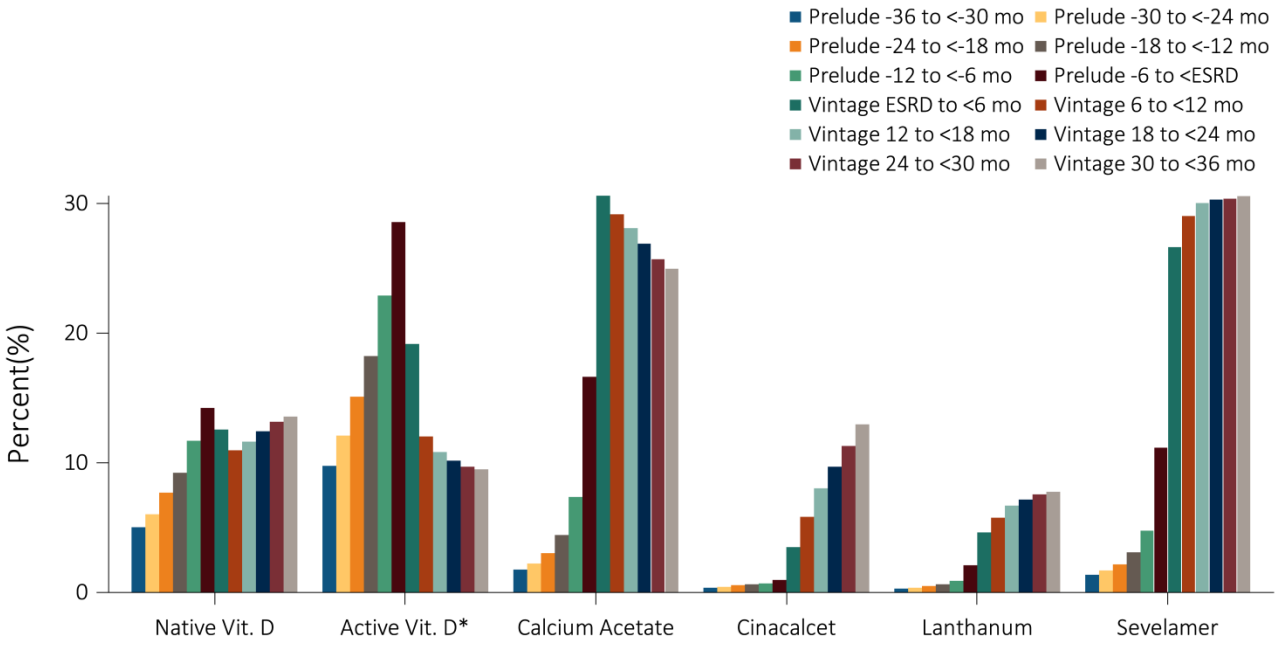


Figure 8.6 continued on next page.

vol 1 Figure 8.6 Granular Prescribed Medication Data for incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2014, with data up to -36 months prior to transition (prelude) and up to +36 months after transition (vintage) (data were abstracted from 68,435 veterans) *(continued)*

(c) Medications 16-21

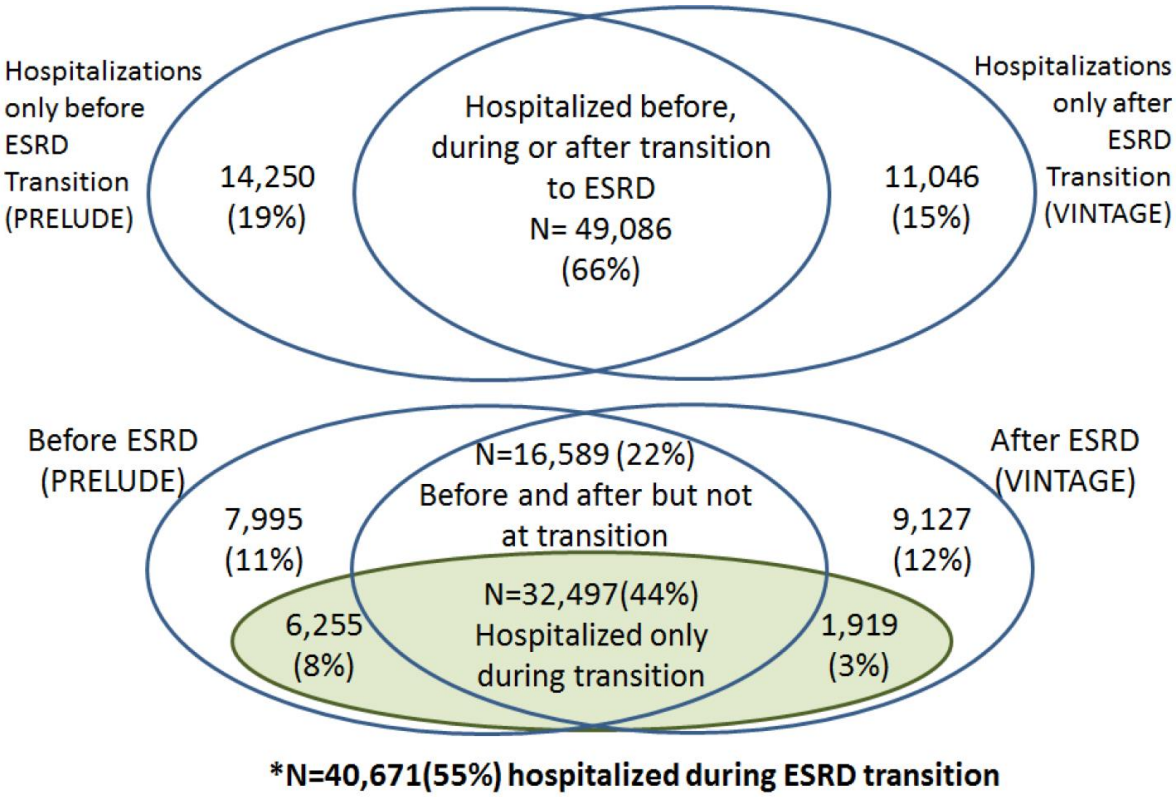


*Data source: VHA Administrative data, CMS Medicare Inpatient and Outpatient data. *Data on EPO, iron and active vitamin D medication use in the vintage period were affected by these medications being administered in commercial HD units and were therefore were probably not well-captured by either CMS or VA databases. Abbreviations: ESRD, end-stage renal disease; mo, month; Ch, channel, Hyperglyc, hyperglycemics; ESA, erythropoietin stimulating agents, Vit, vitamin.*

HOSPITALIZATION PATTERN DURING TRANSITION TO ESRD

Data on hospitalizations for the 85,505 veterans who transitioned to ESRD over 6.5 years (10/2007-3/2014) were collected from both inpatient and outpatient visits from VA, CMS Medicare, and USRDS data sources. There were 74,382 patients, or 87% of all 85,505 ESRD transitioning veterans, who were hospitalized at least once during a period of -5 years prior to (prelude) and +2 years after transition to ESRD (vintage). Figure 8.7 shows a Venn diagram of these hospitalization counts: 14,250(19%) veterans were hospitalized only before but not after, and 11,046 (15%) veterans were hospitalized only after but not before the transition to ESRD. Over 66% of the population ever hospitalized during this period were hospitalized both before and after transition to ESRD (N=49,086). There were 40,671 veterans (55%) who experienced the transition to ESRD while they were in the hospital, including 32,497 veterans (44%) who were hospitalized before, after, and during ESRD transition.

vol 1 Figure 8.7 Hospitalization events in 74,382 incident ESRD veterans who transitioned to ESRD during 10/1/2007-3/31/2014

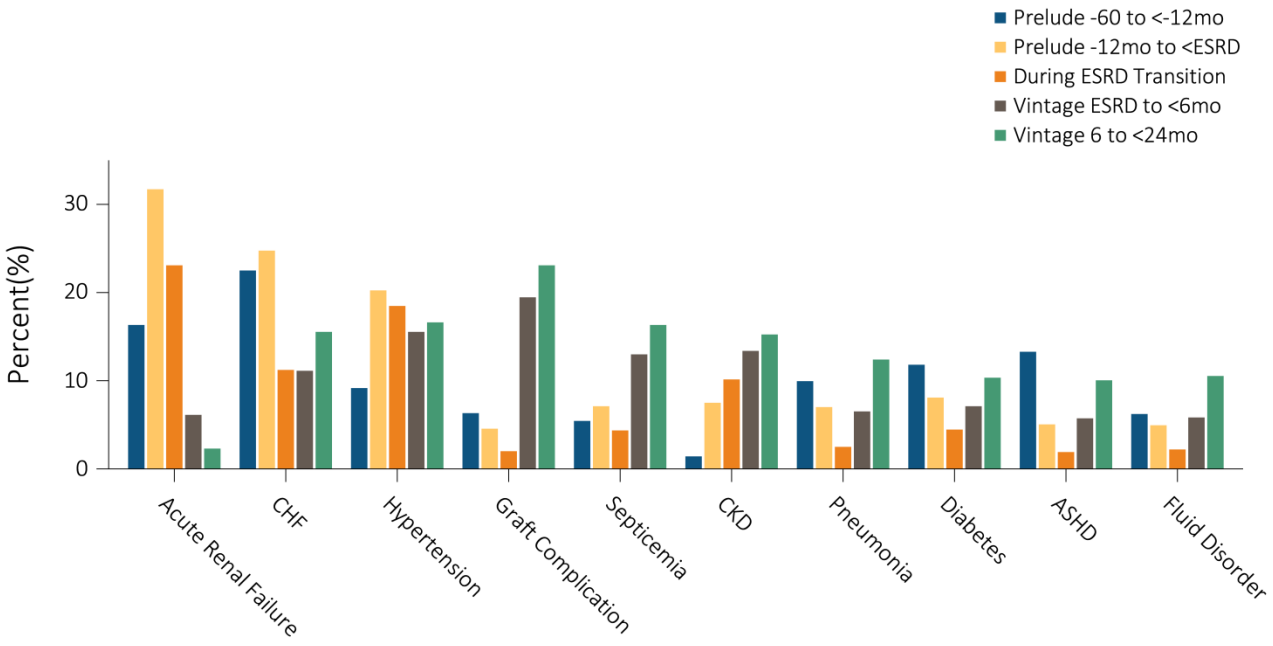


*Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. *Unique patients with an event during transition and before or after transition to ESRD. Data ranging from -60 months prior to transition (prelude) to +24 months after transition (vintage), Upper Venn diagram: Three major hospitalization categories; Lower Venn diagram: Focus of hospital events during transition to ESRD with shaded area showing patients whose transition to ESRD occurred in the hospital (n=40,671). Abbreviations: ESRD, end-stage renal disease.*

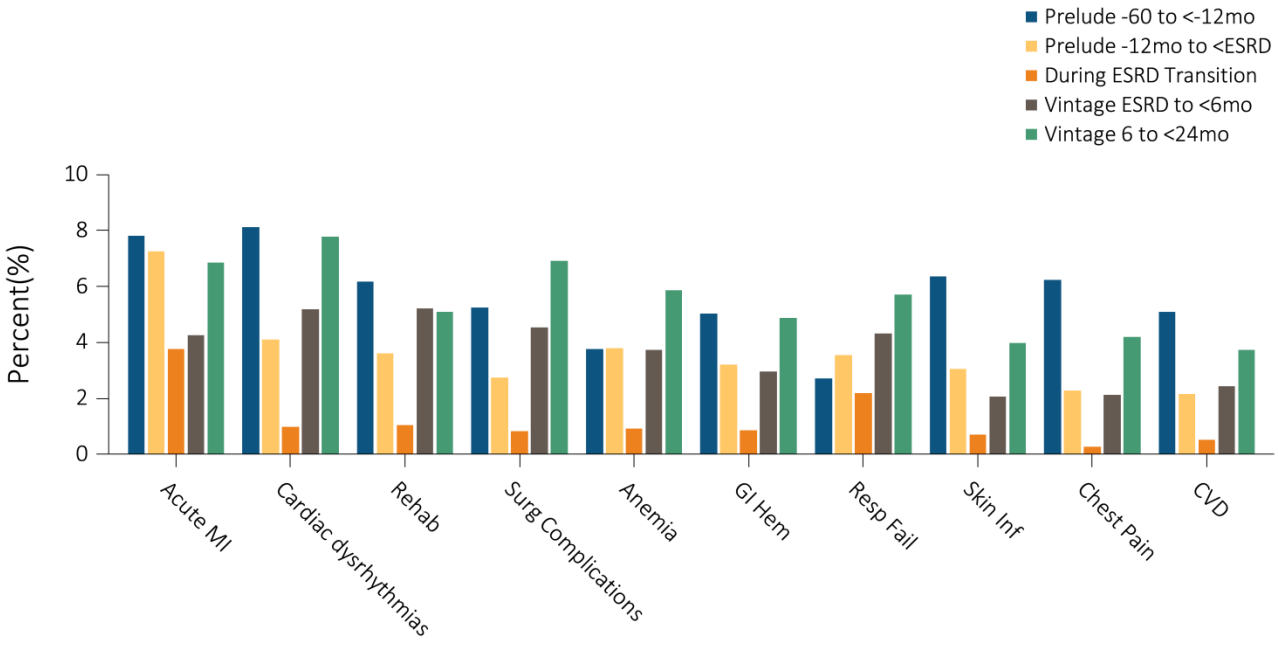
Cause-specific hospitalization events were also analyzed based on the primary diagnosis. Figure 8.8 shows the top 20 causes of hospitalization among 74,382 veterans who transitioned to ESRD over the 6.5-year period (10/2007-3/2014), and who had at least one hospitalization event from -5 years prelude to +2 years vintage surrounding the transition intercept. These hospitalizations were then divided into five temporal categories, including two prelude periods (the final 12 months of prelude and the time prior to these 12 months, where the patient discharge day was considered as prior to the transition to ESRD), two vintage categories (the first six months of ESRD, and thereafter, where the admission day was after transition to ESRD), and finally the fifth group consisting of the hospitalization that included the ESRD initiation event or preemptive kidney transplantation, i.e., any hospitalization that began in the prelude and ended in the vintage. The top 20 causes of hospitalization included acute kidney injury, congestive heart failure (CHF), HTN, dialysis access complications (graft complication), septicemia, chronic kidney disease (CKD), pneumonia, diabetes, atherosclerotic heart disease (ASHD), fluid overload (fluid disorder), acute myocardial infarction (acute MI), cardiac arrhythmias rehabilitation, surgery (surgical complication), anemia, gastrointestinal (GI) hemorrhage, respiratory failure, skin infection (skin inf.), chest pain, and cerebrovascular disease (CVD). Of note, septicemia-related hospital events increased dramatically after ESRD transition. The most common causes of hospital admission that also consisted of the ESRD transition day included acute kidney injury, HTN, CHF, and CKD.

vol 1 Figure 8.8 Top 20 causes of hospitalizations in 74,382 incident ESRD veterans who were hospitalized at least once during the 60 months prior to ESRD transition (prelude) up to 24 months after ESRD transition (vintage).

(a) Causes 1-10



(b) Causes 11-20



Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Abbreviations: ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVD, acute cerebrovascular disease; ESRD, end-stage renal disease; GI Hem, gastrointestinal hemorrhage; MI, myocardial infarction; mo, month; Resp Fail, respiratory failure; Skin Inf, skin infection; surg, surgical.

Hospitalization events during each of the five aforementioned periods are ranked in Table 8.3. Congestive heart failure (CHF) and acute kidney injury were the most common reasons for hospital admission prior to ESRD transition, whereas dialysis access complications were the most common cause after ESRD transition. For hospitalizations that included the ESRD transition events, acute kidney injury (AKI) was the leading cause.

vol 1 Table 8.3. Ranking of the top 20 causes of hospitalization in 74,382 incident ESRD veterans who were hospitalized at least once during the period of -60 months prior to transition (prelude) to +24 months after transition (vintage)

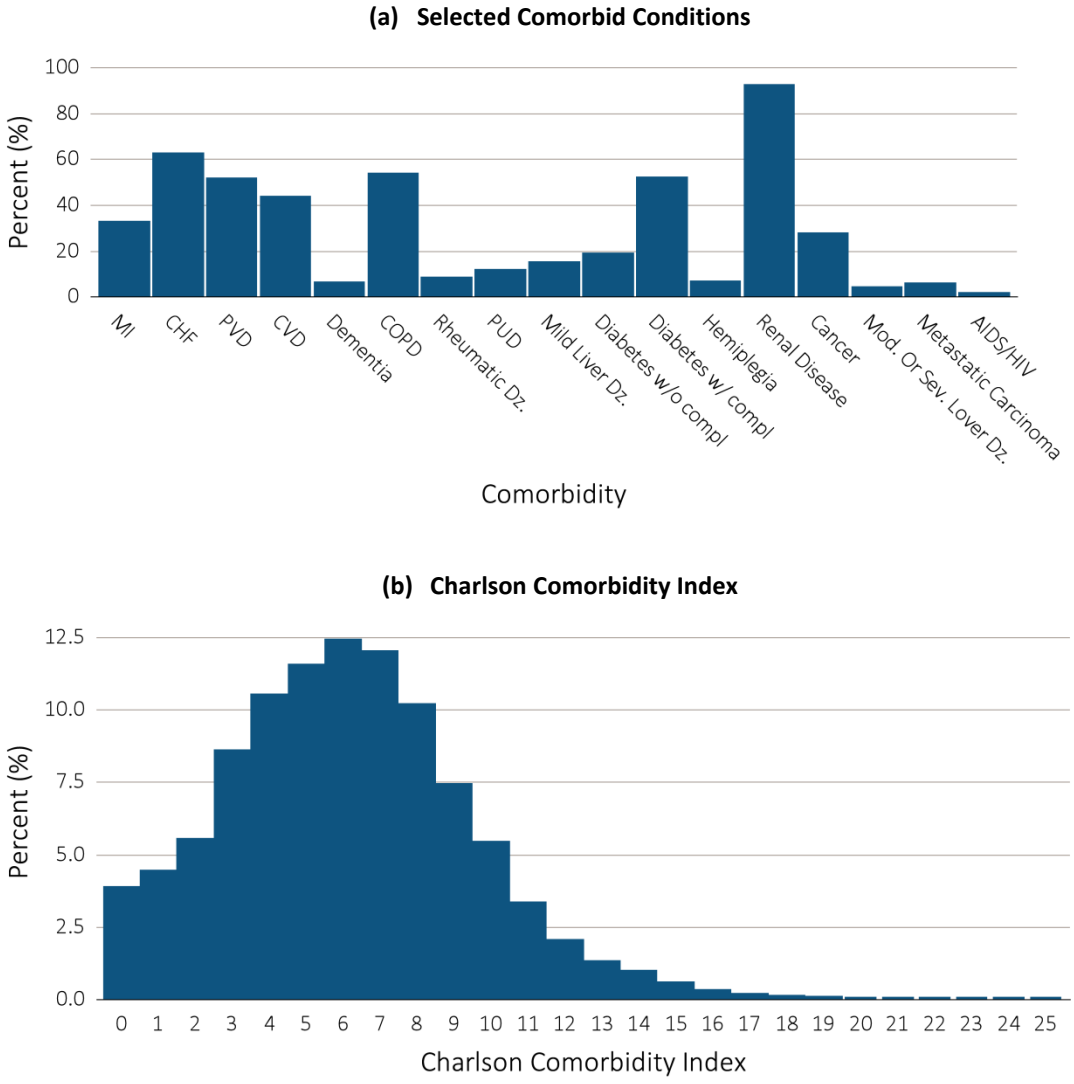
Reason	Whole Cohort	Prelude -60 mo. to <-12 mo.	Prelude -12 mo. to <ESRD	During ESRD Transition	Vintage ESRD to <6 mo.	Vintage 6 mo. to <24 mo.
Acute Renal Failure	**1**	2	**1**	**1**	8	
CHF	2	**1**	2	3	5	4
Hypertension	3	6	3	2	2	2
Graft Complication	4	12	11	11	**1**	**1**
Septicemia	5	14	7	6	4	3
CKD	6		6	4	3	5
Pneumonia	7	5	8	8	7	6
Diabetes	8	4	4	5	6	8
ASHD	9	3	9	12	10	9
`Fluid Disorder	10	13	10	10	9	7
Acute MI	11	8	5	7	15	12
Cardiac dysrhythmias	12	7	12	14	12	10
Rehab	13	11	14	13	11	15
Surgical Complications	14	15	19	17	13	11
Anemia	15		13	15	16	13
GI Hem	16	17	16	16	18	16
Respiratory Fail	17		15	9	14	14
Skin Infection	18	9	17	18		
Chest Pain	19	10				19
CVD	20	16				
COPD		18			18	
Urinary Tract Infection		20		19		
Osteoarthritis						
Aortic; peripheral; and visceral			19			
Heart valve disorders			20			
Other circulatory disease				17	17	
Other nervous system disorders					20	

Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Abbreviations: ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVD, acute cerebrovascular disease; ESRD, end-stage renal disease; GI Hem, gastrointestinal hemorrhage; MI, myocardial infarction; mo, month.

Comorbid Conditions upon Transition to ESRD

Data related to comorbid conditions were obtained from multiple VA and CMS sources, and were based on ICD-9 diagnoses. After merging data from all sources, 82,598 veterans (96.6%) were identified as being diagnosed with at least one comorbid condition in the prelude period. Figure 8.9 (upper panel) shows the most common comorbidities among these veterans prior to transition to ESRD; the comorbidity list is restricted to those used for the calculation of Charlson Comorbidity Index (Deyo method), as shown in Figure 8.9 (lower panel). The calculation of the Charlson Comorbidity Index excluded renal disease from the score [See the Kaiser Permanente-Southern California Section of this chapter for Charlson Comorbidity Index equation and score calculation used]. In addition to renal disease, CHF, diabetes, chronic obstructive pulmonary disease, and peripheral vascular disease were present in over half of the veterans. Of note, almost a quarter of all patients had a prior diagnosis of cancer and over 30% had a prior myocardial infarction.

vol 1 Figure 8.9 Selected comorbid conditions (a) for calculation of the Charlson Comorbidity Index (b) prior to transition to ESRD in 82,598 incident ESRD veterans

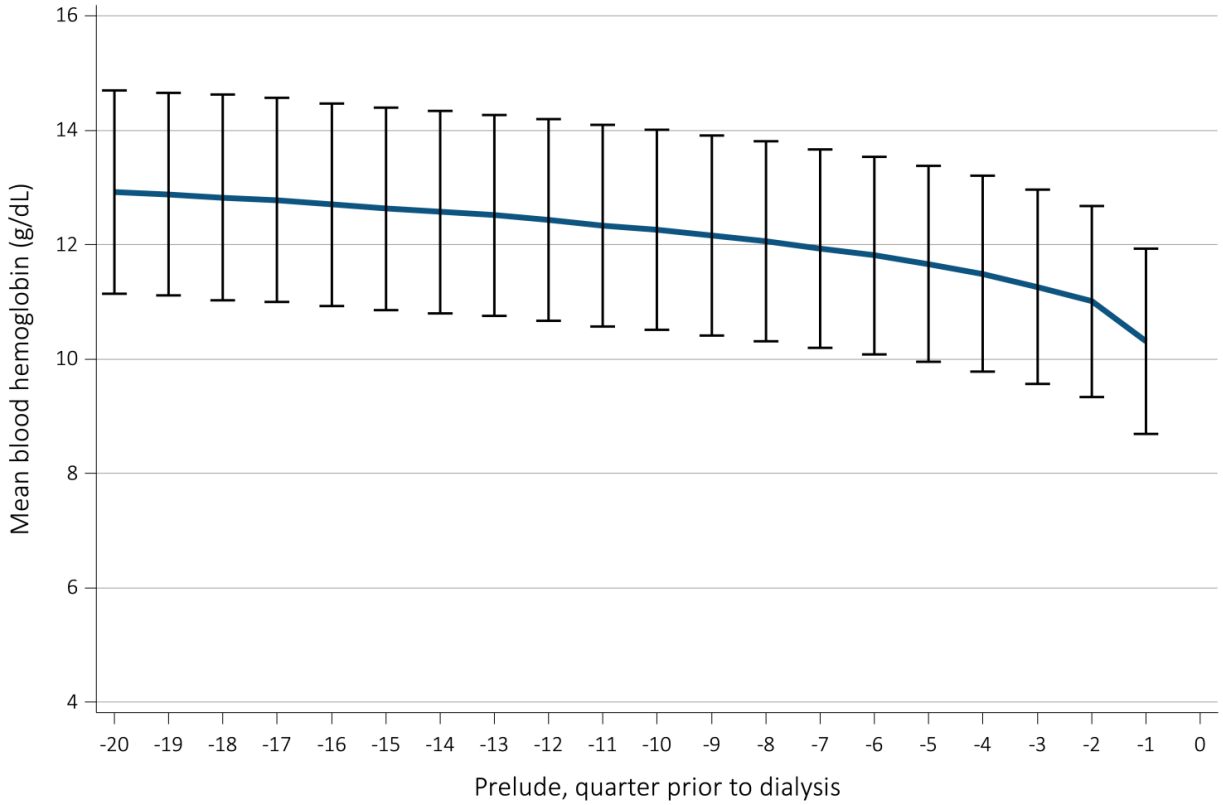


Data source: VHA Administrative data, CMS Medicare Inpatient and Outpatient data. Abbreviations: CHF, congestive heart failure; compl, complications; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; Dz, disease; ESRD, end-stage renal disease; MI, myocardial infarction; Mod, moderate; PVD, peripheral vascular disease; PUD, peptic ulcer disease; Set, Severe.

Trends during Prelude Period (Prior to ESRD Transition)

Selected prelude (pre-ESRD) trends in laboratory data for up to 5 years prior to transition are shown below. Figure 8.10 shows the pre-ESRD trend in average blood hemoglobin in 47,854 veterans who transitioned to ESRD over 20 calendar quarters, or 5 years. Mean blood hemoglobin dropped from 13 g/dL to below 11 g/dL over the prelude period of progression from CKD to ESRD.

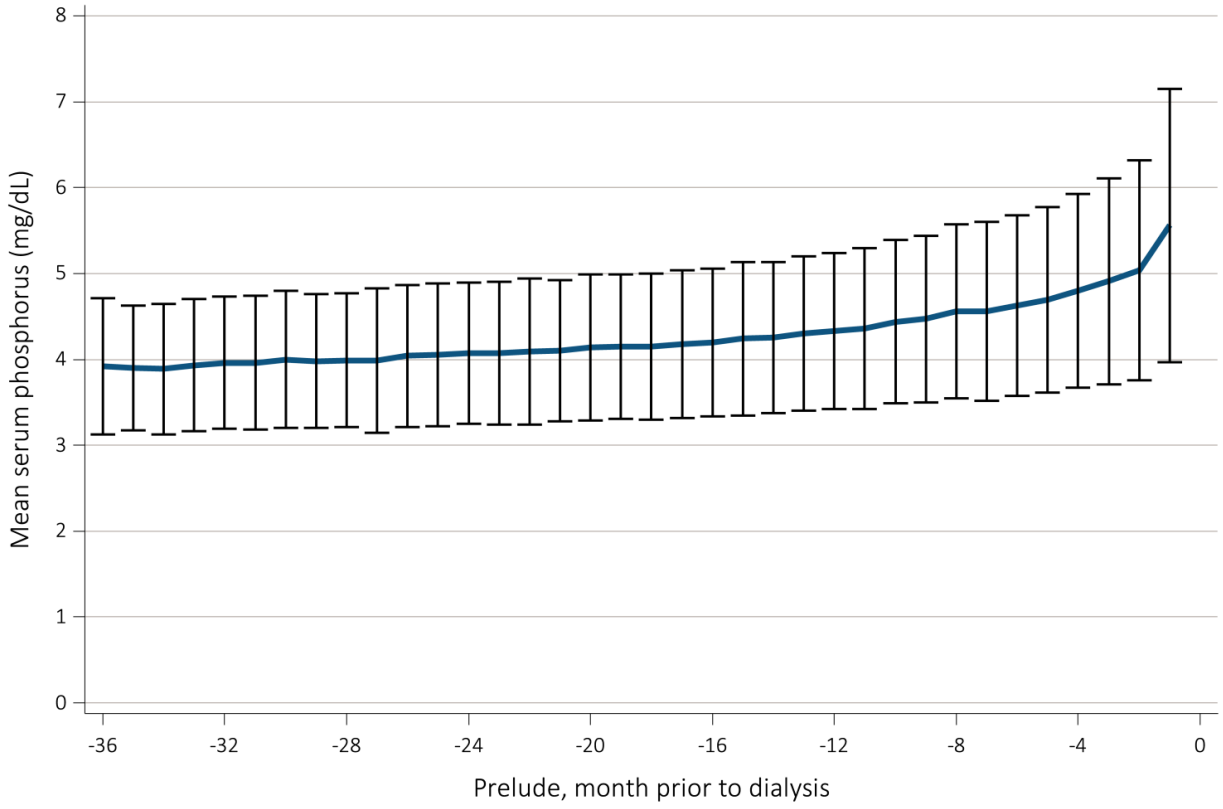
vol 1 Figure 8.10 Trend in blood hemoglobin level during the prelude (pre-ESRD) time over 20 calendar quarters in 47,854 veterans who later transitioned to ESRD during 10/1/2007-3/31/2014.



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

Figure 8.11 shows the pre-ESRD trend in averaged serum phosphorus in 24,765 veterans who transitioned to ESRD over 36 months or 3 years. Serum phosphorus increased from 4 to above 5.5 mg/dL immediately prior to transition to ESRD.

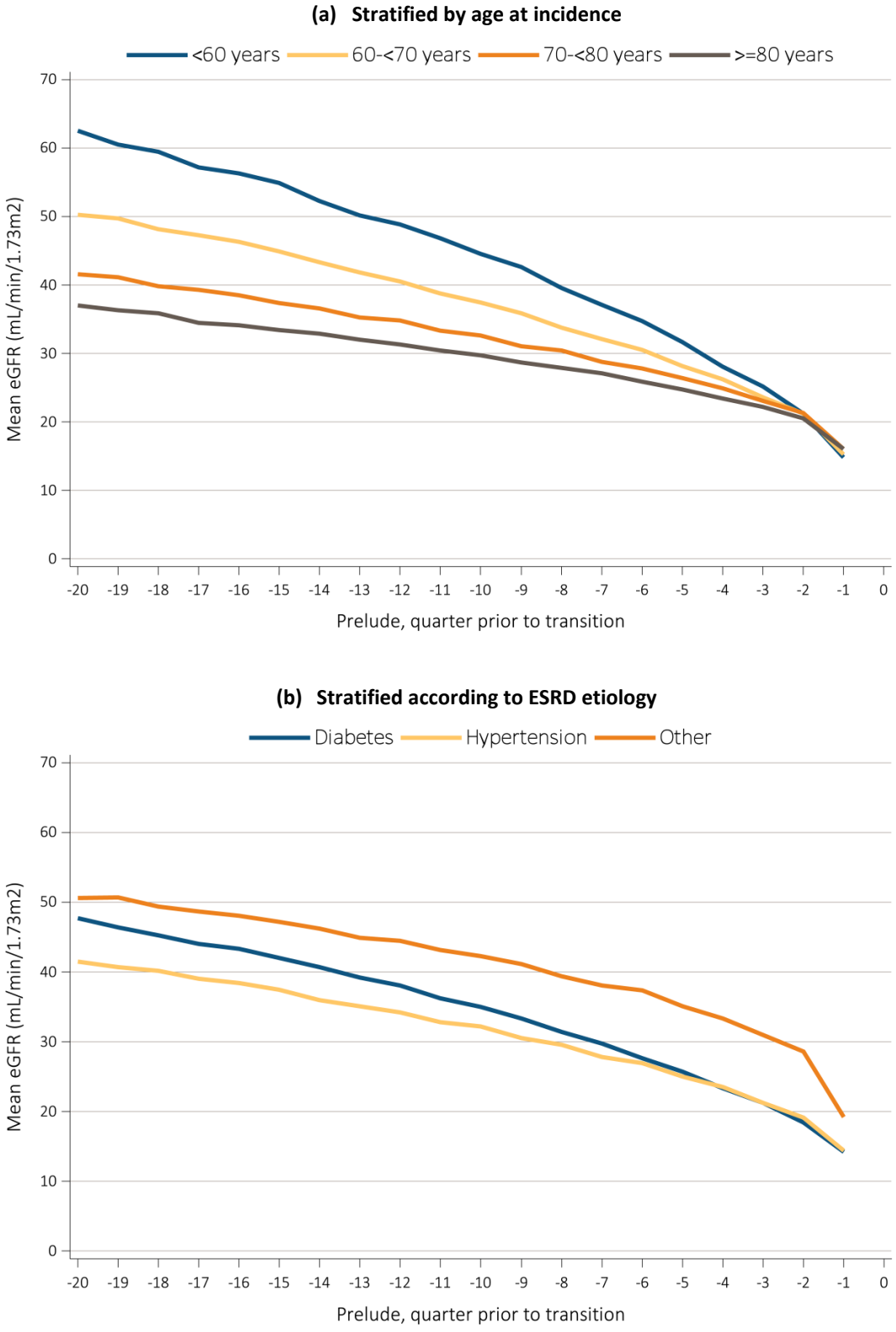
vol 1 Figure 8.11 Trend in serum phosphorus level during the prelude (pre-ESRD) time over 36 months in 24,765 veterans who transitioned to ESRD during 10/1/2007-3/31/2014.



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

Figure 8.12 shows the pre-ESRD trends in average eGFR calculated by the CKD-EPI creatinine equation for 49,871 veterans who transitioned to ESRD over 20 calendar quarters (5 years), stratified by age and cause of ESRD. Panel a shows that CKD patients who transition at an older age have slower rate of progression than younger patients. Panel b suggests that those with diabetes as a cause of ESRD have a faster CKD progression.

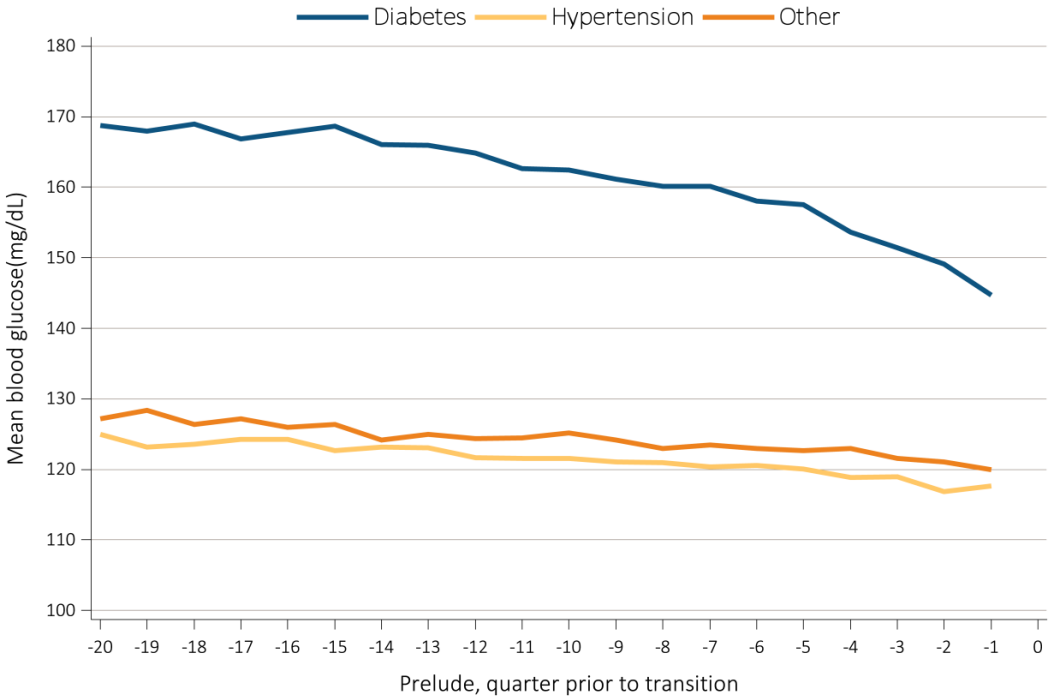
vol 1 Figure 8.12 Trends in eGFR during the prelude (pre-ESRD) time over 20 calendar quarters in 49,871 veterans who transitioned to ESRD during 10/1/2007-9/31/2011.



Data source: VHA Administrative data, USRDS ESRD Database. Abbreviations: eGFR; estimated glomerular filtration rate ;ESRD, end-stage renal disease; mL/min/1.73m2, milliliter per minute per 1.73 meters squared.

Figure 8.13 shows the pre-ESRD trend in glucose level by ESRD-reason for 49,608 veterans who transitioned to ESRD over 20 calendar quarters, or 5 years. Patients whose ESRD was due to diabetes appeared to exhibit a gradual fall in serum glucose over time, as their CKD progressed to ESRD. Blood glucose levels did not change among patients whose ESRD was not due to diabetes.

vol 1 Figure 8.13 Trend in blood glucose level during the prelude (pre-ESRD) time over 20 calendar quarters in 49,608 veterans who transitioned to ESRD during 10/1/2007-3/31/2014.



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

Data from Kaiser Permanente of Southern California

California is the most populous (38 million) and racially/ethnically diverse U.S. state. Southern California (SC) is the most populous mega-region of California with 23 million people (60% of California's population), and bears four of the nation's 50 most populated cities (Los Angeles, San Diego, Fresno, and Long Beach). It encompasses the Los Angeles Metropolitan region (including Los Angeles and Orange Counties combined, with >17 million people) and is the fifteenth largest economy in the world. In addition to substantial socioeconomic diversity, SC has remarkable racial/ethnic diversity (38% Hispanics, 9% non-Hispanic Asians, and 8% non-Hispanic Blacks). Kaiser Permanente of Southern California (KP-SC) is an integrated health care system that provides comprehensive health services for approximately four million residents of Southern California. KP-SC is the largest Kaiser Permanente (KP) region. Table 8.4 shows the demographic characteristics of the KP-SC member population compared to the 2010 US census and California populations. Proportion of males to females as well as distribution by age appears similar to both US census and California specific populations. Proportion of Hispanic patients matches that of the California specific total population. KP-SC has a larger proportion of non-Hispanic Black and a smaller proportion of Asian patients in comparison to the California total population.

vol 1 Table 8.4. Demographic characteristics of the Kaiser Permanente Southern California member population compared to the 2010 US census and California populations

		KPSC* (%)	US census 2010 (%)	California 2010 (%)
Sex				
	Male	48.2	49.2	49.7
	Female	51.8	50.8	50.3
Age				
	Under 5 years	5.7	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	11.4
Ethnicity				
	Hispanic	37.2	16.3	37.6
	Non-Hispanic	52.9	83.7	62.4
	Unknown	9.9		
Race				
	White	47.1	74.8	61.6
	Black	9.7	13.6	7.2
	Native American Indian and Alaska	0.4	1.7	1.9
	Asian	8.9	5.6	14.9
	Others	6.9		18.9
	Unknown	27.1		

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

TRANSITION TO ESRD IN KAISER PERMANENTE OF SOUTHERN CALIFORNIA

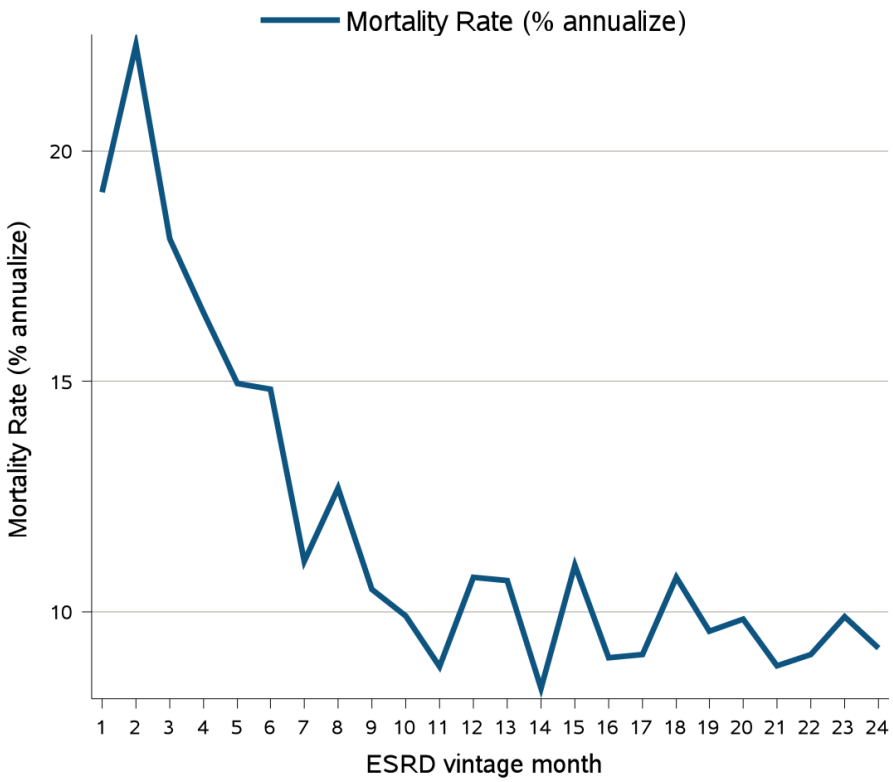
The Kaiser Permanente transition to ESRD (TC-CKD) database is maintained by the KP-SC Renal Business Group, in which all members undergoing dialysis or transplantation were tracked through the health system's Renal Program, and regularly reconciled with internal dialysis unit census and outside claims[7]. Patients' demographic information—including race, ethnicity, sex, and zip code—were linked to the KP-SC Membership and Benefit Research Data Warehouse created by the Research and Evaluation (R&E) Department, which mainly relies on four KP systems: Operational Data Store (ODS), HealthConnect (HC), Enhanced Prenatal Services System (PSS), and Membership Extract Enrollment Management (MXEM). Other data such as socioeconomic information (education and household income) were collected from the KP-SC Geocoding database created by the R&E Department, in which three sources from U.S. Census, Claritas (i.e. Nielsen), and American Community Survey (ACS) five-year summary were combined. Mortality data of the ESRD population were obtained from the KP-SC Mortality database, which combines multiple data sources, including 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 seven years between 01/01/2007 and 12/31/2013, a total of 8,038 KP-SC members transitioned to ESRD. They were 62.5 ± 14.7 years old (mean ± SD) and included 4,664 (58.0%) men and 3,374 (42.0%) women. Race/ethnic groups included non-Hispanic whites (2403, 29.9%), Blacks (1703, 21.2%), Asians (816, 10.2%), Hispanics (2866, 35.7%), and those of other race (250, 3.1%). According to SCPMG Renal program records, the cause of ESRD was diabetes in 4,189 (50.4%) patients and HTN in 1,488 (18.5%). At transition to ESRD, 6,806(84.6%) started on in-center HD, 1,030 (12.8%) started on PD (CAPD and CCPD), and 23 (0.3%) started on home hemodialysis. Among 6,829 patients starting on HD at transition, arteriovenous (AV) fistula was used in 2,428 (35.7%) and AV graft was used in 231 (3.4%) patients for initial dialysis access. Pre-emptive transplant occurred in 156 (1.9%) at transition. During the first three months, 392 (4.9%) of all incident ESRD patients died.

OUTCOMES OF KAISER PERMANENTE SOUTHERN CALIFORNIA PATIENTS WHO TRANSITIONED TO ESRD

The annualized mortality rates among the 8,038 incident dialysis patients over the first 24 months of the vintage are depicted in Figure 8.14. The higher mortality rates in the first several months bear resemblance to that observed among veterans with incident ESRD and the U.S. ESRD population, overall.

vol 1 Figure 8.14 Annualized unadjusted mortality rate of the 8,038 incident ESRD patients who transitioned to ESRD during 1/1/2007-12/31/2013 who were followed for up to 24 months (N=8,038)

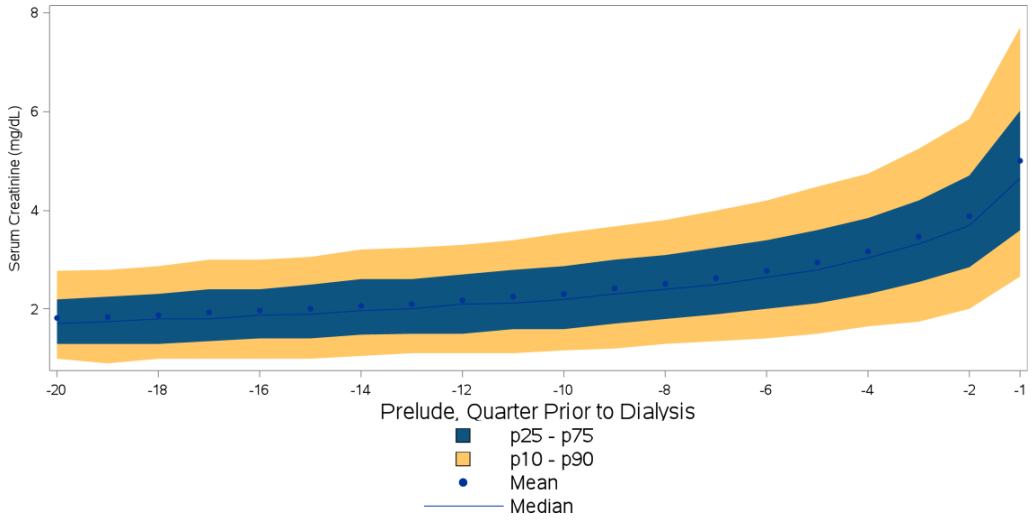


Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease.

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

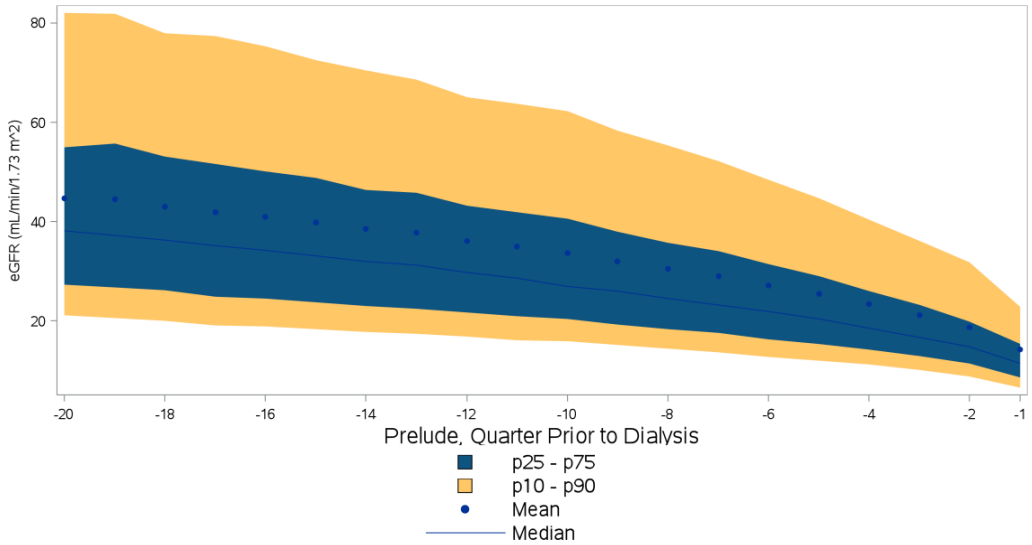
These data were extracted from the KP-SC Laboratory database which tracks inpatient and outpatient laboratory orders and results, spanning over 20 years. Figures 8.15 and 8.16 show prelude variables (including serum creatinine and eGFR) averaged by 91 day quarters (n=20 quarters) among the 7,885 patients who transitioned to dialysis. Age-stratified eGFR trend over 20 quarters shows that older CKD patients had a slower progression rate than younger patients (Figure 8.17).

vol 1 Figure 8.15 Trend in serum creatinine level during the prelude (pre-ESRD) period over 20 calendar quarters among 7,885 patients who transitioned to dialysis during 1/1/2007-12/31/2013



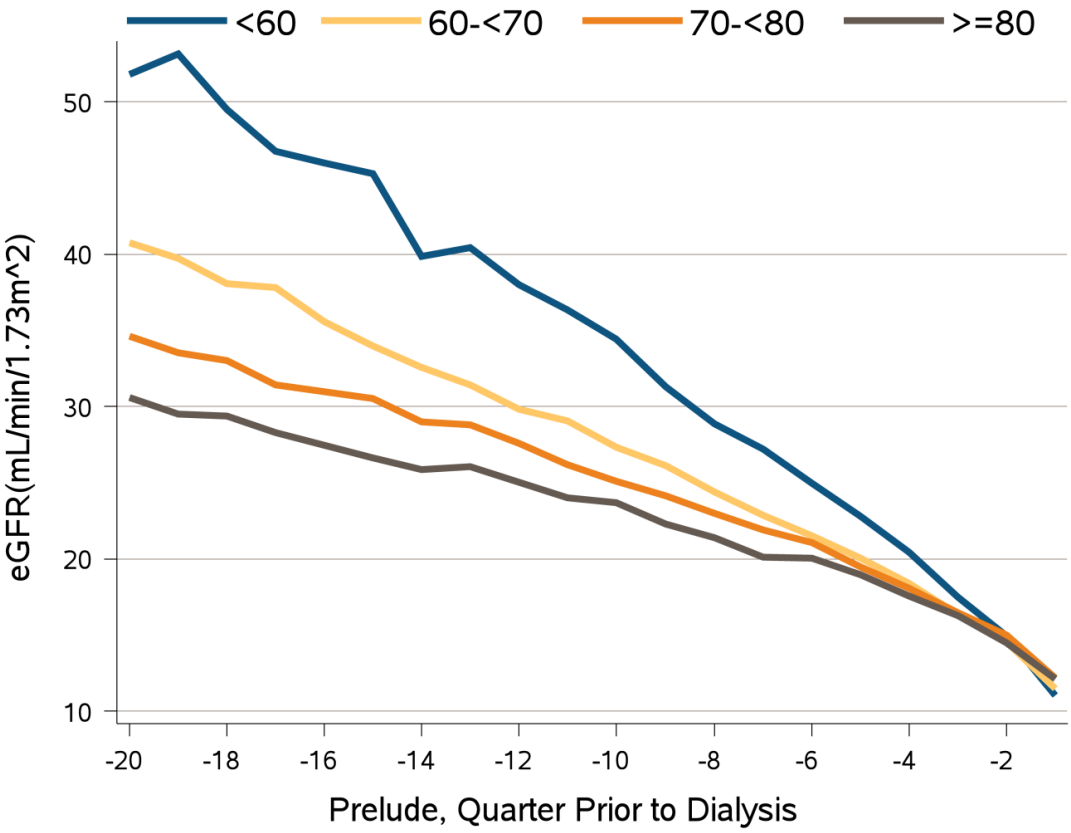
Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: ESRD, end-stage renal disease; mg/dL, milligrams per deciliter; p, percentile.

vol 1 Figure 8.16 Trend in eGFR during the prelude (pre-ESRD) period over 20 calendar quarters among 7,885 patients who transitioned to dialysis during 1/1/2007-12/31/2013



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

vol 1 Figure 8.17 Age-at-incidence stratified trends in eGFR during the prelude (pre-ESRD) period over 20 calendar quarters among 7,885 patients who transitioned to dialysis during 1/1/2007-12/31/2013

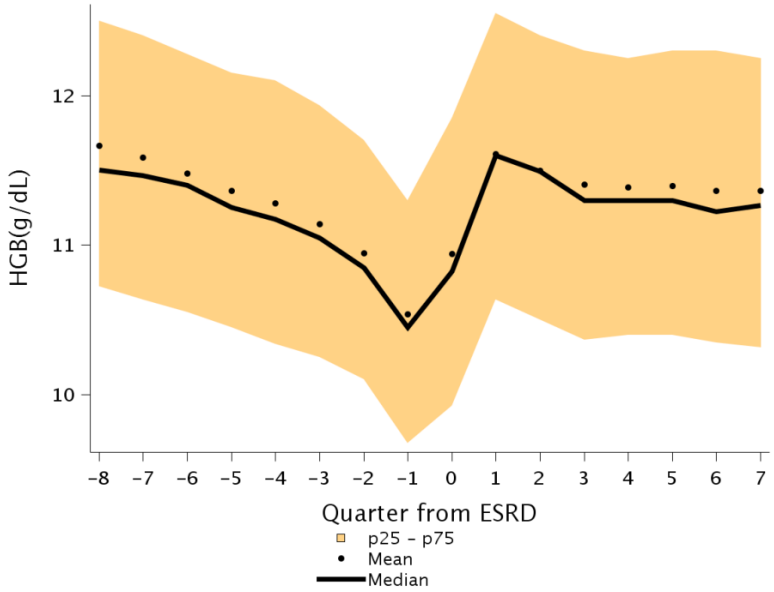


Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: eGFR; estimated glomerular filtration rate ;ESRD, end-stage renal disease; mL/min/1.73m2, milliliter per minute per 1.73 meters squared.

Among the 8,038 patients who transitioned to ESRD, the next set of figures show selected KP-SC laboratory data for hemoglobin, HbA1C, phosphorus, parathyroid hormone (PTH) and albumin levels during the prelude (pre-ESRD) and vintage (post-ESRD) periods over eight prelude (quarters -8 to -1) and eight vintage (quarters 0 to +7) calendar quarters (see Figure 8.18, 8.19, 8.20, 8.21 and 8.22 respectively).

Mean hemoglobin gradually decreased from 11.66 g/dL to a nadir of 10.54 g/dL in the prelude period of progression from CKD to ESRD. Immediately after transition to ESRD, a slight increase is mean hemoglobin to 10.94 g/dL was observed in the first quarter (quarter 0), followed by a rise to a peak of 11.60 g/dL in the second quarter (quarter 1). Subsequent mean hemoglobin in vintage quarter 3 and later appeared fairly stable (Figure 8.18).

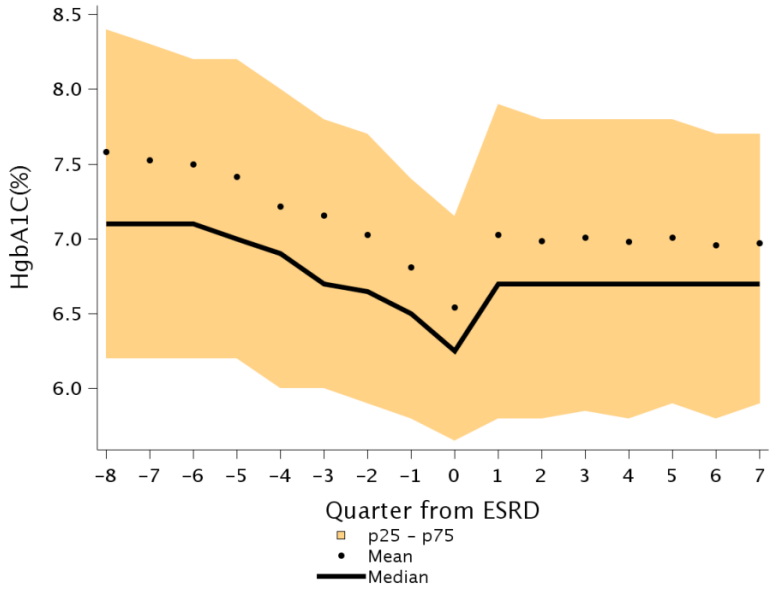
vol 1 Figure 8.18 Trend in hemoglobin levels (g/dL) over 8 calendar quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 8,038 patients who transitioned to ESRD during 1/1/2007-12/31/2013



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

In Figure 8.19, mean HbA1C levels dropped from 7.58% to 6.81% in the prelude period, then slightly decreased even further from 6.81% to 6.54% immediately after transition to ESRD. In the second quarter post transition, mean HbA1c levels rose to 7.03% and remained fairly stable afterwards in the vintage period.

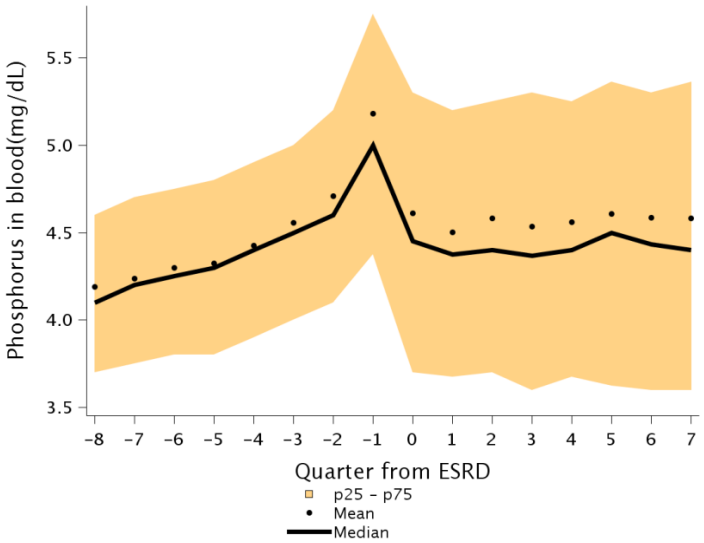
vol 1 Figure 8.19 Trend in HgbA1C levels (% of total Hgb) over 8 calendar quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 8,038 patients who transitioned to ESRD during 1/1/2007-12/31/2013



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: HbA1C, hemoglobin A1C; Hb, hemoglobin; ESRD, end-stage renal disease ; p, percentile.

Mean phosphorus increased in the prelude period from 4.19 mg/dL to 5.18 mg/dL (Figure 8.20). Immediately after transition to ESRD, mean phosphorus decreased from 5.18 mg/dL to 4.61 mg/dL and remained fairly stable in the vintage period.

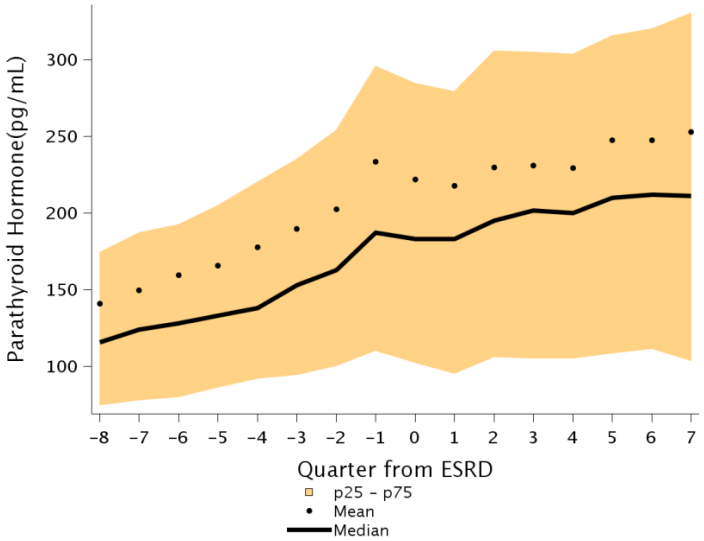
vol 1 Figure 8.20 Trend in phosphorus levels (mg/dL) over 8 calendar quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 8,038 patients who transitioned to ESRD during 1/1/2007-12/31/2013



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

Figure 8.21 shows mean parathyroid hormone (PTH) steadily increasing over the prelude and vintage periods from 141.18 pg/mL to 252.84 pg/mL. Transition to ESRD did not appear to modify the increase trajectory of PTH over time.

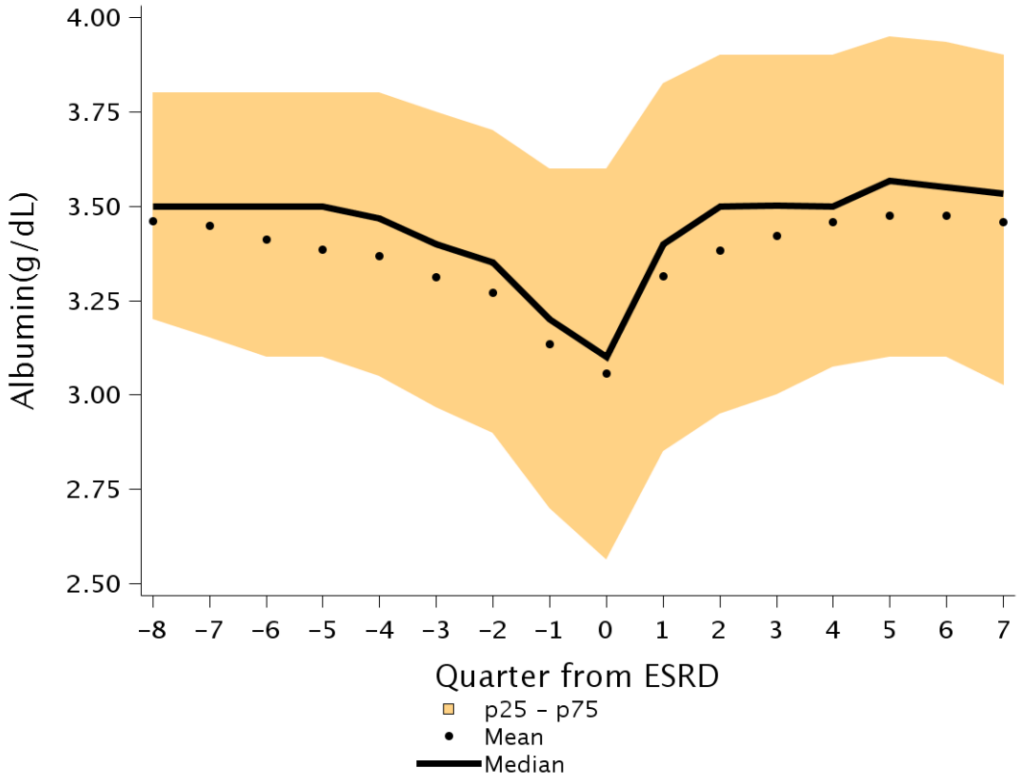
vol 1 Figure 8.21 Trend in PTH levels (pg/mL) over 8 calendar quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 8,038 patients who transitioned to ESRD during 1/1/2007-12/31/2013



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

Mean albumin dropped from 3.46 g/dL to 3.06 g/dL over the prelude period and until the first quarter post transition to ESRD, but increased to 3.31 g/dL in the second vintage quarter and subsequently remained stable over the following vintage period (Figure 8.22).

vol 1 Figure 8.22 Trend in albumin levels (g/dL) over 8 calendar quarters each in the prelude (pre-ESRD) and vintage (post-ESRD) periods among 8,038 patients who transitioned to ESRD during 1/1/2007-12/31/2013



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

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. A macro originally developed at Manitoba Centre for Health Policy (MCHP) website was used to estimate Charlson Comorbidity Index (CCI) scores (see Figure 8.23). A revised, weighted Charlson Comorbidity Index (CCI) score that excluded renal disease was calculated according to the formula below:

CCI = 1* Myocardial Infarction + 1* Congestive 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

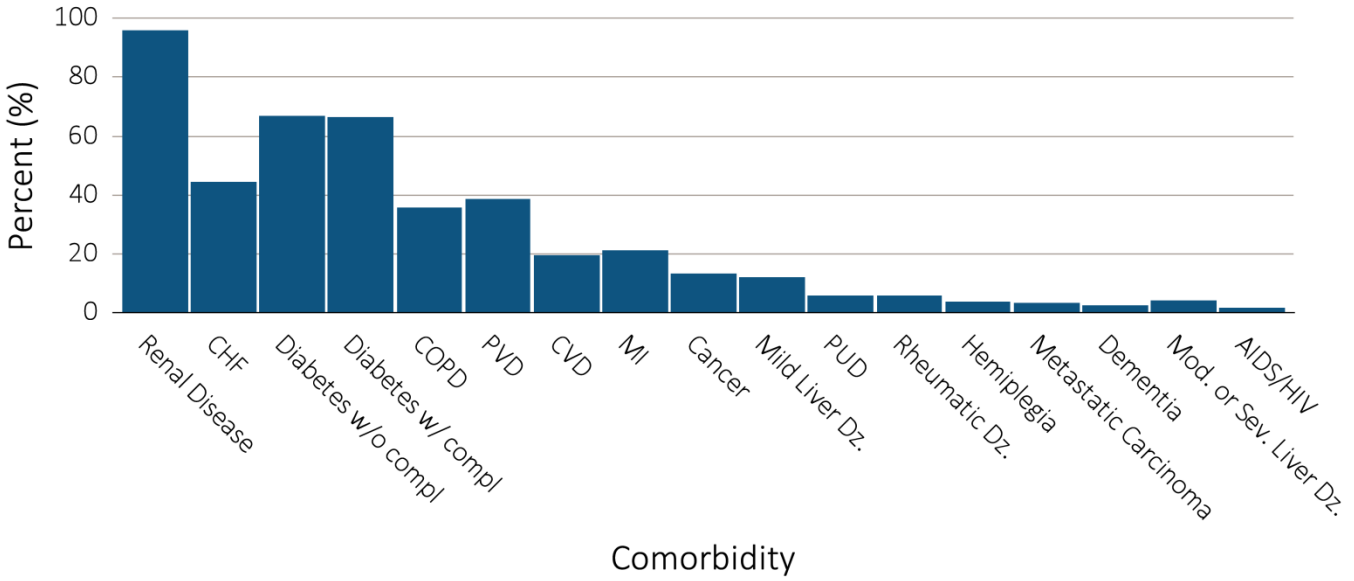
+ 2* Diabetes with chronic complications + 2* Paraplegia or Hemiplegia + 2* Any Cancer

+ 3* Moderate or Severe Liver Disease

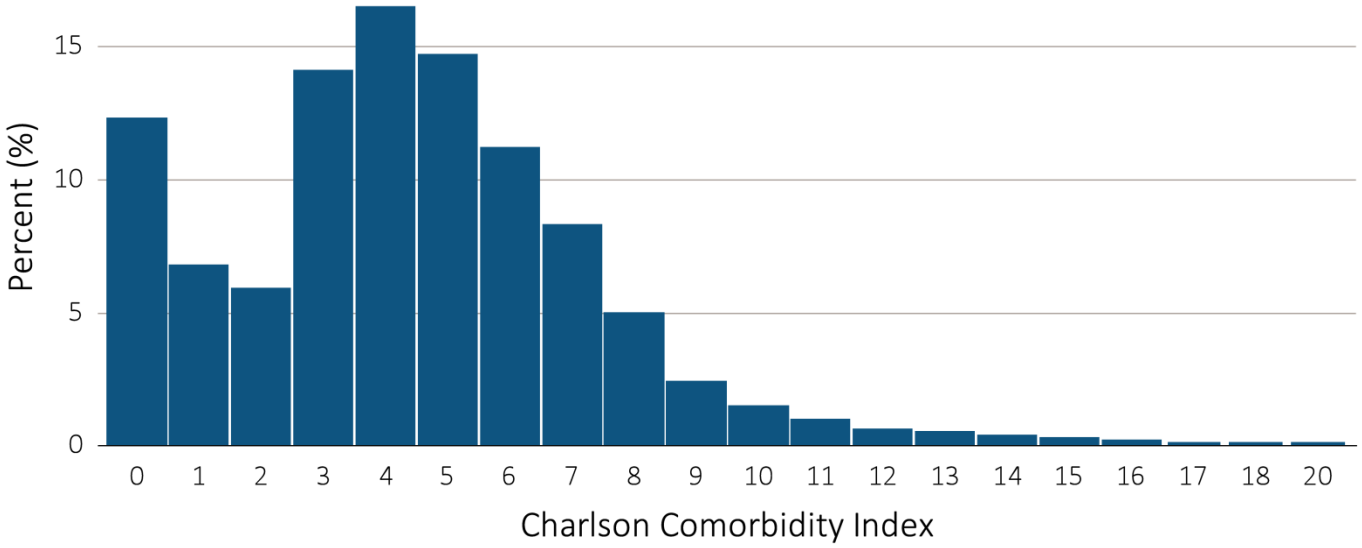
+ 6* Metastatic Carcinoma + 6*AIDS/HIV

vol 1 Figure 8.23 Selected comorbid conditions for calculation of the Charlson Comorbidity Index prior to transition to ESRD 8,038 incident ESRD patients

(a) Comorbid Conditions



(b) Charlson Comorbidity Index



Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviations: CHF, congestive heart failure; compl, complications; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; Dz, disease; ESRD, end-stage renal disease; MI, myocardial infarction; Mod, moderate; PVD, periphral vascular disease; PUD, peptic ulcer disease; Sev, Severe.

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