

## Chapter 8: Transition of Care in CKD

- Almost 30% of all 52,172 veterans who transitioned to ESRD across the nation over a 4-year period (10/2007-9/2011) received anti-depressant medications prior to transition (prelude period), while after transition to ESRD (vintage period) the anti-depressant prescription rate increased slightly.
- Phosphorus binders were rarely prescribed during the prelude period prior to ESRD transition, but a major surge was observed in the final six months of the prelude period, followed by a substantial rise during the dialysis vintage period.
- Among comorbid conditions that were obtained from multiple sources for 47,555 veterans who transition to ESRD with at least one identified comorbidity, congestive heart failure (CHF) and diabetes mellitus were each present in over half of the veterans, chronic pulmonary disease was recorded in over 40%, and almost a quarter of all patients had the diagnosis of cancer, while 28% had prior myocardial infarction.
- Among the 46,625 veterans who transitioned to ESRD over the 4-year period with at least one hospitalization event, the most common causes of hospital admission that also included the ESRD transition day in the hospital included: acute kidney injury (AKI, acute renal failure), hypertension, congestive heart failure, and CKD per se, while septicemia-related hospital admissions increased dramatically after ESRD transition.
- Congestive heart failure (CHF) was the most common reason for hospital admission prior to ESRD transition (prelude time), whereas dialysis access complications were the most common cause after ESRD transition (vintage time).
- For hospitalizations that included the transition to ESRD event, i.e., the first hemodialysis treatment, AKI was the leading cause of hospitalization.
- Prelude trend analyses provide important information about changes in clinical and laboratory measures over time during several years prior to transition to ESRD, including measured serum phosphorus in 11,896 veterans who eventually transitioned to ESRD over 5 years, which gradually increased from the 3.8 to 4.0 range to above 5.5 mg/dL immediately prior to transition to ESRD.

### 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<sup>2</sup>. The main databases used in these analyses are created from the linkage between the national USRDS data and two large longitudinal databases of NDD-CKD patients, i.e., the national (entire U.S.) Veterans Affairs (VA) database, and the

regional (Southern California) Kaiser Permanente (KP-SC) database. These linkages allow 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 consists of 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) will be examined.

In the first phase of this Special Study operation we have examined the recent national veterans

and KP-SC cohorts of incident ESRD patients. We provide pre-ESRD (prelude) data on all available ESRD transitions since 10/1/2007 among veterans and since 1/1/2007 among KP-SC patients. Some of these analyses including preliminary post-ESRD data of approximately 52,000 incident ESRD veterans who transitioned to ESRD over four years, i.e., between 10/1/2007 and 9/30/2011, were presented in our first report in the 2014 ADR. This year our chapter includes additional data of the first two years of the vintage period in these incident dialysis patients; we also present the -5 year prelude (pre-ESRD) data for the first time along with additional data from the USRDS. In future ADRs we plan to provide annual updates based on linkages to data from thousands of incident ESRD patients who transition to ESRD in subsequent years.

As stated under the original goals of this Special Study Center, we also plan 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 such pre-ESRD factors 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 United States of whom 9 million are enrolled in the Veterans Health Administration (VHA), including almost 6 million who receive their healthcare in one of the VHA facilities. During the fiscal year of 2013 there were 86.4 million outpatient visits and 694,700 inpatient admissions at Veterans Affairs (VA) healthcare facilities<sup>1</sup>. Whereas currently some 90% of the U.S. veteran population consists of males, it is estimated that by 2040 approximately 18% of the VA population will be females. Minority veterans comprised about 22% of the total veterans' population in 2014. The majority of minority veterans are those of Black or African American race (12% of all veterans), and Hispanics or Latinos of any race comprise approximately 7% of all veterans<sup>2</sup>.

The VHA facility network consists of 150 hospitals, along with 820 community-based outpatient clinics and 300 vet centers<sup>3</sup>. 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 by local private providers (outsourced by the VHA) in cases where the VHA cannot provide adequate care, e.g. 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<sup>4</sup>. For patients requiring in-center dialysis treatment, the VHA provides dialysis both through dialysis 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 which maintain and operate an in-house (in-center) dialysis center<sup>5</sup>. Most such hospital based dialysis units provide both chronic outpatient and acute inpatient dialysis treatments in the same location simultaneously. In the USRDS ADR census they are usually counted under the category of "hospital based" facilities. Approximately 90% of the ESRD veterans, however, receive dialysis treatment in non-VHA facilities including dialysis chains, but their transition data, including and in particular their prelude and early vintage analyses are also included in this chapter (see below).

## HIGHLIGHTS OF THE INCIDENT ESRD VETERANS DATA BETWEEN 10/1/2007 AND 9/30/2011

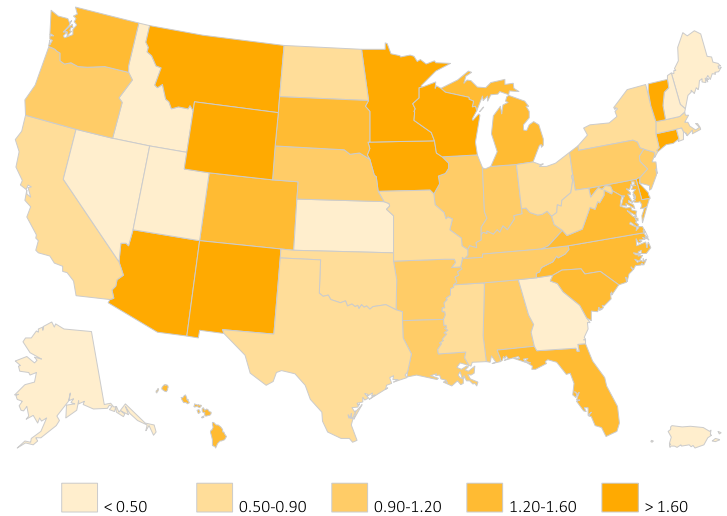
As reported in the 2014 ADR chapter, between 10/1/2007 and 9/30/2011 (over four fiscal years), 52,172 veterans transitioned to ESRD (mean  $\pm$  SD age: 70.3  $\pm$  12.1 years old) including 24% Blacks and 6% Hispanics. The cause of ESRD in majority of them was diabetes mellitus (41.7%) or hypertension (31.4%). During the very early vintage period mortality was exceptionally high, so that during the first three months after transition 10.4% of all incident ESRD veterans died, while 1.4% received kidney transplantation during this time. Hemodialysis therapy was the dominating modality comprising 92.3% of the incident ESRD veterans at three months, whereas home dialysis modalities were scarce including peritoneal dialysis (6.1%) and home hemodialysis (<1%) at this time.

### PREEMPTIVE KIDNEY TRANSPLANTATION AMONG VETERANS ACROSS THE NATION

Figure 8.1 shows the proportions of preemptive kidney transplantation in each state and territory of the United States. The rates are calculated based on the number of preemptive transplants divided by the total number of the incident ESRD veterans in that state or territory (n=589 preemptive transplantations over four years in the entire nation). The states with the highest preemptive kidney transplant rates among veterans (>1.6%) were Arizona, Connecticut, Delaware, Iowa, Minnesota, Montana, New Mexico, Vermont, Wisconsin, and Wyoming.

As reported in the 2014 ADR chapter on Transition of Care in CKD, during each year of the 4-year observation period approximately 13,000 veterans transitioned to ESRD, with an average rate of ESRD transition of 1,087 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 Veterans population data using the Census Fact Finder site<sup>6</sup>. We then calculated counts of all veterans in each year and per age strata. The USRDS incidence rates

vol 1 Figure 8.1. Distribution of preemptive kidney transplant rates among 52,172 incident ESRD veterans across the states and territories of the United States, 10/1/2007-9/30/2011



Data source: VHA Administrative data, USRDS ESRD Database. States and territories of the United States of America. Abbreviations: ESRD, end-stage renal disease.

for ESRD among U.S. adults were obtained from the 2014 SAFS databases for comparison. For the three calendar years 2008, 2009 and 2010, the ESRD incident rates among veterans were 604.6, 624.0 and 604.1 per million veterans, respectively. Given the ESRD incident rates of 488.0, 499.3 and 495.6 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, 1.25, and 1.22 for calendar years 2008 through 2010, respectively, suggesting that the ESRD is 22% to 25% 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. On an age specific and age adjusted basis, the rate of ESRD is 25 to 40% lower than the U.S. rate of ESRD. This lower-than-expected risk occurs despite the fact that the VA population is predominantly male. The remarkably low rate of ESRD among VA patients is unexplained. Is it because the VA system provides an integrated health care system with better care to CKD patients? Is it because there is a selection bias of persons into military service? After all, there is a screening of military candidates that could remove persons with greater risk of ESRD from the resultant VA pool of persons. Further research may shed some light on this issue.

vol 1 Table 8.1. Rates and ratios of incident ESRD among veterans and in U.S. adults, 10/1/2007-9/30/2011

	55-64 years			65-74 years			75 years or older		
	2008	2009	2010	2008	2009	2010	2008	2009	2010
<b>Incident ESRD veterans</b>	3,180	3,292	3,115	3,054	3,187	3,080	5,924	5,787	5,740
<b>All veterans</b>	5,718,302	5,441,739	5,340,529	4,148,572	4,152,331	4,294,221	4,911,012	4,851,671	4,839,173
<b>ESRD rate in veterans, per million</b>	<b>556</b>	<b>605</b>	<b>583</b>	<b>736</b>	<b>768</b>	<b>717</b>	<b>1206</b>	<b>1193</b>	<b>1186</b>
<b>ESRD rate in the U.S., per million</b>	773	778	752	1297	1311	276	545	1559	1582
<b>ESRD rate ratio (Vet: U.S.)<sup>a</sup></b>	<b>0.72</b>	<b>0.78</b>	<b>0.78</b>	<b>0.57</b>	<b>0.59</b>	<b>0.56</b>	<b>0.78</b>	<b>0.76</b>	<b>0.75</b>

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. <sup>a</sup>Veterans to U.S. rate ratios. Abbreviations: ESRD, end-stage renal disease; PM; per million; Vet, veterans.

The status of incident ESRD veterans during the first three months upon transition to ESRD (10/1/2007-9/30/2011) is shown in Table 8.2. On Day 1 versus Day 90 of the ESRD service, 82.9% and 78.4% of the 52,172 veterans (n=43,256 and 40,918), respectively, received in-center hemodialysis treatment, whereas the number of peritoneal dialysis (PD) patients at these two points in time was 4.9% (n=2,552) and 5.2% (n=2,697). There were 1.1% (n=589) registered preemptive kidney transplant recipients on Day 1 of

ESRD service initiation. During the first three months of the transition to ESRD, 10.3% (n=5,348) died, 1.3% (n=701) received a kidney transplantation, and 3.5% (n=1,789) stopped dialysis therapy including recovered from ESRD. The 10.4% crude mortality rate of incident ESRD veterans during the first three months is equivalent to an annualized mortality rate of 41.6% and reflects the similar early excess mortality found in the general ESRD population.

vol 1 Table 8.2. Status of 52,172 incident ESRD veterans on Day 1 and Day 90 after transition to ESRD, 10/1/2007-9/30/2011

	Day 1		Day 90	
	n	%	n	%
<b>Dialysis Modality</b>				
In-center	43,256	82.9	40,918	78.4
Home HD	260	0.5	258	0.5
CAPD	1,405	2.7	1,302	2.5
CCPD	1,174	2.2	1,395	2.7
Uncertain <sup>a</sup>	5,287	10.1	447	0.9
<b>Outcomes<sup>b</sup></b>				
Death	201	0.4	5,348	10.3
Transplant	589	1.1	701	1.3
Lost to follow-up			5	<0.1
Recovered			1,798	3.5
<b>Total</b>	<b>52,172</b>	<b>100</b>	<b>52,172</b>	<b>100</b>

Data source: USRDS ESRD Database. Table adapted from the 2014 USRDS Annual Data Report. <sup>a</sup>Uncertain groups have no known dialysis modality, <sup>b</sup>n for outcomes is cumulative for subsequent periods after Day 1. Abbreviations: CAPD, continuous ambulatory peritoneal dialysis; CCPD, continuous cycling peritoneal dialysis; ESRD, end-stage renal disease; HD hemodialysis.

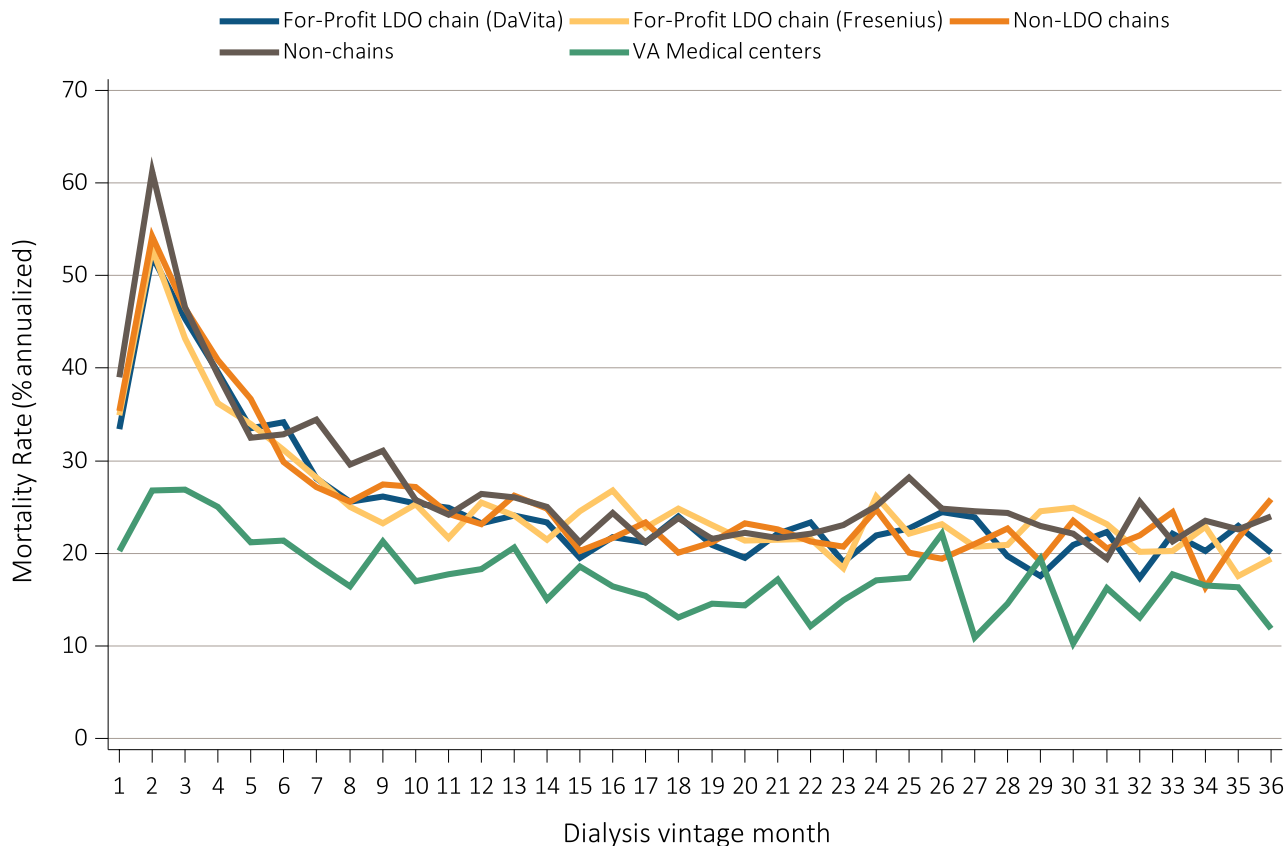
**DIALYSIS PROVIDERS AND OUTCOMES AFTER TRANSITION TO ESRD**

Upon transition to ESRD only 9.9% (n=5,157) received dialysis therapy in one of the in-center dialysis units based at VHA medical centers, while 52.1% of all incident dialysis veterans received maintenance dialysis therapy in outsourced facilities that included for-profit “large dialysis organizations” (LDO), i.e., Fresenius Medical Care (FMC, 27.6%) and DaVita Kidney Care (DVT, 24.5%), or in other dialysis chains (13.1%) or in a dialysis unit that did not belong to any chain (i.e. free-standing and hospital based units, 21.1%). The mean age of veterans at the initiation of the dialysis treatment in a VHA medical center was 64.6 years compared to 70.3 to 72.1 years in the outsourced (non-VHA) dialysis facilities; and VHA medical centers had 41.3% Black patients as compared to 24.1% of all incident ESRD veterans. Higher proportion of Blacks and younger age may explain lower mortality rates in VHA based dialysis units. In addition to age and race, further adjustments for potential differences in comorbidity burden and/or other patient characteristics will be necessary to better describe provider-associated outcomes in dialyzed veterans.

Figure 8.2 shows the crude, annualized, month-by-month mortality rates during the first 36 months after transition to ESRD across dialysis providers. As shown here mortality rates were exceptionally high during the first several months of transition to ESRD among all providers. The annualized mortality in Month 2 was the highest (>50% per year) in non-VHA units and lowest (26.8% per year) in VHA affiliated dialysis units. Given higher fluctuation of the rates in Year 3 that is likely secondary to small size of the denominators during this time, all subsequent mortality analyses are based on the first 24 months (two years) of vintage to mitigate imprecision.

Table 8.3 shows the crude month-by-month mortality rates in the first 24 months after transition to ESRD across dialysis providers as the source of the rates in Figure 8.2. As shown here mortality rates were exceptionally high during the first several months of transition to ESRD among all providers. The annualized mortality in Month 2 was the highest (>50% per year) in non-VHA units and lowest (26.8% per year) in VHA affiliated dialysis units.

**vol 1 Figure 8.2. Annualized monthly unadjusted mortality of incident ESRD veterans who transitioned to ESRD during 10/1/2007-9/30/2011 and who were followed for up to 36 months, by dialysis provider**



Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Abbreviation: DaVita, DaVita Kidney Care; ESRD, end-stage renal disease; LDO, large dialysis organization; VA, Veterans’ Affairs.

vol 1 Table 8.3. Annualized month-by-month unadjusted mortality in 52,172 incident ESRD veterans during the first 24 months after transition to ESRD by dialysis provider, 10/1/2007-9/30/2011

Month	DVT			FMC			Other Chains			Non-Chain			VHA		
	Died	Alive	Rate %	Died	Alive	Rate %	Died	Alive	Rate %	Died	Alive	Rate %	Died	Alive	Rate %
1	355	12,763	33.38	418	14,376	34.89	202	6,847	35.4	358	11,005	39.04	86	5,100	20.24
2	538	12,408	52.03	615	13,958	52.87	300	6,645	54.18	543	10,647	61.2	112	5,014	26.8
3	449	11,870	45.39	480	13,343	43.17	246	6,345	46.52	392	10,104	46.56	110	4,902	26.93
4	377	11,421	39.61	388	12,863	36.2	208	6,099	40.92	318	9,712	39.29	100	4,792	25.04
5	308	11,044	33.47	353	12,475	33.96	180	5,891	36.67	254	9,394	32.45	83	4,692	21.23
6	306	10,736	34.2	315	12,122	31.18	142	5,711	29.84	250	9,140	32.82	82	4,609	21.35
7	244	10,430	28.07	277	11,807	28.15	126	5,569	27.15	255	8,890	34.42	71	4,527	18.82
8	217	10,186	25.56	240	11,530	24.98	116	5,443	25.57	213	8,635	29.6	61	4,456	16.43
9	217	9,969	26.12	219	11,290	23.28	122	5,327	27.48	218	8,422	31.06	78	4,395	21.3
10	206	9,752	25.35	233	11,071	25.26	118	5,205	27.2	176	8,204	25.74	61	4,317	16.96
11	198	9,546	24.89	196	10,838	21.7	103	5,087	24.3	162	8,028	24.22	63	4,256	17.76
12	181	9,348	23.23	226	10,642	25.48	96	4,984	23.11	173	7,866	26.39	64	4,193	18.32
13	184	9,167	24.09	209	10,416	24.08	107	4,888	26.27	167	7,693	26.05	71	4,129	20.63
14	175	8,983	23.38	183	10,207	21.51	99	4,781	24.85	157	7,526	25.03	51	4,058	15.08
15	143	8,808	19.48	205	10,024	24.54	79	4,682	20.25	130	7,369	21.17	62	4,007	18.57
16	157	8,665	21.74	219	9,819	26.76	83	4,603	21.64	147	7,239	24.37	54	3,945	16.43
17	150	8,508	21.16	182	9,600	22.75	88	4,520	23.36	125	7,092	21.15	50	3,891	15.42
18	167	8,358	23.98	195	9,418	24.85	74	4,432	20.04	138	6,967	23.77	42	3,841	13.12
19	143	8,191	20.95	177	9,223	23.03	77	4,358	21.2	123	6,829	21.61	46	3,799	14.53
20	131	8,048	19.53	161	9,046	21.36	83	4,281	23.27	124	6,706	22.19	45	3,753	14.39
21	146	7,917	22.13	159	8,885	21.47	79	4,198	22.58	119	6,582	21.7	53	3,708	17.15
22	151	7,771	23.32	157	8,726	21.59	73	4,119	21.27	119	6,463	22.1	37	3,655	12.15
23	121	7,620	19.06	131	8,569	18.35	70	4,046	20.76	122	6,344	23.08	45	3,618	14.93
24	137	7,499	21.92	184	8,438	26.17	82	3,976	24.75	130	6,222	25.07	51	3,573	17.13

Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. Provider is based on the patient's provider on Day 1. Rates represent the 12-month annualized rate. Abbreviations: DVT, DaVita Kidney Care; ESRD, end-stage renal disease; FMC, Fresenius Medical Care; VHA, Veterans' Health Administration.

**PRESCRIBED MEDICATIONS UPON TRANSITION TO ESRD**

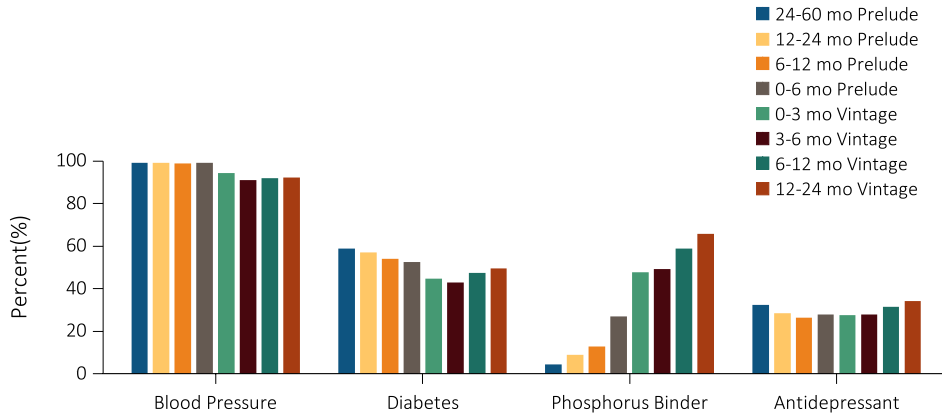
Patterns of medication use before, during and after transition to ESRD are examined in this section. Four groups of medications were analyzed including (1) medication used for blood pressure management (beta blockers, alpha blockers, calcium channel blockers, vasodilators, thiazide diuretics, loop diuretics, potassium sparing diuretics, and RAAS inhibitors); diabetes medications (insulin and oral hypoglycemic); (3) phosphorus binders (sevelamer, lanthanum, and calcium acetate) and (4) antidepressants. As shown in Figure 8.3 over 90% of patients were on blood pressure lowering medications prior to ESRD

transition, and this high medication rate persisted during and throughout post-transition period. Diabetes medications were given to 50% of all veterans prior to ESRD transition, but this rate declined to 40% in Year 1 of the vintage. Phosphorus binders were rarely prescribed during the prelude to ESRD, but a major surge was observed in the final six months of the prelude and immediately prior to transition to ESRD, followed by a substantial rise during the vintage period. Anti-depressants showed a rather constant prescription pattern independent of transition to ESRD, in that almost 30% of veterans received these medications during both prelude and vintage, although some upwards trends are observed after transition to ESRD.

vol 1 Figure 8.3. Medications prescribed to 52,172 incident ESRD veterans who transitioned to ESRD from 10/1/2007-9/30/2011

**HOSPITALIZATION PATTERN DURING TRANSITION TO ESRD**

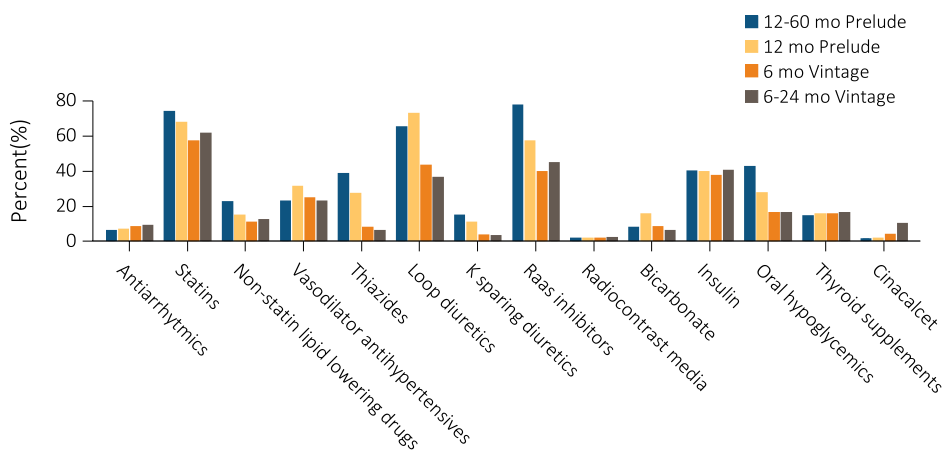
To obtain accurate hospitalization data for the 52,172 veterans who transitioned to ESRD over the four years (10/2007-9/2011), additional database merging was done between the veteran ESRD data and the inpatient and outpatient data from VA sources (including Inpatient Acute Care Main, Inpatient Acute Care Surgery, MedSAS Outpatient Event file, and MedSAS Inpatient Encounters file) as well as the CMS Medicare-Inpatient and Outpatient data sources (including CMS RIF-Outpatient, and Additional Chronic Conditions obtained from CMS Beneficiary Files under BASF & MBSF). 46,625 patients or 89.4% of all veterans who transitioned to ESRD were hospitalized at least once during a period of -5 years prior to (prelude) and +2 years after transition to ESRD (vintage). Figure 8.5 shows the Venn diagram of these hospitalization counts: 6,610 veterans were hospitalized only before but not after and 6,743 only after but not before the transition to ESRD, whereas 33,272 veterans were in the hospital both before and after the ESRD transition. There were 27,503 veterans (52.7%) in whom the transition to ESRD happened while they were in the hospital, including 22,817 veterans (43.7%) whose only hospitalization event during the entire seven years of observation (from -5 year prelude to +2 year vintage) was to transition to ESRD.



Data source: VHA Administrative data, CMS Medicare Inpatient and Outpatient data. An individual's data includes the period from 60 months prior to transition (prelude) to 24 months following transition (vintage). Abbreviations: ESRD, end-stage renal disease; mo, month.

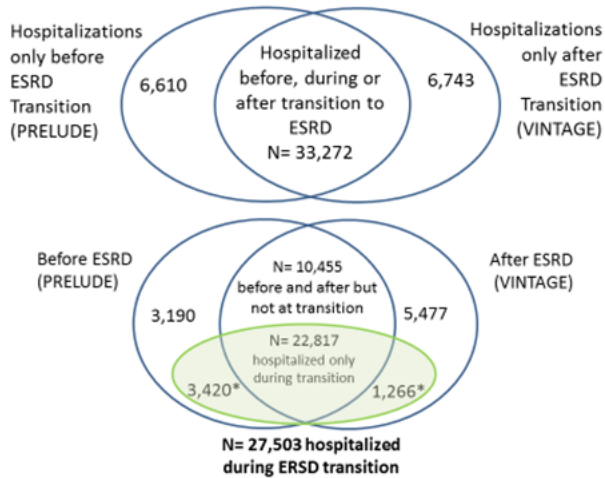
More granular data on type of prescribed medications are presented in Figure 8.4. The time periods are combined into 2 prelude periods (last 12 months and prior to final 12 months) and two vintage periods (first six months and after six months of dialysis therapy). As shown here, statins, RAAS inhibitors and loop diuretics were prescribed to over two-thirds of veterans during the prelude time. The use of thiazide, potassium sparing and loop diuretics dropped dramatically after transition to ESRD. Bicarbonate use showed a surge in the final 12 months of prelude. The calcimimetic agent cinacalcet was mostly prescribed in the vintage but not prelude time.

vol 1 Figure 8.4. Detail of the medications prescribed to 52,172 incident ESRD veterans who transitioned to ESRD during 10/1/2007-9/30/2011



Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. An individual's data includes the period from 60 months prior to transition (prelude) to 24 months following transition (vintage). Abbreviations: ESRD, end-stage renal disease; K, potassium; mo, month.

vol 1 Figure 8.5. Hospitalization events in 46,625 incident ESRD veterans who transitioned to ESRD during 10/1/2007-9/30/2011



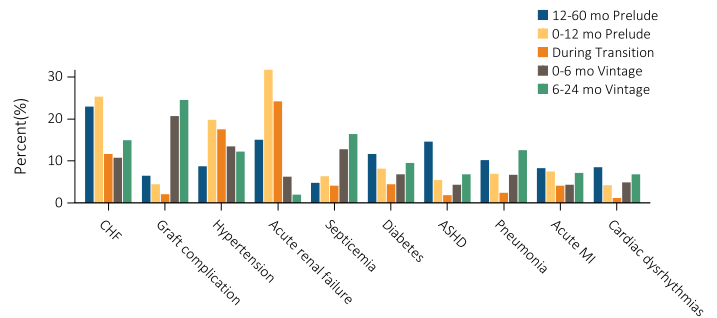
Data source: VHA Administrative data, USRDS ESRD Database, CMS Medicare Inpatient and Outpatient data. An individual's data includes the period from 60 months prior to transition (prelude) to 24 months following transition (vintage). Upper Venn diagram: three major hospitalization categories; Lower Venn diagram: focus of hospital events during transition to ESRD. Abbreviations: ESRD, end-stage renal disease. \* Unique patients with an event during transition and before or after transition to ESRD

Cause-specific hospitalization events were also analyzed. Figure 8.6 shows the top 20 causes of hospitalization among 46,625 veterans who transitioned to ESRD over the 4-year period (10/2007-9/2011) with at least one hospitalization event from -5 years prelude to +2 years vintage surrounding the transition intercept. These hospitalizations were then divided into five time categories, including two prelude periods (the final 12 months of prelude and the time prior to these 12 months, in that the patient discharge day was still prior to transition to dialysis), two vintage categories (the first six months of dialysis therapy, and thereafter, in that the admission day was after transition to ESRD) and finally the fifth group consisting of the dialysis initiation event or preemptive kidney transplantation, i.e., any hospitalization that started in the prelude and ended in the vintage. The top 20 causes of hospitalization included congestive heart failure (CHF), dialysis access complications (graft complication), hypertension, acute kidney injury (acute renal failure), septicemia, diabetes, atherosclerotic heart disease (ASHD), pneumonia, acute myocardial infarction (acute MI), cardiac arrhythmias, fluid overload (fluid disorder), rehabilitation, surgery (surgical complication), chronic kidney disease (CKD), GI hemorrhage, chest pain, respiratory failure, skin infection (skin Inf), COPD, and cerebrovascular disease (CVD). Of

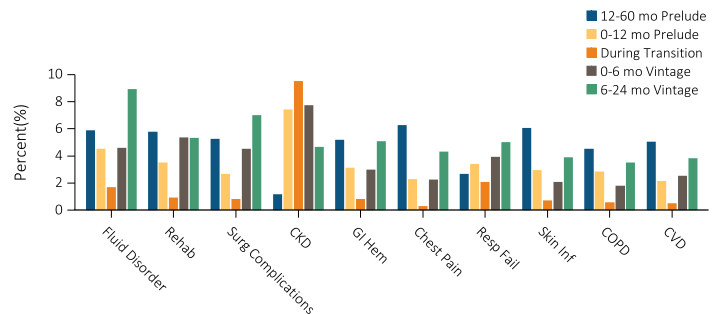
note, septicemia related hospital events increased dramatically after ESRD transition. The most common causes of hospital admission that also consisted of the ESRD transition day included acute renal failure, hypertension, CHF, and CKD.

vol 1 Figure 8.6. The top 20 causes of hospitalizations in 46,625 incident ESRD veterans who were hospitalized at least once during the period between 60 months prior to ESRD transition (prelude) and 24 months following ESRD transition (vintage)

(a) 10 of the top 20 causes of hospitalizations



(b) 10 of the top 20 causes of hospitalizations



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; 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 8.4. Congestive heart failure (CHF) is the most common reason for hospital admission prior to ESRD transition during prelude time, whereas dialysis access complications is the most common cause after ESRD transition. For hospitalizations that included the ESRD transition events (mostly first dialysis therapy), acute renal failure (AKI) was the leading cause.



vol 1 Table 8.4. Ranking of the top 20 causes of hospitalization in 46,625 incident ESRD veterans who were hospitalized at least once during the period between 60 months prior to ESRD transition (prelude) and 24 months following ESRD transition (vintage)

Hospitalization Event	Overall (7 year cohort)	-60 to -12 months of prelude	Last 12 months of prelude	During ESRD transition	First 6 months of vintage	+6 to +24 months of vintage
Congestive heart failure	1	1	1	3	4	2
Dialysis access (graft) complication	2	9	10	10	1	1
Hypertension	3	7	3	2	3	4
Acute renal failure	4	3	2	1	8	
Septicemia	5	18	8	7	2	3
Diabetes	6	4	4	5	6	6
Atherosclerotic heart disease	7	2	9	12	15	10
Pneumonia	8	5	7	8	7	5
Acute myocardial infarction	9	6	5	6	13	8
Cardiac dysrhythmias	10	8	12	13	10	11
Fluid disorder/fluid overload	11	13	11	11	12	7
Rehabilitation	12	12	15	14	9	12
Surgical complications	13	14	19	15	11	9
Chronic kidney disease	14		6	4	5	15
Gastrointestinal hemorrhage	15	16	16	16	17	14
Chest pain	16	10				16
Respiratory failure	17		14	9	14	13
Skin infection	18	11	18	18		18
Chronic obstructive pulmonary disease	19	15	17			17
Acute cerebrovascular disease	20	17			19	19
Peripheral and visceral atherosclerosis		19				
Anemia			13			
Urinary tract infection		20	20		18	20
Other circulatory disease					16	
Intestinal infection					20	
Aortic; peripheral, visceral artery aneurysm				19		
Multiple myeloma				20		

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

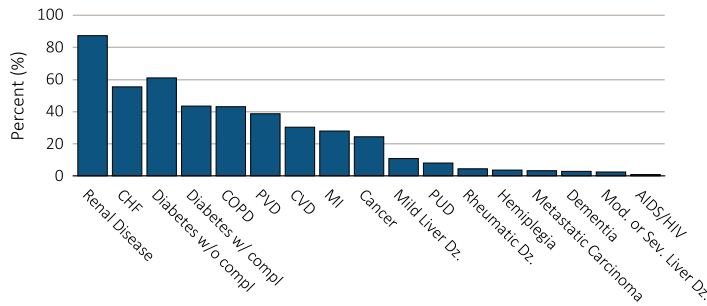
### COMORBID CONDITIONS UPON TRANSITION TO ESRD

Comorbid conditions are examined in this section. The comorbidity data were obtained from multiple sources as described under the hospitalization section. After merging comorbid conditions from all sources, 47,555 veterans (91.2%) were identified with at least one comorbid condition. Figure 8.7a shows the most common comorbidities among these

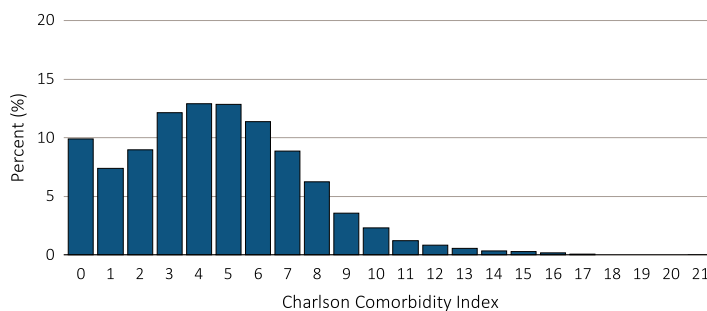
veterans prior to transition to ESRD; the comorbidity list is restricted to those used for the calculation of Charlson Comorbidity Index, as shown in Figure 8.7b. In addition to renal disease, CHF and diabetes were present in over half of the veterans, while chronic pulmonary disease was recorded in over 40%. Of note, almost a quarter of all patients had the diagnosis of cancer and 28% had prior myocardial infarction.

vol 1 Figure 8.7. Selected comorbid conditions for calculation of the Charlson Comorbidity Index prior to transition to ESRD in 47,555 incident ESRD veterans

(a) Common comorbidities among veterans prior to transition to ESRD



(b) Charlson Comorbidity Index Score



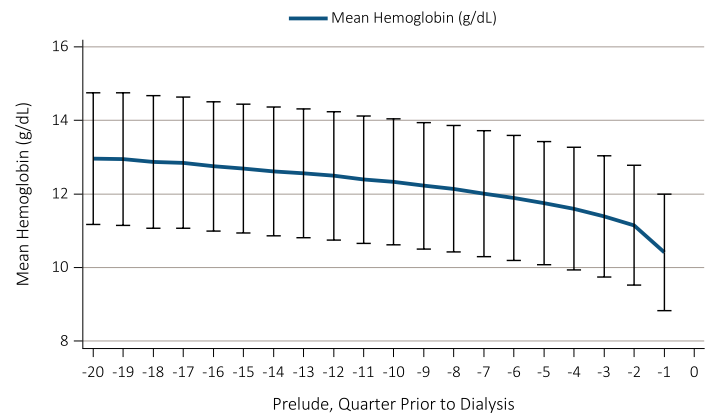
Data source: VHA Administrative data, USRDS ESRD Database. Abbreviations: CHF, congestive heart failure; compl, complications; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; Dz, disease; ESRD, end-stage renal disease; MI, myocardial infarction; Mod, moderate; PVD, peripheral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

TRENDS DURING PRELUDE PERIOD (PRIOR TO ESRD TRANSITION)

This section includes for the first time selected prelude (pre-ESRD) data and their trends by going back in time for up to -5 years prior to the transition intercept. This period of time reflected by a negative number is referred to as the “prelude” to distinguish it from the “vintage”, which is the time (shown with a positive number) after the transition to ESRD. Vintage and prelude start with the start of dialysis therapy (or preemptive transplant) going forward and backward.

Selected prelude trends of the laboratory data are shown below. Figure 8.8 shows the pre-ESRD trend in blood hemoglobin in 28,717 veterans who eventually transitioned to ESRD over 20 calendar quarters or five years. As shown here blood hemoglobin dropped from 13 to below 11 g/dL over the prelude period with progression of CKD to ESRD.

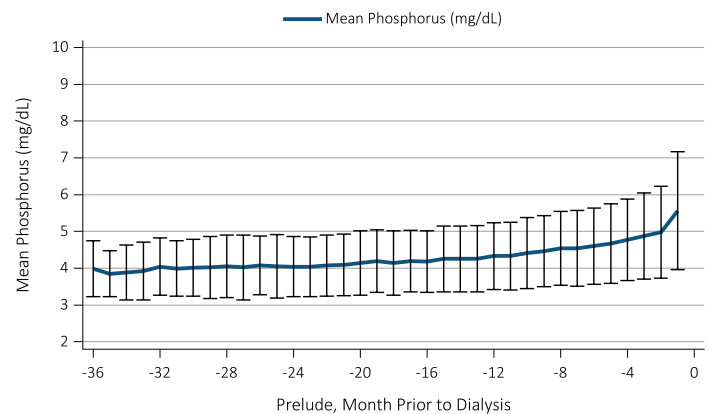
vol 1 Figure 8.8. Trend in blood hemoglobin levels during the prelude (pre-ESRD) period, over 20 calendar quarters in 28,717 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011



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

Figure 8.9 shows the pre-ESRD trend in serum phosphorus in 11,896 veterans who eventually 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 8.9. Trend in serum phosphorus level during the prelude (pre-ESRD) period, over 36 months in 11,896 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011

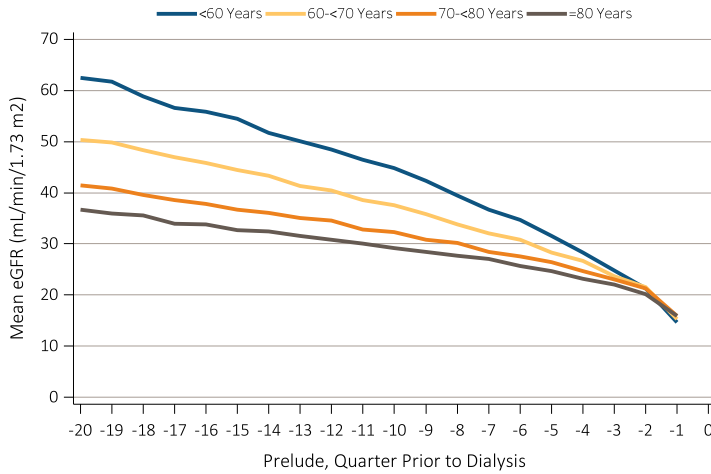


Data source: VHA Administrative data, USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease; mg/dL, milligrams per deciliter.

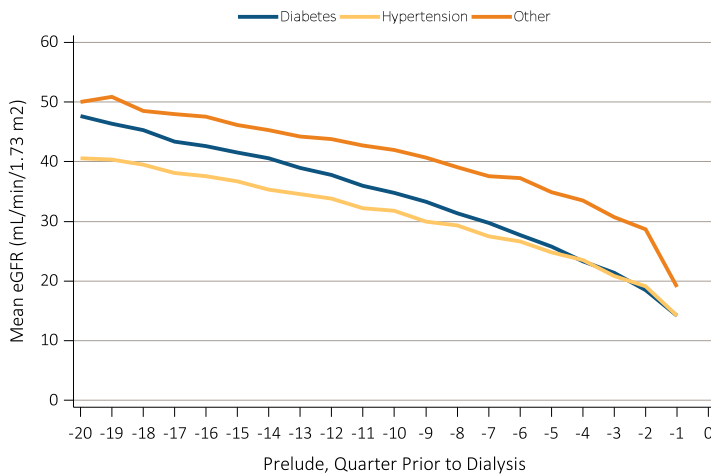
Figure 8.10 shows the pre-ESRD trend in eGFR in 30,245 veterans who transitioned to ESRD over 20 calendar quarters (five years). The upper panel shows that older CKD patients have slower rate of progression than younger patients. The lower panel suggests that those with diabetes as a cause of ESRD have a faster CKD progression.

**vol 1 Figure 8.10. Trend in eGFR during the prelude (pre-ESRD) period, over 20 calendar quarters in 30,245 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011**

**(a) Stratified by age**



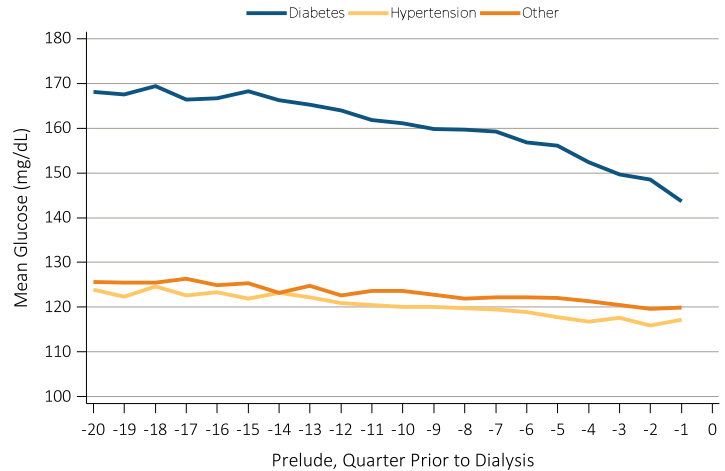
**(b) Stratified according to ESRD etiology**



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

Figure 8.11 shows the pre-ESRD trend in glucose in 29,920 veterans who transitioned to ESRD over 20 calendar quarters or five years. Diabetic patients appear to exhibit a gradual fall in serum glucose over time as their CKD progresses to ESRD. Blood glucose levels do not change among persons whose ESRD is not due to diabetes.

**vol 1 Figure 8.11. Trend in blood glucose level during the prelude (pre-ESRD) period, over 20 calendar quarters in 29,920 veterans who later transitioned to ESRD during 10/1/2007-9/31/2011**



Data source: VHA Administrative data, USRDS ESRD Database. Abbreviations: ESRD, end-stage renal disease.

**Kaiser Permanente of Southern California**

California is the most populous (38 million) and racially/ethnically diverse U.S. state, and 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, 14% Asians, and 7% Blacks). The Kaiser Permanente of Southern California (KP-SC) Health System is an integrated health care system that provides comprehensive health services for ~4 million residents of Southern California. KP-SC is the KP's largest region.

**TRANSITION TO ESRD IN KAISER PERMANENTE OF SOUTHERN CALIFORNIA**

The Kaiser Permanente transition to ESRD database contains race, ethnicity, sex, and zip code as well as socioeconomic information (education and household income) created from the KP-SC Geocoding database defined using the 2009 U.S. Census data. Mortality data of ESRD 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).

Between 01/01/2007 and 12/31/2011 a total of 5,989 KP-SC members transitioned to ESRD. They were 62.6 ± 14.6 years old (mean ± SD). They included 57.7% men and 42.3% women. Racial/ethnic groups included non-Hispanic whites (31.1%), Blacks (21.9%), Asians (9.5%), Hispanics (34.3%), and others (2.3%). The cause of ESRD was diabetes in 51.1% and hypertension in 18.5%. During the first three months, 6.3% of all incident ESRD patients died and 2.5% received kidney transplantation. After three months, 82.6% were on HD and 12.3% on PD (CAPD and CCPD). Around 0.5% received home hemodialysis.

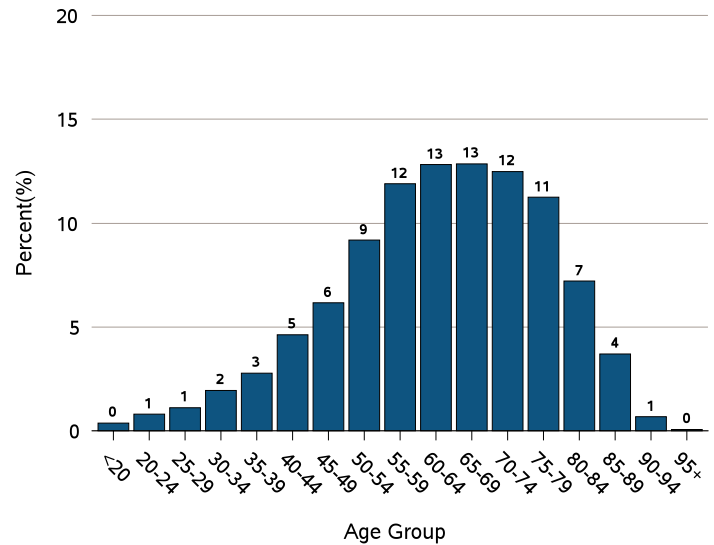
Table 8.5 and Figure 8.12 show the age distribution upon first ESRD service.

vol 1 Table 8.5. Age distribution of 5,989 KP-SC patients who transitioned to ESRD, 1/1/2007-12/31/2011

Age group	Frequency	Percent (%)
<20	23	0.38
20-24	48	0.8
25-29	67	1.12
30-34	117	1.95
35-39	167	2.79
40-44	278	4.64
45-49	369	6.16
50-54	550	9.18
55-59	712	11.89
60-64	767	12.81
65-69	770	12.86
70-74	748	12.49
75-79	673	11.24
80-84	432	7.21
85-89	222	3.71
90-94	41	0.68
95+	5	0.08

Data source: Kaiser Permanente Southern California Electronic Health Records. Also see Figure 8.12. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California.

vol 1 Figure 8.12. Age distribution of 5,989 KP-SC patients who transitioned to ESRD, 1/1/2007-12/31/2011

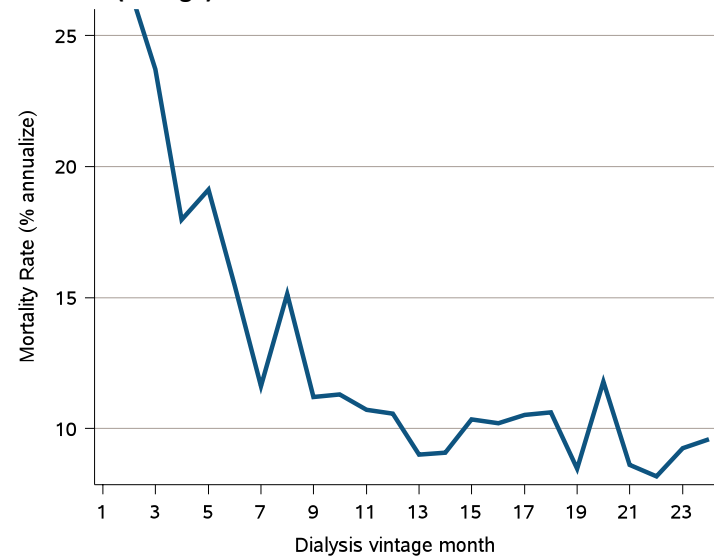


Data source: Kaiser Permanente Southern California Electronic Health Records. Also see Figure 8.6. Abbreviations: ESRD, end-stage renal disease; KP-SC, Kaiser Permanente Southern California.

### OUTCOMES OF KP-SC PATIENTS WHO TRANSITIONED TO ESRD

The annualized mortality rates of the 5,989 incident dialysis patients over the first 24 months of the vintage are depicted under Figure 8.13. The high mortality in the first several months bears resemblance to that seen among incident ESRD veterans and the U.S. ESRD population.

vol 1 Figure 8.13. Annualized mortality rate of the 5,989 incident dialysis patients over the first 24 months after ESRD transition (vintage)

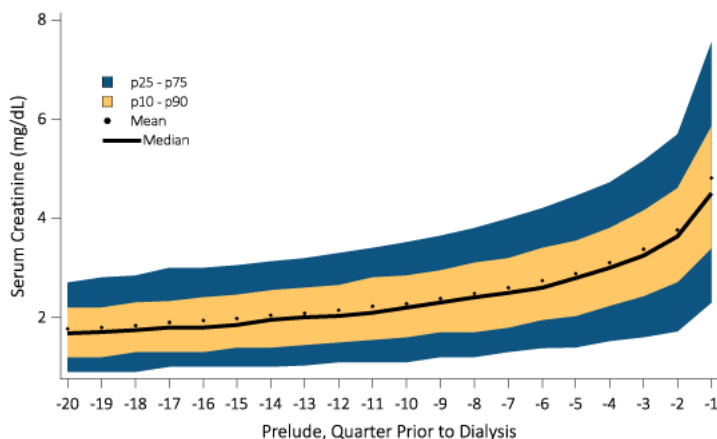


Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviation: ESRD, end-stage renal disease.

### PRELUDE LABORATORY TRENDS OF TC-CKD DATA IN KP-SC

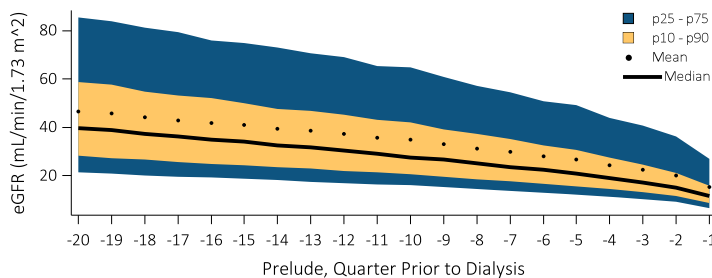
These data were created from the Kaiser Permanente Southern California Laboratory database which tracks KP-SC inpatient and outpatient laboratory orders and its results covers over 20 years of data. Prelude variables (serum creatinine, and eGFR) are averaged by 91 day quarters (n=20), six months (n=6) and years (n=5) prior to the start of dialysis (see Figure 8.14).

**vol 1 Figure 8.14. Gradual rise in serum creatinine level during the period prior to ESRD transition (prelude) of 20 calendar quarters, among 5,665 patients who later transitioned to dialysis**



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

**vol 1 Figure 8.15. eGFR during the period prior to ESRD transition (prelude) of 20 calendar quarters, among 5,665 patients who later transitioned to dialysis**



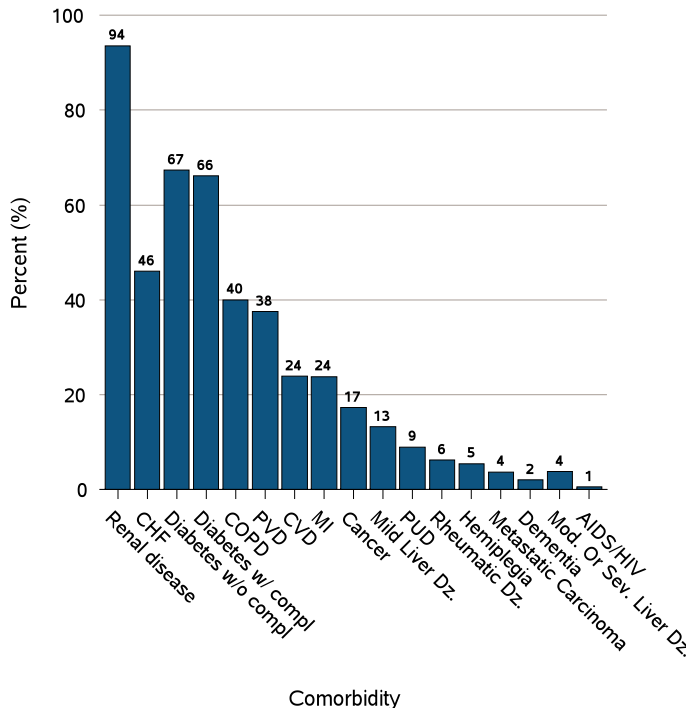
Data source: Kaiser Permanente Southern California Electronic Health Records. Abbreviation: eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease; mL/min, milliliters per minute.

### TC-CKD COMORBIDITY DATA PRIOR TO ESRD TRANSITION AT KP-SC

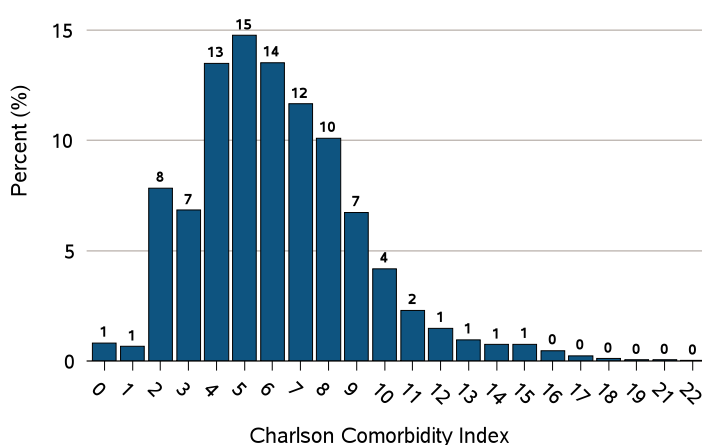
The comorbidity data during the prelude period were created from the Kaiser Permanente Southern California utilization database that provides comprehensive KP-SC patients medical utilization information from 1981 to the present (see Figure 8.16).

**vol 1 Figure 8.16. Selected comorbid conditions for calculation of the Charlson Comorbidity Index prior to transition to ESRD in 5,858 KP-SC patients**

**(a) Common comorbidities among veterans prior to transition to ESRD**



**(b) Charlson Comorbidity Index Score**



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; KP-SC, Kaiser Permanente Southern California; MI, myocardial infarction; Mod, moderate; PVD, peripheral vascular disease; PUD, peptic ulcer disease; Sev, Severe.

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