Chapter 3:
Morbidity and Mortality in Patients with CKD

- In this 2017 Annual Data Report (ADR) we introduce analysis of a new dataset. To provide a more comprehensive examination of morbidity patterns, we now compliment the Medicare 5% sample with information from the Optum Clinformatics™ Data Mart, including beneficiaries of a large commercial insurance provider. This allows us to further examine trends with respect to rates of hospitalization for all-cause and cause-specific reasons.

MORTALITY

- In 2015, Medicare patients with CKD experienced a mortality rate of 109.7 per 1,000 patient-years. When adjusted for sex, age, and race, the rate remained more than double the 45.6 per 1,000 patient-years of those without CKD. Mortality rates increased with CKD severity, but the gap has narrowed between CKD and non-CKD patients from 2003-2015 (Table 3.1 and Figure 3.1).

- Male patients without CKD experienced higher mortality rates of 51.5 per 1,000 patient-years than did females, at 41.3. This relative difference was similar among those with CKD, with a mortality rate of 120.2 per 1,000 patient-years for males and 102.6 for females (Table 3.1 and Figure 3.4).

- In a comparison adjusted for sex and age, 2015 Medicare patients with CKD showed lower rates of mortality for those of White race at 110.5 per 1,000 patient-years, than for Blacks/African Americans at 114.5 per 1,000. This racial difference contrasts to that seen specifically in Stages 4 to 5 patients, where Whites had substantially higher mortality than Blacks (Figure 3.5).

HOSPITALIZATION

- Among patients with CKD, a decrease in hospitalization rates occurred from 2014 to 2015; even after adjustment the Medicare CKD group decreased by 2.1%, from 595 to 583 per 1,000 patient-years at risk, and by 1.7%, from 237 to 233 per 1,000 for the no-CKD group. In contrast, during the same period an increase in hospitalization rates occurred for Optum Clinformatics™ beneficiaries; even after adjustment the CKD group increased by 3.9%, from 174 to 181 per 1,000 patient-years at risk (Figure 3.7).

- Not surprisingly, after adjustment for sex and race, rates of hospitalization in older patients were greater than for younger age cohorts. In the CKD group, those over 85 years of age had 752.2 admissions per 1,000 patient-years. This was 44.3% higher than the 521.1 per 1,000 rate of those aged 66 to 69 years (Figure 3.12).

- Racial differences in hospitalization rates were notable. Black patients with CKD had higher adjusted rates of hospitalization, 664.3 per 1,000 patient-years, than did Whites, with 580.3 per 1,000, and those of other races at 491.2; disparity increased with disease severity (Figure 3.14).

REHOSPITALIZATION

- At 21.5%, rates of rehospitalization for CKD patients were higher than the 15.5% for those without CKD (Table 3.3).

- In Medicare patients without CKD, males exhibited a higher rehospitalization rate than did females, with age and race adjusted percentages of 16.2 and 14.9 (Table 3.3).

Introduction

In Volume 1, Chapter 2, *Identification and Care of Patients with Chronic Kidney Disease*, we analyzed diagnosis codes from Medicare and Optum

Clinformatics™ claims to document the increasing recognition of CKD. The ascertainment of CKD cases through claims data has improved in recent years. This has likely resulted in decreased estimates of average disease severity, as influenced by the early

disease stage of those identified most recently. Thus, recent changes in mortality- and hospitalization-rate trends should be interpreted in this context.

In this chapter we evaluate the morbidity and mortality of patients with and without chronic kidney disease (CKD). We begin by examining mortality as it interacts with the patient characteristics of CKD severity, age, sex, race, and the common comorbid conditions of diabetes mellitus (DM) and cardiovascular disease (CVD). The co-occurrence of DM and CVD with CKD increase a patient's risk of death. This is clinically significant, as cardiovascular risk factors are relatively undertreated in CKD patients in the United States (U.S.). We illustrate this in Volume 1, Chapter 1, *CKD in the General Population*, through data on disease awareness, treatment, and control of risk factors from the population-level National Health and Nutrition Examination Survey (NHANES) cohorts.

We then similarly focus on patients' hospitalizations—for all-causes, and separately for CVD, infection, and other cause-related admissions. It has been established for over a decade that rates of hospitalization for CVD and infection also rise with CKD stage (Go et al., 2004). In general, and not surprisingly, rates of hospitalizations among CKD patients also increase in the presence of underlying comorbidities, such as DM and CVD. While hospitalization rates have been decreasing over time, the underlying causes for this decline and the lessons learned from these data trends require both further research and the application of enhanced quality improvement efforts.

We end with an examination of patient readmission to the hospital within 30 days of discharge from their first hospitalization of the calendar year (referred to as the index hospitalization). Hospital readmissions are a key quality indicator for the Medicare program. In an attempt to lower the rate of readmission, the Medicare Hospital Readmission Reduction Program was instituted as part of the Patient Protection and Affordable Care Act (CMS, 2010), to reduce Medicare payments to hospitals with excess readmissions. Patients with CKD are rehospitalized more frequently than those without diagnosed CKD. These rates have not changed significantly in the past decade, which is of major concern.

Clearly, early detection and active treatment are important considerations in reducing morbidity and mortality in the CKD population. In future iterations of the ADR, we will also examine additional non-Medicare data sources for Emergency Department visits in the CKD population.

Methods

As in previous years, we use data from the Medicare 5% sample's fee-for-service patients aged 66 and older. Roughly 98% of Americans aged 65 and older qualify for Medicare, and as a result, analysis of Medicare data is representative of this demographic. However, as Medicare data for those under 65 is skewed towards the sickest of patients in that age group, we do not include Medicare patients under 65 in the analyses for this Chapter.

All Medicare analysis samples were limited to patients aged 66 and older who were continuously enrolled in Medicare. Employing a one-year entry period allowed us to identify CKD and other medical conditions using ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) and ICD-10-CM (International Classification of Diseases, Tenth Revision, Clinical Modification) diagnosis codes as available from Medicare.

This year, in addition to the Medicare 5% sample, for analyses of hospitalization rates we utilized one additional data source: the Optum Clinformatics™ Data Mart dataset available from OptumInsight, and representing claims from a large U.S. national health insurance company. In contrast to the Medicare data, the Optum Clinformatics™ Data Mart dataset represents primarily working-age people and their minor dependents. We limited inclusion to patients aged 22 and older who were continuously enrolled in the Optum Clinformatics™. Employing a one-year entry period again allowed us to identify CKD and other medical conditions using ICD-9-CM and ICD-10-CM diagnosis codes.

Optum Clinformatics™ includes the date of death from the Social Security Death Master File. In November 2011, the Social Security office stopped

sourcing mortality dates from states, and now only includes dates obtained from other sources such as funeral homes and family members. This resulted in a 30% drop in reported dates of death. We considered this to be a limitation to the data, and chose not to include Optum Clinformatics™ in the mortality analyses.

Details of this data are described in the _Data Sources_ section of the _CKD Analytical Methods_ chapter. See the _CKD Analytical Methods_ section of the _CKD Analytical Methods_ chapter for an explanation of the analytical methods used to generate the study cohorts, figures, and tables in this chapter. Microsoft Excel and PowerPoint files containing the data and graphics for these figures and tables are available to download from the _USRDS website_.

Mortality Rates

As with many chronic conditions, mortality in patients with CKD is of paramount importance as a major outcome. In Table 3.1 we present mortality rates

for several demographic subgroups of patients, both unadjusted and adjusted for age, sex, and race. This year we again applied modified adjustment variables; in the 2014 ADR and in previous years, data was also adjusted for prior year hospitalization and disease comorbidities. We removed these covariates in the 2015 ADR as we believed that adjustment to this extent would result in artificially low mortality rates. This modification should be kept in mind when comparing adjusted rates with those in prior ADRs.

For patients with CKD, the unadjusted mortality rate in 2015 was 134.8 per 1,000 patient-years; this decreased to 109.7 per 1,000 after adjusting for age, sex, and race (standard population: 2015). As expected, mortality rates rose as age increased, particularly for the oldest cohort. In all cases, male patients had slightly higher mortality rates than did females, more so for those with CKD and when adjusted.

For patients with CKD, White patients had higher unadjusted mortality rates than did Blacks, but lower adjusted mortality rates, primarily due to the older age distribution among Whites as compared to Blacks.

vol 1 Table 3.1 Unadjusted and adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by CKD status, 2015

| | Unadjusted | | Adjusted | |
	No CKD	All CKD	No CKD	All CKD
All	43.8	134.8	45.6	109.7
Age				
66–69	15.4	64.6	15.1	63.0
70–74	21.3	70.6	21.1	68.7
75–84	44.0	115.9	44.1	113.5
85+	142.8	255.6	143.6	253.9
Sex				
Male	44.5	138.4	51.5	120.2
Female	43.3	131.5	41.3	102.6
Race				
White	44.6	137.8	45.8	110.5
Black/African American	43.8	125.9	49.4	114.5
Other	31.4	105.3	36.5	88.3

Data source: Medicare 5% sample. January 1, 2015 point prevalent patients aged 66 and older. Adjusted for age/sex/race. Standard population all patients, 2015. Abbreviation: CKD, chronic kidney disease.

Trends in the mortality rates for Medicare patients aged 66 and older are shown in Figure 3.1. Unadjusted mortality in CKD patients has decreased by 29.7% since 2003, from 192 deaths per 1,000 patient-years to 135 deaths in 2015. For those without CKD, the unadjusted rate decreased from 54 deaths per 1,000 patient-years in 2003 to 44 deaths in 2015, a reduction of 18.5%.

When adjusted for age, race, and sex, the 2015 mortality rate for CKD patients reduced considerably, to 111 deaths per 1,000 patient-years at risk (Figure 3.1.b; standard population: 2014). Among those without CKD, adjustment for these factors resulted in a slightly higher mortality rate of 46 deaths per 1,000, as compared to the unadjusted rate of 44. One major contributor to the discrepancy between adjusted and unadjusted death rates was the relative age difference between the CKD and no-CKD cohorts. In 2015, the mean age of patients with CKD was 78.9 years, compared to 75.4 years for those without, and 75.8 years for the sample as a whole. In 2006, CKD stage-specific coding was introduced. This may explain the increased mortality rate for the CKD group in 2006.

vol 1 Figure 3.1 Unadjusted and adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by CKD status and year, 2003-2015
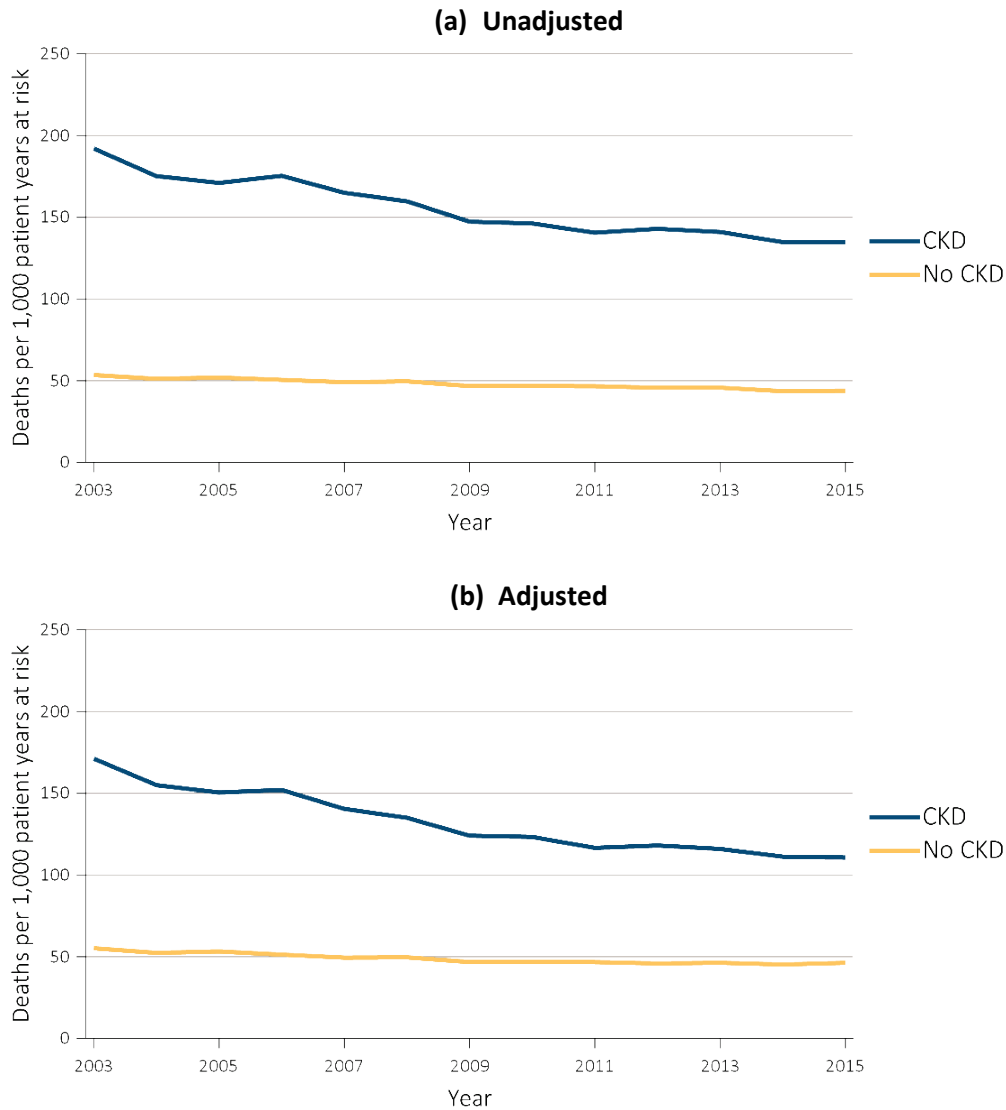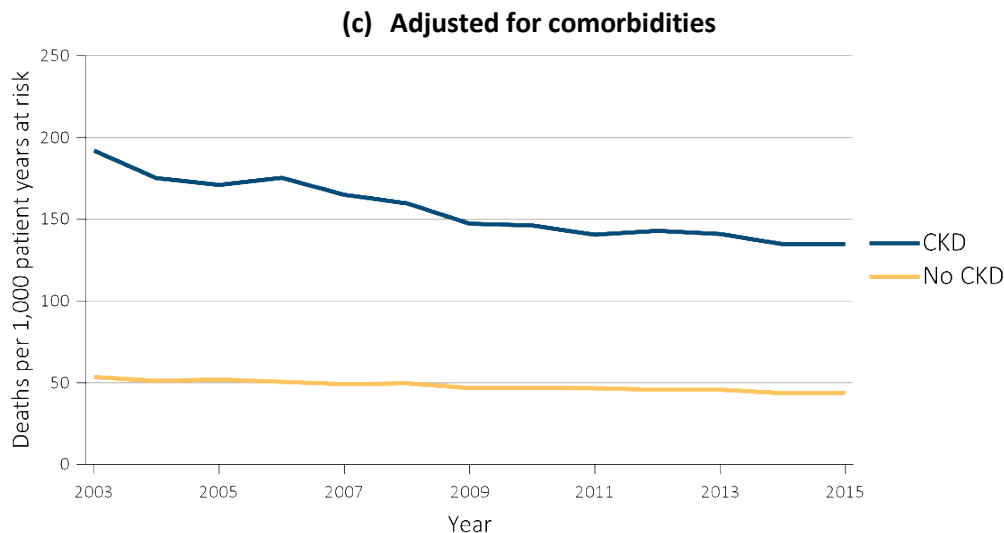
(a) Unadjusted

(b) Adjusted

Figure 3.1 continued on next page.

vol 1 Figure 3.1 Unadjusted and adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by CKD status and year, 2003-2015 (*continued*)
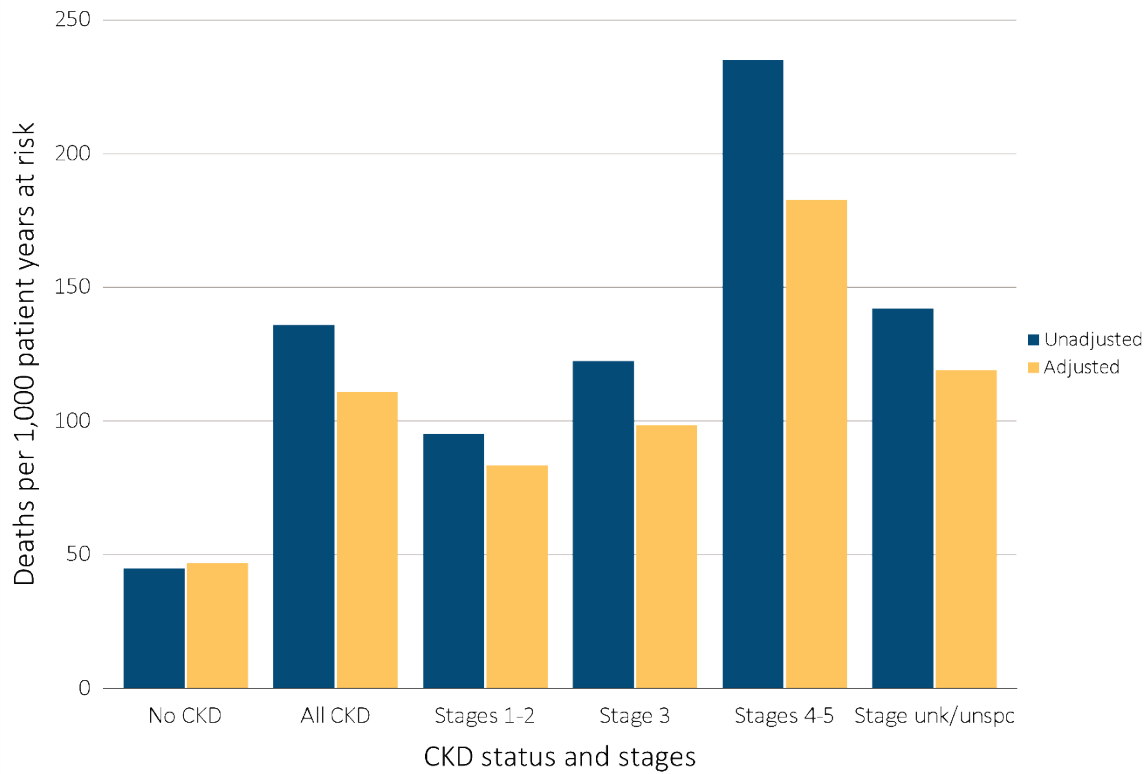
(c) Adjusted for comorbidities

Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. 1.b adjusted for age/sex/race and 1.c adjusted for age/sex/race/comorbidities. Standard population Medicare 2014 patients. Abbreviation: CKD, chronic kidney disease.

Rates increased with advancing CKD stage, as shown in Figure 3.2, a finding consistent with studies using biochemical measures of serum creatinine with validated equations to estimate glomerular filtration rate to define CKD (Matsushita et al., 2010). As expected, unadjusted mortality rates rose progressively, from 94 deaths per 1,000 patient-years for those in Stages 1 or 2, to 121 for Stage 3, and 234 for Stages 4 or 5 (without ESRD; stages identified by the ICD-10-CM codes, see Table A). Those without an identified CKD stage or with a diagnosis other than from the N18 code series had an unadjusted mortality rate falling between that of Stage 3 and Stages 4 or 5, at 141 deaths per 1,000 patient-years at risk.

After adjustment, death rates for Stages 1 or 2 and Stage 3 were 82 and 97 deaths per 1,000 patient-years. The adjusted rate for Stages 4 or 5 was higher, at 182 deaths per 1,000. Those with an unspecified CKD stage had death rates at 118 per 1,000 patient-years.

vol 1 Figure 3.2 Unadjusted and adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by CKD status and stage, 2015

Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race. Standard population Medicare 2015 patients. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Table A. ICD-9-CM and ICD-10-CM codes for Chronic Kidney Disease (CKD) stages (introduced in 2006)

| ICD-9-CM code[a]	ICD-10-CM code[a]	Stage
585.1	**N18.1**	CKD, Stage 1
585.2	**N18.2**	CKD, Stage 2 (mild)
585.3	**N18.3**	CKD, Stage 3 (moderate)
585.4	**N18.4**	CKD, Stage 4 (severe)
585.5	**N18.5**	CKD, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis[b])
CKD Stage unspecified	**CKD Stage unspecified**	For these analyses, identified by multiple codes including 585.9, 250.4x, 403.9xm & others

[a] *For analyses in this chapter, CKD stage estimates require at least one occurrence of a stage-specific code, and the last available CKD stage in a given year is used.*
[b] *In USRDS analyses, patients with ICD-9-CM code 585.6 or ICD-10-CM code N18.6 & with no ESRD 2728 form or other indication of end-stage renal disease (ESRD) are considered to have code 585.5 or N18.5.*

Adjusted mortality rates for 2015 are shown in Figure 3.3 by CKD status and age group. As expected, the mortality rates for older patient groups were higher. In the CKD group, those aged 66-69 years had a mortality rate of 63 deaths per 1,000 patient-years at risk, while those aged 75-84 had nearly double that, at 114 deaths. As also might be expected, patients aged 85 and older experienced the highest rates of mortality, with 254 deaths per 1,000 patient-years.
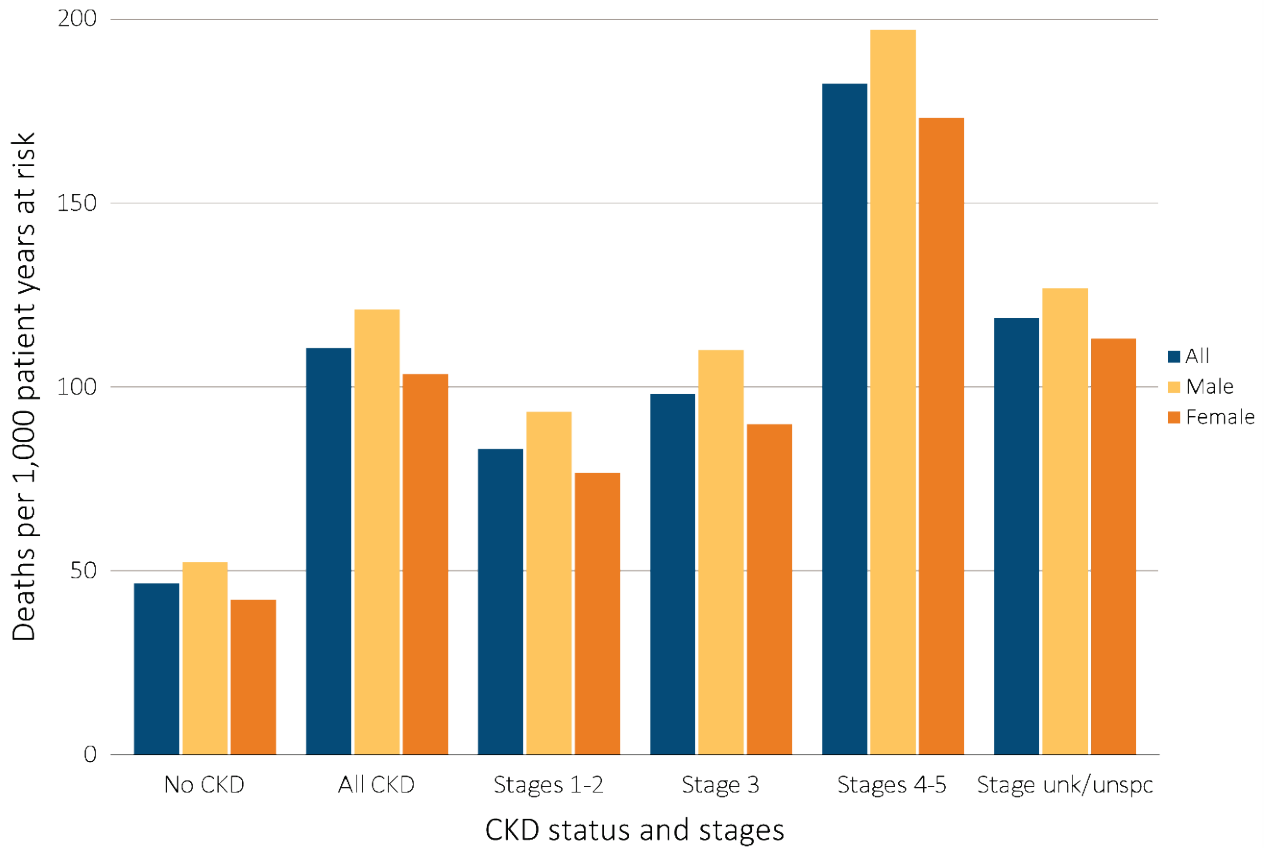
vol 1 Figure 3.3 Adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by age, CKD status, and stage, 2015
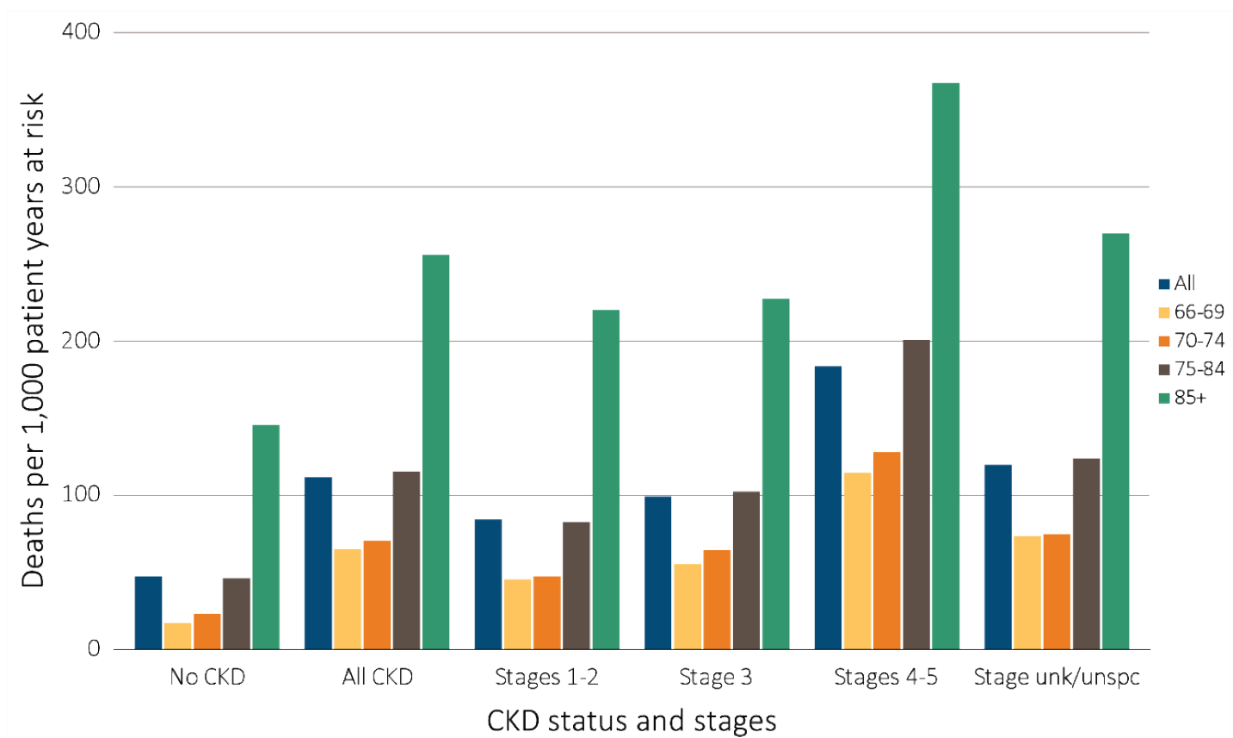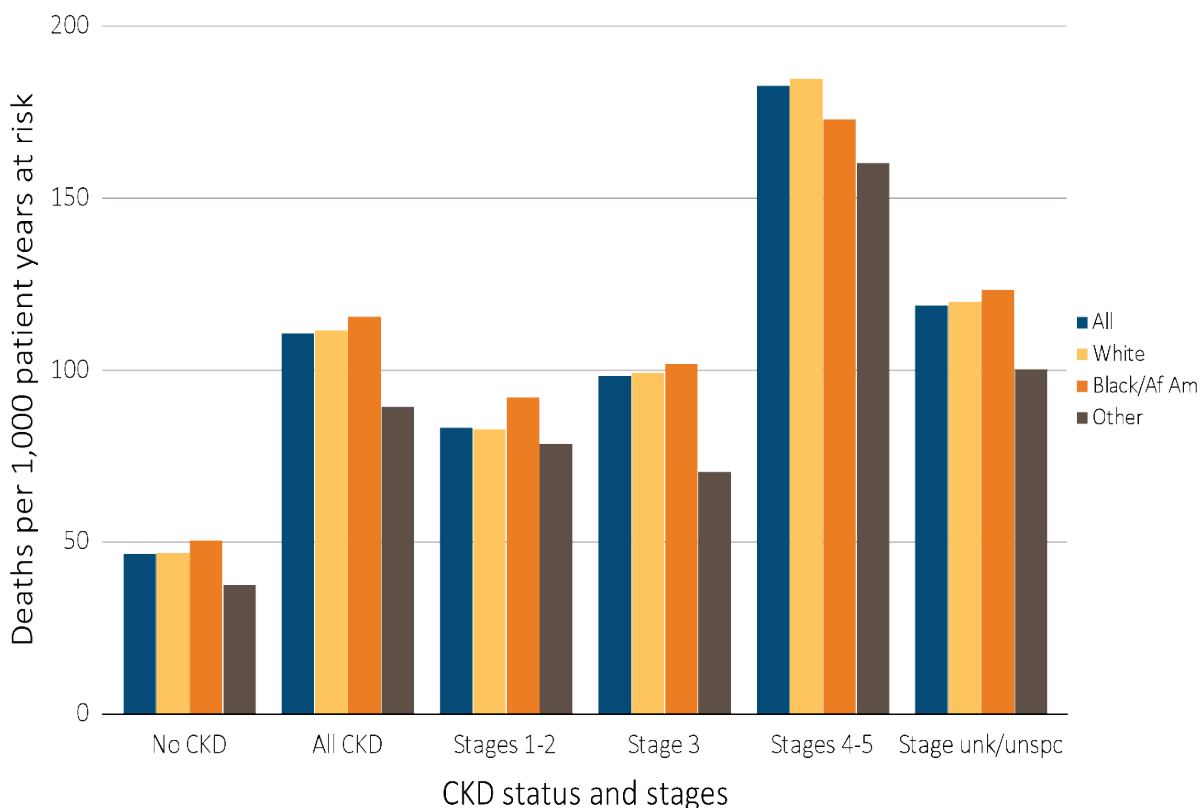

Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race. Standard population Medicare 2015 patients. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

A comparison of adjusted 2015 mortality rates by CKD group and sex is shown in Figure 3.4. The rates for males were higher than for females in all stages.

vol 1 Figure 3.4 Adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by sex, CKD status, and stage, 2015
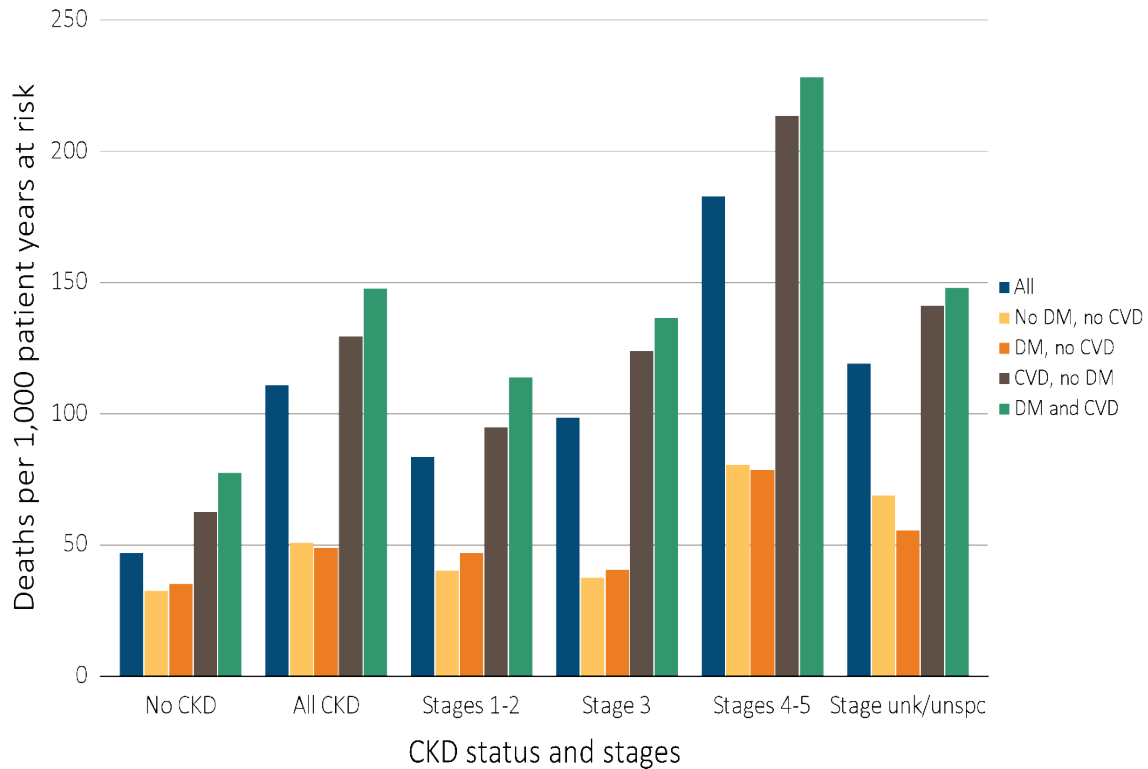

Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race. Standard population Medicare 2015 patients. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Figure 3.5 illustrates mortality rates adjusted by race, CKD status, and stage. The rates for the CKD group were more than twice those of the no-CKD group for patients of all races. Variation by race was inconsistent across CKD stages. Rates were higher for Blacks than Whites in all Stages except for 4 to 5. For Whites the adjusted rates were 82 per 1,000 patient-years at risk for Stages 1 or 2, 98 per 1,000 for Stages 3, and 184 for Stages 4 to 5. The Black patient group showed adjusted rates of 91 deaths per 1,000 patient-years at risk in Stages 1 or 2, with 101 per 1,000 and 172 per 1,000 in Stages 3 and 4 to 5.

vol 1 Figure 3.5 Adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by race, CKD status, and stage, 2015

Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race. Standard population Medicare 2015 patients. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Adjusted rates of mortality also increased with greater patient health complexity. Figure 3.6 presents mortality rates by the presence of two common comorbidities of CKD—DM and CVD. These comorbid conditions dramatically influenced the health outcomes. In 2015, those with CKD but without DM or CVD had an adjusted mortality rate of 50 deaths per 1,000 patient-years at risk, while those with both DM and CVD experienced triple that rate, at 146 deaths per 1,000 patient-years. Diabetes alone, however, did not increase mortality risk among persons with CKD, at 48 deaths per 1,000 patient-years at risk.

vol 1 Figure 3.6 Adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by cardiovascular disease and diabetes mellitus, CKD status, and stage, 2015

Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race. Standard population Medicare 2015 patients. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; unk/unspc, CKD stage unidentified.

Hospitalization Rates

Table 3.2 presents all-cause hospitalization rates in 2015 for older Medicare patients and younger Optum Clinformatics™ patients, by whether they had recognized CKD during 2015. Among Medicare patients, the unadjusted rate for those with CKD was 614 hospitalizations per 1,000 patient-years at risk, compared to a much lower rate of 227 for patients without CKD. Among Optum Clinformatics™ patients, the unadjusted rate for those with CKD was 214 hospitalizations per 1,000 patient-years at risk, compared to a much lower rate of 36 for patients without CKD.

Across all demographic characteristics, the 2015 unadjusted hospitalization rate for patients with CKD was more than twice the corresponding rate for patients without CKD. Once adjustment was made for age, race, and sex, the hospitalization rate for Medicare patients with CKD of 581 per 1,000 patient-years at risk was 151.2% greater than for those without CKD, at 231 per 1,000. The hospitalization rate for Optum Clinformatics™ patients with CKD of 180 per 1,000 patient-years at risk was 400% greater than for those without CKD, at 36 per 1,000. As with mortality, the adjusted hospitalization rate increased with age for all patients, except those 40-65 years.

In contrast to the mortality findings, however, women with CKD had higher adjusted hospitalization rates of 592 per 1,000 patient-years at risk than did men, at 574 per 1,000. For Medicare recipients, women without CKD had lower adjusted hospitalization rates of 229 per 1000 than did men, at 235. For Optum Clinformatics™ patients, women had higher unadjusted and adjusted hospitalization rates than men, in both the with and without CKD cohorts.

vol 1 Table 3.2 Unadjusted and adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare and Optum Clinformatics™ patients, by CKD status, 2015
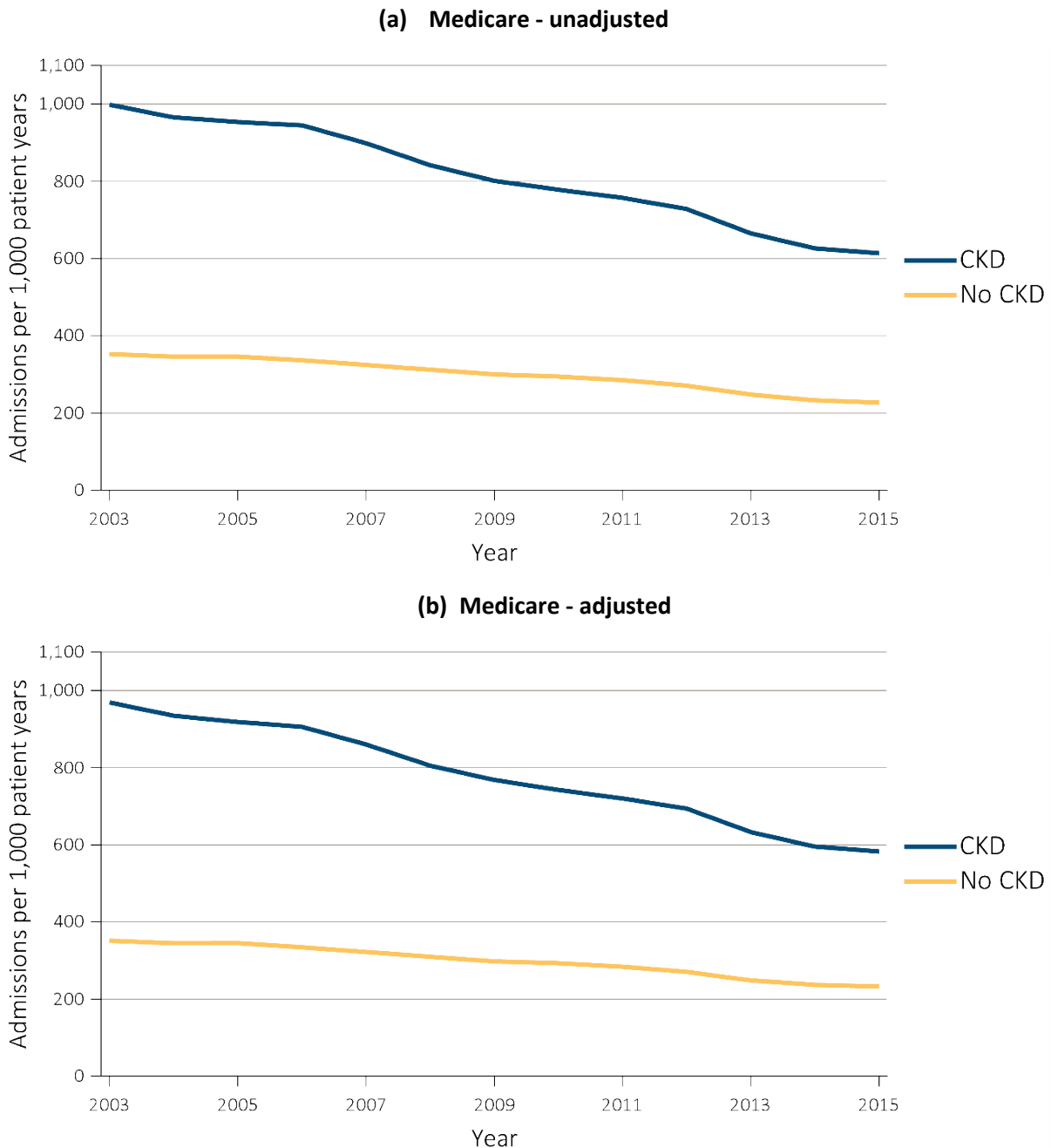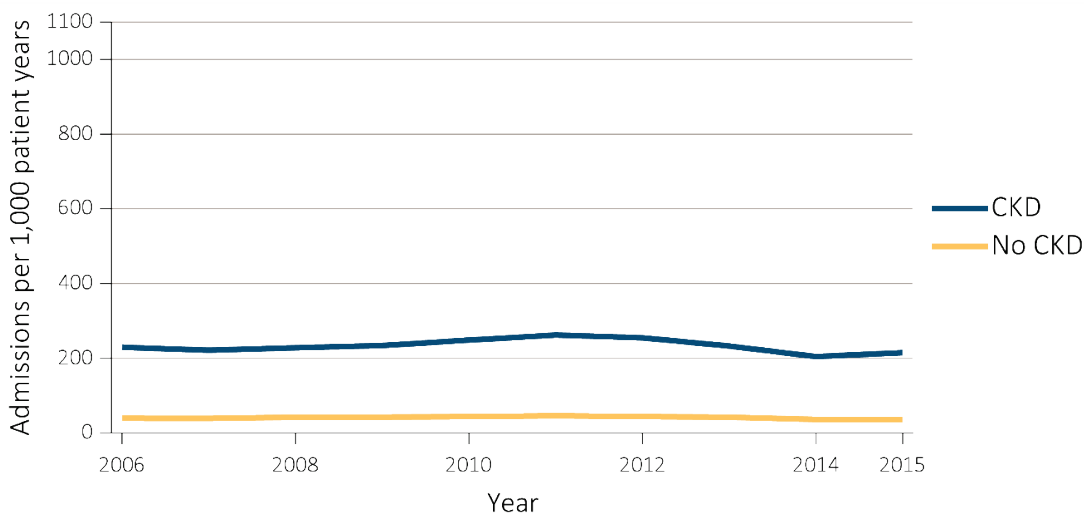
	Medicare (aged 66+)				Optum Clinformatics™ (aged 22+)			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	No CKD	All CKD	No CKD	All CKD	No CKD	All CKD	No CKD	All CKD
All	226.8	613.8	231.0	581.1	35.8	214.1	35.9	179.8
Age								
22-39	·	·	·	·	34.7	156.2	35.5	154.6
40-65	·	·	·	·	32.8	186.1	32.8	186.4
65+	·	·	·	·	102.7	342.0	100.9	343.3
66–69	137.7	519.7	138.5	521.1	·	·	·	·
70–74	179.8	516.7	179.5	519.9	·	·	·	·
75–84	261.7	610.7	261.4	608.9	·	·	·	·
85+	413.8	750.0	416.7	752.2	·	·	·	·
Sex								
Male	219.1	603.4	234.8	573.5	25.5	202.0	25.6	161.5
Female	232.6	623.4	228.8	591.8	46.3	230.3	46.4	197.2
Race								
White	230.3	612.3	232.8	580.3	38.0	226.4	37.9	188.7
Black/African American	237.4	677.9	250.2	664.3	28.6	225.5	38.6	194.8
Other	163.9	520.0	179.6	491.2	38.6	165.2	29.0	147.4

Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2015 point prevalent Medicare patients, aged 66 and older. Standard population all Medicare patients, 2015. Optum Clinformatics™ commercial insurance patients aged 22 and older who were enrolled in the plan, did not have diagnoses of ESRD, and were alive on January 1, 2015. Adjusted for age/sex/race; rates by one factor are adjusted for the others. .No data available, cell intentionally left blank. Standard population all Optum Clinformatics™ patients, 2015. Abbreviation: CKD, chronic kidney disease.

Figure 3.7 presents the trends in hospitalization rates for Medicare and Optum Clinformatics™ patients over the past 13 years. The overall trend relationships between adjusted and unadjusted rates, CKD and no-CKD groups, were consistent with other data presented thus far.

After adjustment, the pattern of hospitalization rates across this time frame showed a gradual decline and less variability. A reduction in hospitalization rates occurred from 2014 to 2015. Even after adjustment the Medicare rates showed a decrease—by 2.1%, from 595 to 583 per 1,000 patient-years at risk for the CKD group, and by 1.7%, from 237 to 233 per 1,000 for the no-CKD group. Conversely, an increase in hospitalization rates occurred from 2014 to 2015 in the Optum Clinformatics™ population. Even after adjustment this CKD group increased by 3.9%, from 174 to 181 per 1,000 patient-years at risk.

vol 1 Figure 3.7 Unadjusted and adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare and Optum Clinformatics™ patients, by CKD status and year, 2003-2015
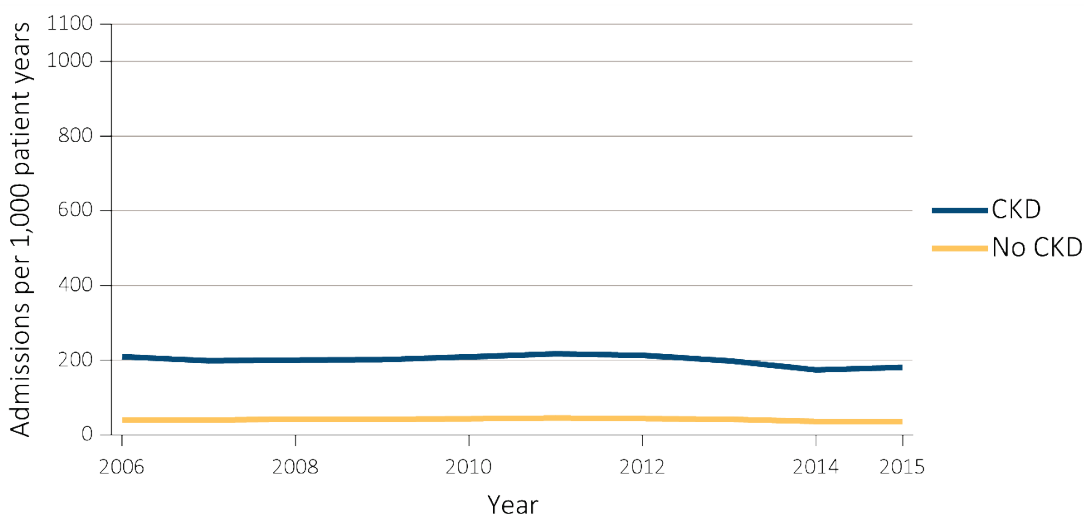

(a) Medicare - unadjusted

(b) Medicare - adjusted

Figure 3.7 continued on next page.

vol 1 Figure 3.7 Unadjusted and adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare and Optum Clinformatics™ patients, by CKD status and year, 2003-2015 *(continued)*

(c) Optum Clinformatics™ - unadjusted

(d) Optum Clinformatics™ - adjusted

Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2015 point prevalent Medicare patients, aged 66 and older. Standard Medicare population all patients, 2014. Optum Clinformatics™ commercial insurance patients aged 22 and older who were enrolled in the plan, did not have diagnoses of ESRD, and were alive on January 1, 2015. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard Optum Clinformatics™ population all patients, 2014. Abbreviation: CKD, chronic kidney disease.

For patients with CKD, differences were observed in the rates of hospitalizations necessary to treat different comorbid conditions. Figure 3.8 shows the adjusted hospitalization rates for all causes. In Figures 3.9 through 3.11 we present Medicare hospitalization rates resulting from CVD (22.5% of all-cause admissions), infection (20.8%), and from a combination of all other cause categories (56.7%). For the Optum Clinformatics™ population we also present hospitalization rates resulting from CVD (10.7% of all-cause admissions), infection (8.3.%), and all other cause categories (75.1%). As the covariates in the adjusted model no longer include comorbidities and prior year hospitalizations, the Medicare adjusted rates may vary noticeably from results presented prior to the 2014 ADR.
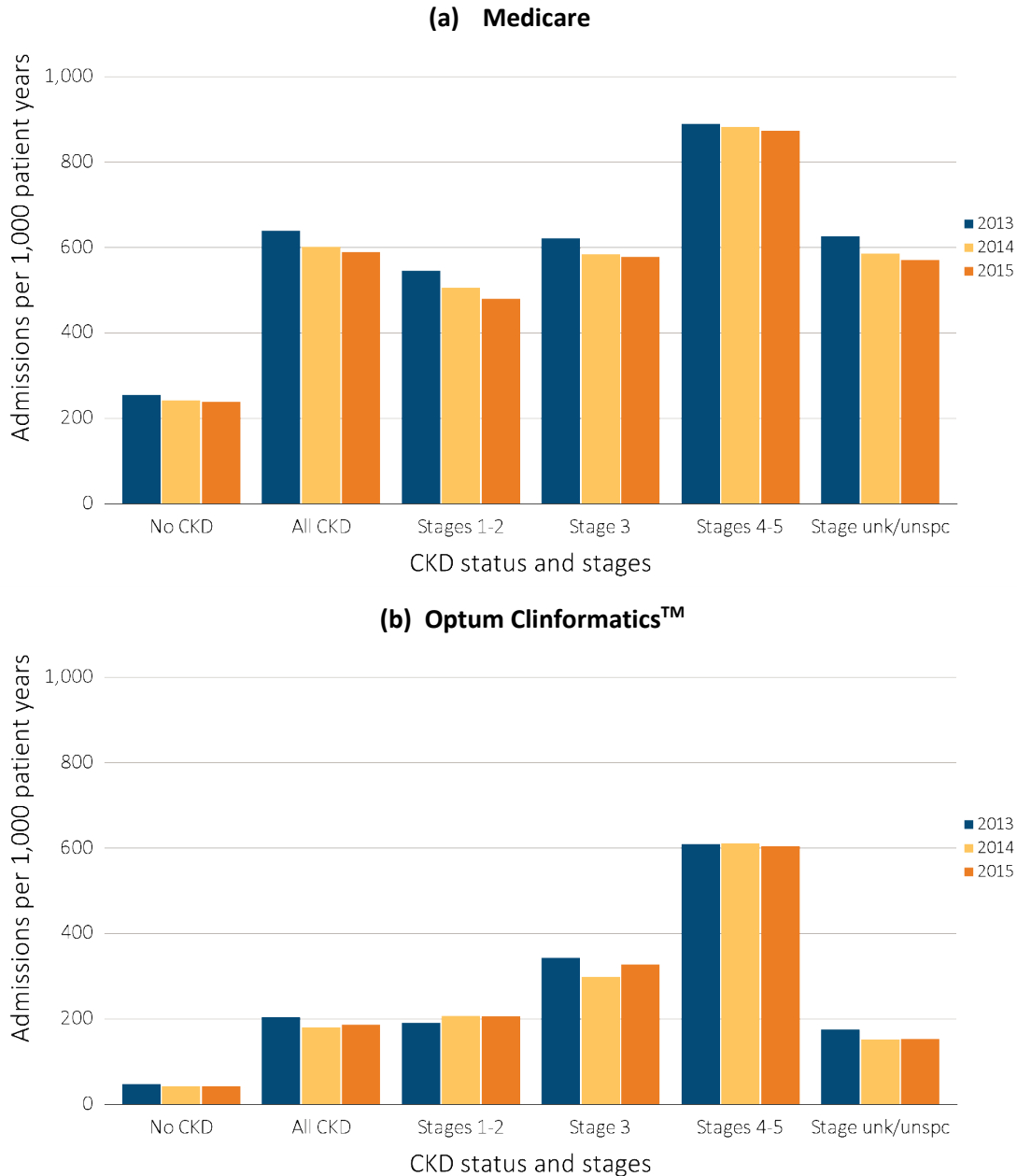
Rates of all-cause hospitalizations in 2015 increased with disease severity, from 474 admissions per 1,000

patient-years for Medicare patients in Stages 1 or 2, to 572 for Stage 3, and 866 for Stages 4 or 5. Rates also increased with severity for the Optum Clinformatics™ cohort, from 201 admissions per 1,000 patient-years for those in Stages 1 or 2, to 322 for Stage 3, and 598 for Stages 4 or 5 (see Figure 3.8).

The pattern of increase for Medicare hospitalizations resulting from a primary diagnosis of
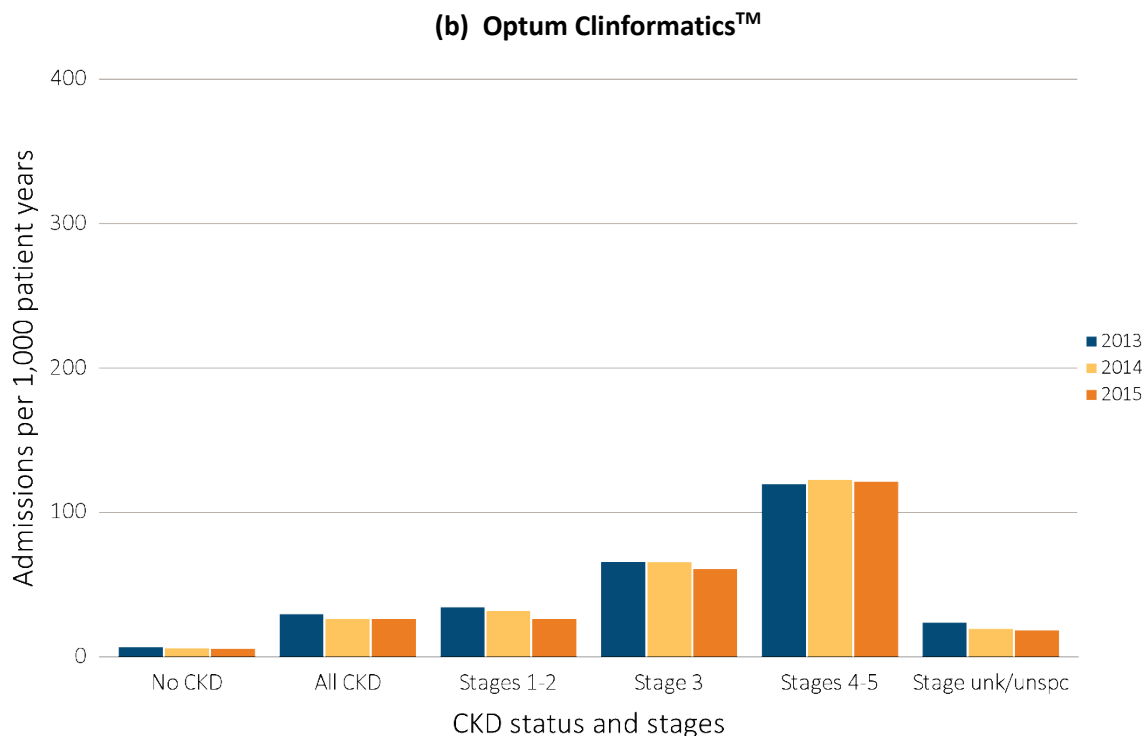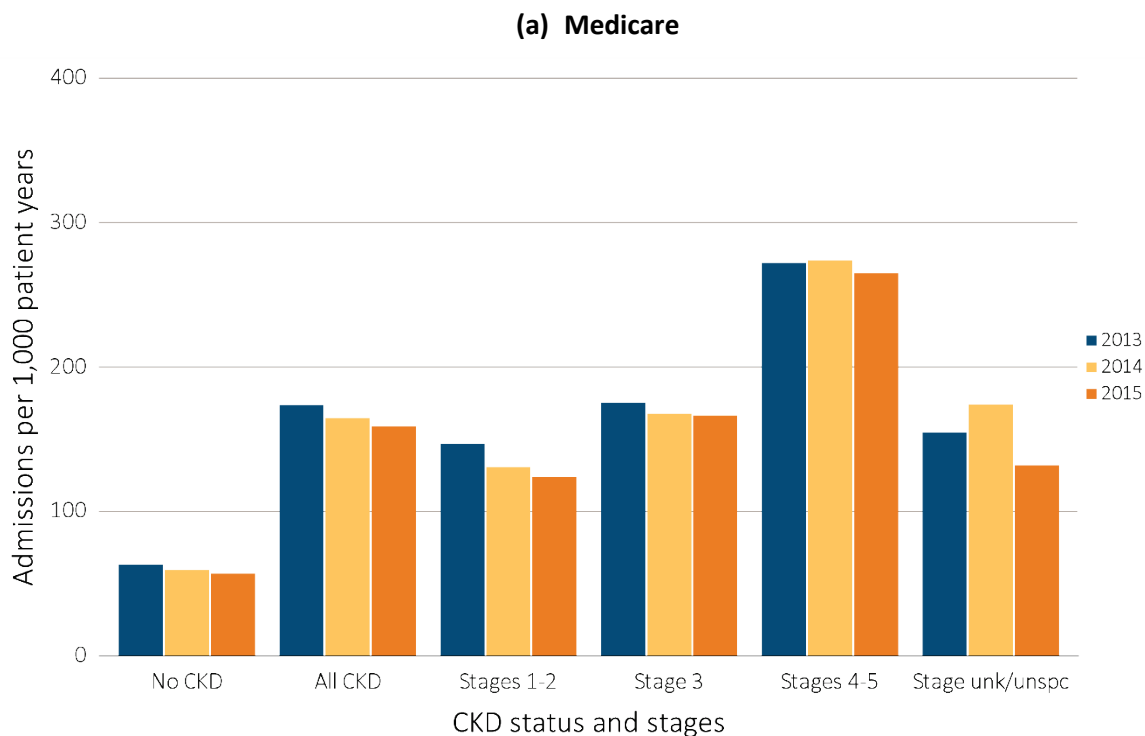
CVD was similar, with rates rising from 122 admissions per 1,000 patient-years for CKD Stages 1 or 2, to 164 for Stage 3, and 263 for Stages 4 or 5. Patients in the Optum Clinformatics™ group experienced 24 admissions per 1,000 patient-years in Stages 1 or 2, increasing to 59 for Stage 3, and 119 for Stages 4 or 5 (see Figure 3.9).

vol 1 Figure 3.8 Adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare and Optum Clinformatics™ patients aged 66 and older, by CKD status and stage, 2013-2015

(a) Medicare
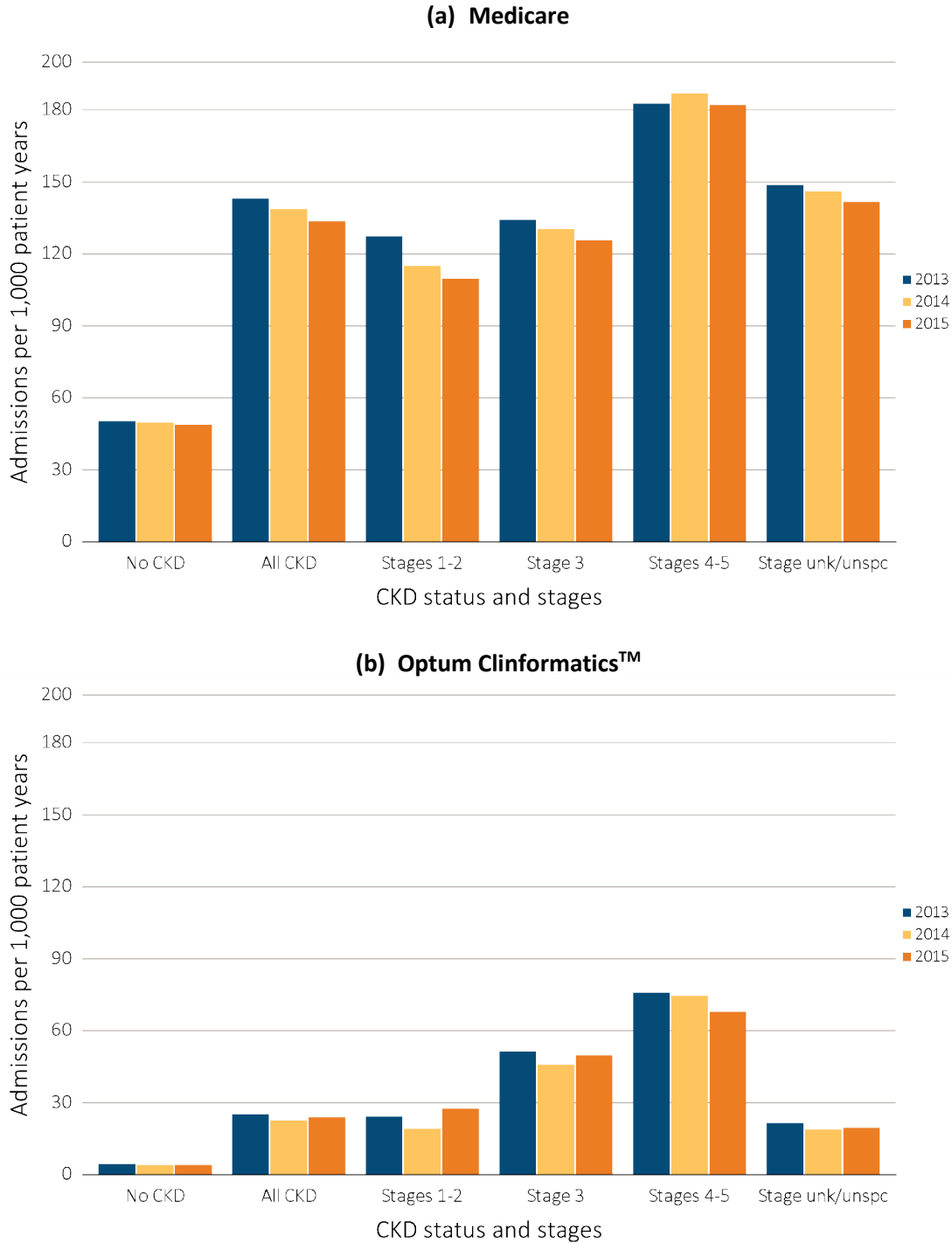

(b) Optum Clinformatics™

Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2015 point prevalent Medicare patients, aged 66 and older. Standard Medicare population all patients, 2014. Optum Clinformatics™ commercial insurance patients aged 22 and older who were enrolled in the plan, did not have diagnoses of ESRD, and were alive on January 1, 2015. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population all Optum Clinformatics™ patients, 2014. Abbreviations: CKD, chronic kidney disease unk/unspc, CKD stage unidentified.

vol 1 Figure 3.9 Adjusted rates of hospitalization for cardiovascular disease per 1,000 patient-years at risk for Medicare and Optum Clinformatics™ patients aged 66 and older, by CKD status and stage, 2013-2015
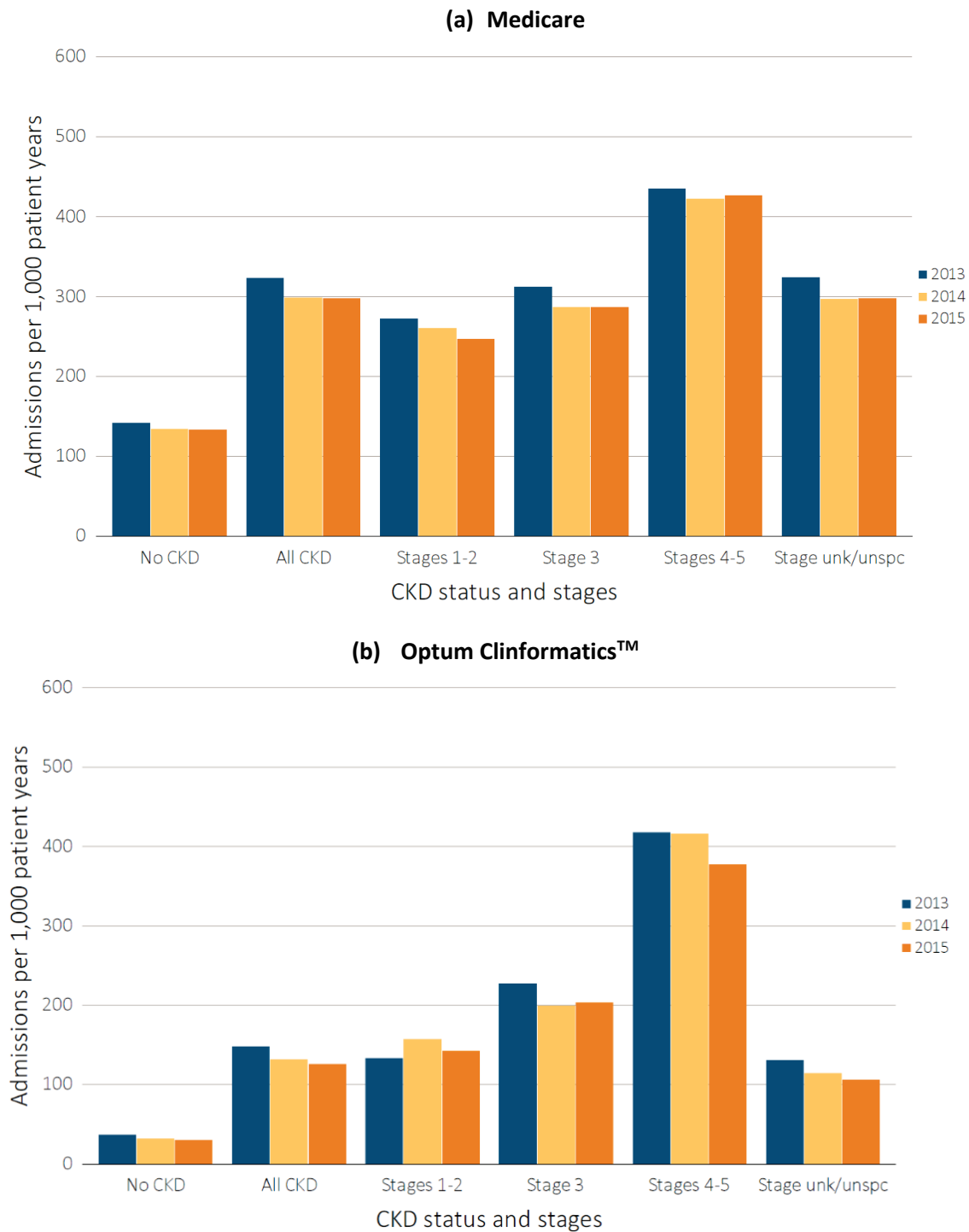

Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2015 point prevalent Medicare patients, aged 66 and older. Standard Medicare population all patients, 2014. Optum Clinformatics™ commercial insurance patients aged 22 and older who were enrolled in the plan, did not have diagnoses of ESRD, and were alive on January 1, 2015. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard Optum Clinformatics™ population all patients, 2014. Abbreviations: CKD, chronic kidney disease unk/unspc, CKD stage unidentified.

Adjusted rates of hospitalization for infection are shown by CKD status and stage in Figure 3.10. Rates in all subgroups decreased from 2013 to 2015, with a small exception for 2014 Medicare patients with Stages 4 or 5. Among Optum Clinformatics™ patients, hospitalization rates did decrease from 2013 to 2015 in Stages 4 or 5.

vol 1 Figure 3.10 Adjusted rates of hospitalization for infection per 1,000 patient-years at risk for Medicare and Optum ClinformaticsTM patients aged 66 and older, by CKD status and stage, 2013-2015
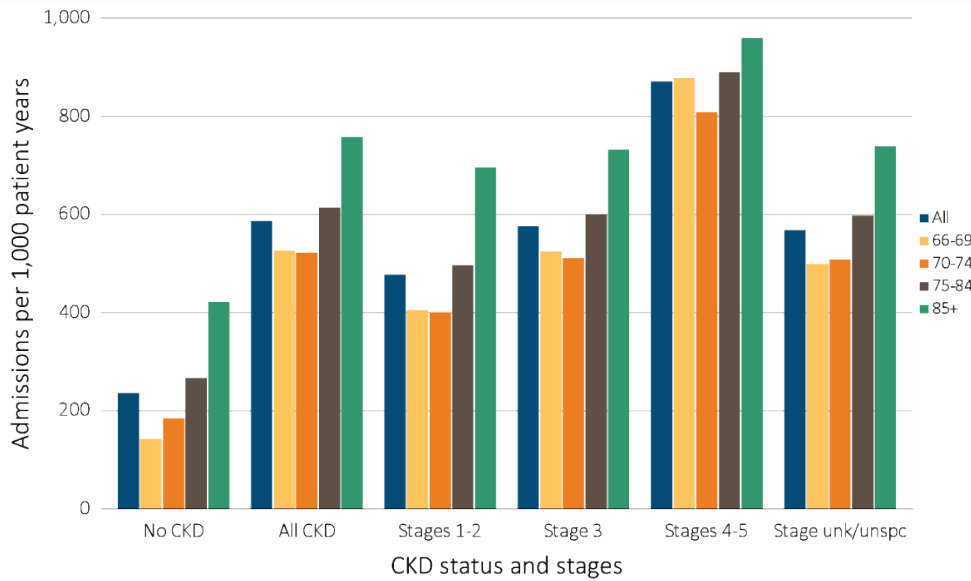

(a) Medicare

(b) Optum Clinformatics™

Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2015 point prevalent Medicare patients, aged 66 and older. Standard Medicare population all patients, 2014. Optum Clinformatics™ commercial insurance patients aged 22 and older who were enrolled in the plan, did not have diagnoses of ESRD, and were alive on January 1, 2015. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population all Optum Clinformatics™ patients, 2014. Abbreviations: CKD, chronic kidney disease unk/unspc, CKD stage unidentified.

Figure 3.11 presents the adjusted rates of hospitalization resulting from all other health causes. The pattern was similar to that seen in Figure 3.8, with admission rates for Medicare patients steadily decreasing from 2013 to 2015.

vol 1 Figure 3.11 Adjusted rates of hospitalization for causes other than cardiovascular disease and infection per 1,000 patient-years at risk for Medicare and Optum Clinformatics™ patients aged 66 and older, by CKD status and stage, 2013-2015

(a) Medicare

(b) Optum Clinformatics™

Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2015 point prevalent Medicare patients, aged 66 and older. Standard Medicare population all patients, 2014. Optum Clinformatics™ commercial insurance patients aged 22 and older who were enrolled in the plan, did not have diagnoses of ESRD, and were alive on January 1, 2015. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard Optum Clinformatics™ population all patients, 2014. Abbreviations: CKD, chronic kidney disease unk/unspc, CKD stage unidentified.

Demographic comparisons also highlight differences in all-cause hospitalization rates for CKD, as shown in Figures 3.12-3.14. In general, and consistent with mortality patterns, older Medicare patients exhibited higher rates of hospitalization than did the younger age cohorts, although the age effect was less pronounced for the CKD population than for the non CKD population.

vol 1 Figure 3.12 Adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by age, CKD status, and stage, 2015
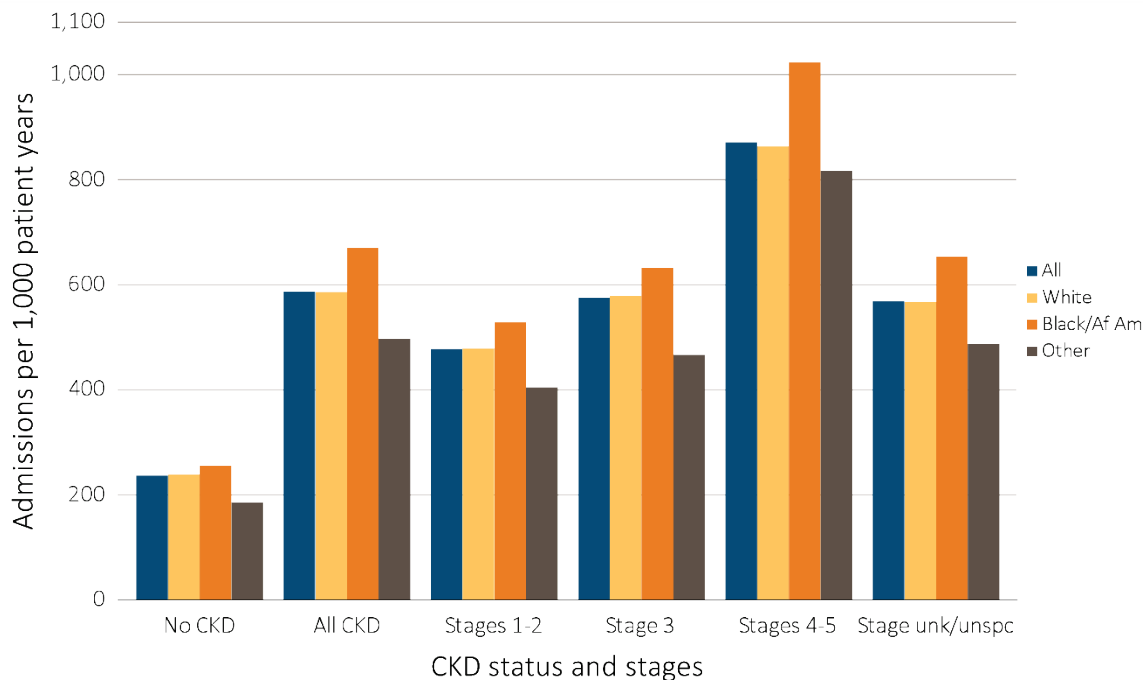

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population all patients, 2015. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

A comparison of adjusted 2015 all-cause hospitalization rates by CKD group and sex is shown in Figure 3.13. The rates for females in all stages of CKD were slightly higher than for males.

vol 1 Figure 3.13 Adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by sex, CKD status, and stage, 2015
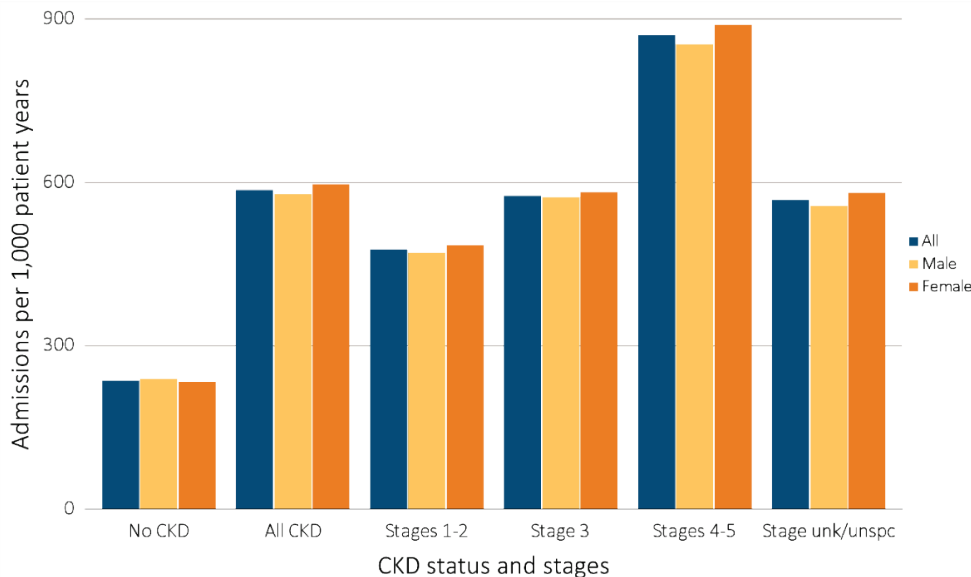
Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population all patients, 2015. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Racial differences in Medicare hospitalization rates were notable. In both the CKD and no-CKD populations, Black patients were hospitalized more frequently than those of Other races. In 2015, Black patients in the CKD group showed higher rates than did Whites or those of Other races, at 664 per 1,000 patient-years versus 580 for Whites and 491 for other

patients (Figure 3.14). This disparity decreased with disease severity; rates for Black patients were 10.6% higher than Whites in Stages 1 or 2 (523 vs. 473), 9.4% higher in Stage 3 (627 vs. 573) and 18.6% higher in Stages 4 or 5 (1018 vs. 858). Patients of Other races experienced the lowest rates of hospitalization in all disease stages.

vol 1 Figure 3.14 Adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by race, CKD status, and stage, 2015
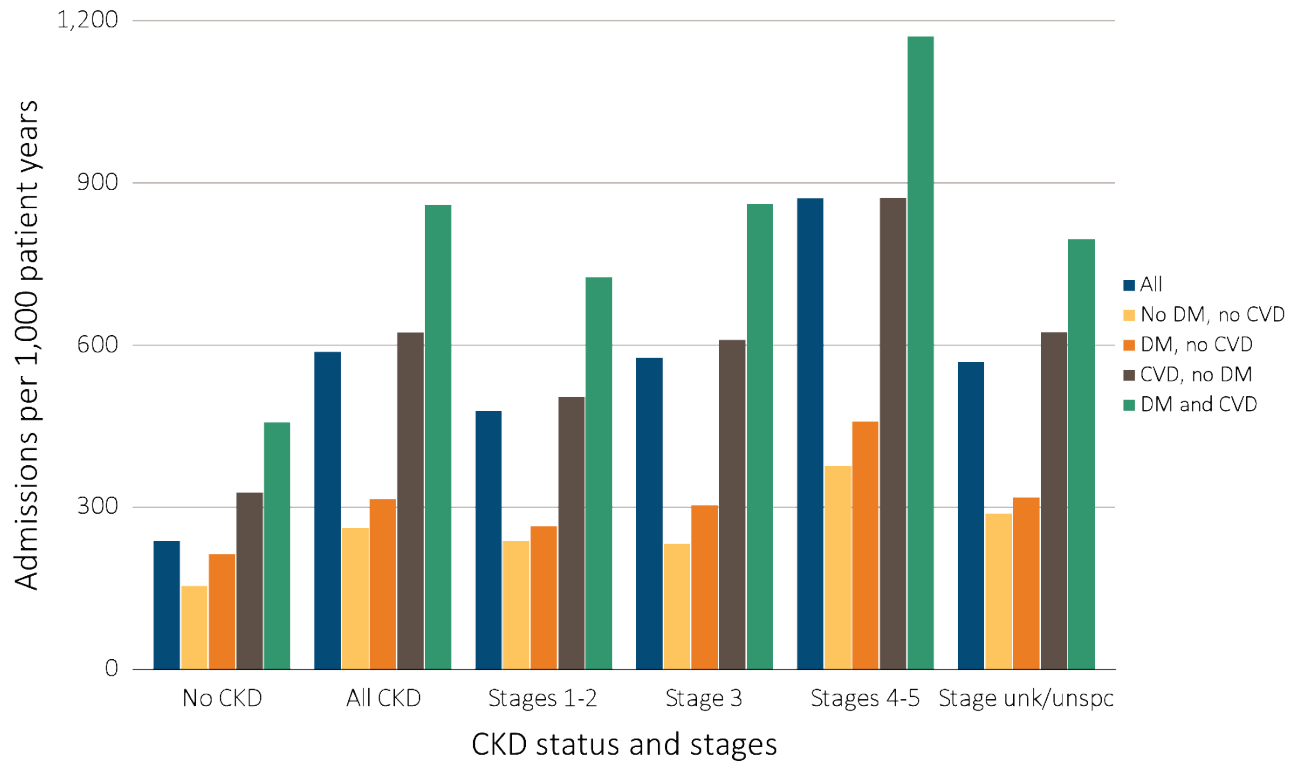

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population all patients, 2015. Abbreviations: Af Am, African American; CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Adjusted rates of all-cause hospitalizations increased in the presence of DM and CVD for Medicare patients both with and without CKD (see Figure 3.15). In the no-CKD population, the adjusted hospitalization rates were 148 per 1,000 patient-years for those without DM or CVD, 207 per 1,000 for patients with DM only, 321 for those with CVD only, and 451 for patients with both DM and CVD.

In 2015, admissions per 1,000 patient-years for those with CKD increased from 255 for patients

without DM or CVD, to 309 for those with only DM and 617 with only CVD, to a high of 853 for CKD patients with both comorbidities. This additional disease burden was most striking for patients with Stage 4 or 5 CKD. Patients with both DM and CVD in addition to late-stage CKD had an all-cause hospitalization rate of 1,165 admissions per 1,000 patient-years, compared to only 370 for late-stage CKD patients without either comorbidity.

vol 1 Figure 3.15 Adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by cardiovascular disease and diabetes mellitus, CKD status, and stage, 2015

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population all patients, 2015. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; unk/unspc, CKD stage unidentified.

Rehospitalization

Reducing the rate of patient readmission that occurs within 30 days of discharge from their original hospitalization is a quality assurance goal for many healthcare systems, including the Medicare program. Table 3.3 shows the distribution of unadjusted percentages of rehospitalization in the 2015 Medicare population among those with and without recognized CKD, by CKD stage, and stratified by age group, sex,

and race. The unadjusted proportion of Medicare patients aged 66 and older who were readmitted to the hospital within 30 days of discharge from a first, all-cause hospitalization was 15.5% for those without CKD and 21.5% for those with CKD (see Table 3.3). These rates represent a slight increase from 2014 levels. Rehospitalization rates increased slightly with stage of CKD, from 20.3% in Stages 1 or 2 to 23.4% in Stages 4 or 5.

vol 1 Table 3.3 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by CKD status and stage, 2015

|	No CKD (%)	All CKD (%)	Stages 1 or 2 (%)	Stage 3 (%)	Stages 4 or 5 (%)	Stage Unknown /unspecified (%)
All	15.5	21.5	20.3	21.4	23.4	23.1
Age						
66-69	15.2	23.8	22.5	23.2	21.0	22.1
70-74	14.8	22.2	19.4	22.1	25.6	22.0
75-84	15.6	22.2	20.7	22.4	23.2	21.7
85+	15.8	20.3	19.9	20.1	22.0	20.0
Sex						
Male	16.2	21.7	21.2	21.8	23.5	20.9
Female	14.9	21.3	19.4	21.0	23.4	21.3
Race						
White	15.3	21.1	19.6	21.2	22.9	20.7
Black/African American	17.6	23.5	23.1	23.3	25.6	22.8
Other	15.5	22.8	23.8	21.1	24.6	24.2
Rehospitalization						
No rehospitalization & died	4.6	6.2	5.2	5.9	8.1	6.3
Rehospitalization & died	1.7	2.6	2.0	2.5	3.6	2.5
Rehospitalization & lived	13.7	18.8	18.2	18.9	19.7	18.5

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2015, and December 1, 2015; unadjusted. Abbreviation: CKD, chronic kidney disease.

The adjusted trend for Medicare readmissions occurring from 2003-2015 is shown in Figure 3.16. Results may differ from those presented in previous edition ADRs, in part because the adjustment variables of disease comorbidity and prior year hospitalization are no longer applied in the model.

Specifically, the percentage of patients who were rehospitalized and lived within 30 days of their initial discharge declined from 22.5% in 2006 to 18.8% in 2015, a decrease of 16.4% over the 14-year period. While any reductions in readmission are encouraging, the proportion of patients who were rehospitalized and subsequently died within 30 days of the initial discharge has not changed significantly—it has increased by 4.0% from 2014. Of note, the rate of patients who were not rehospitalized but died within 30 days of the initial discharge has decreased somewhat, by 15.9% since 2014.

vol 1 Figure 3.16 Adjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare CKD patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by year, 2003-2015
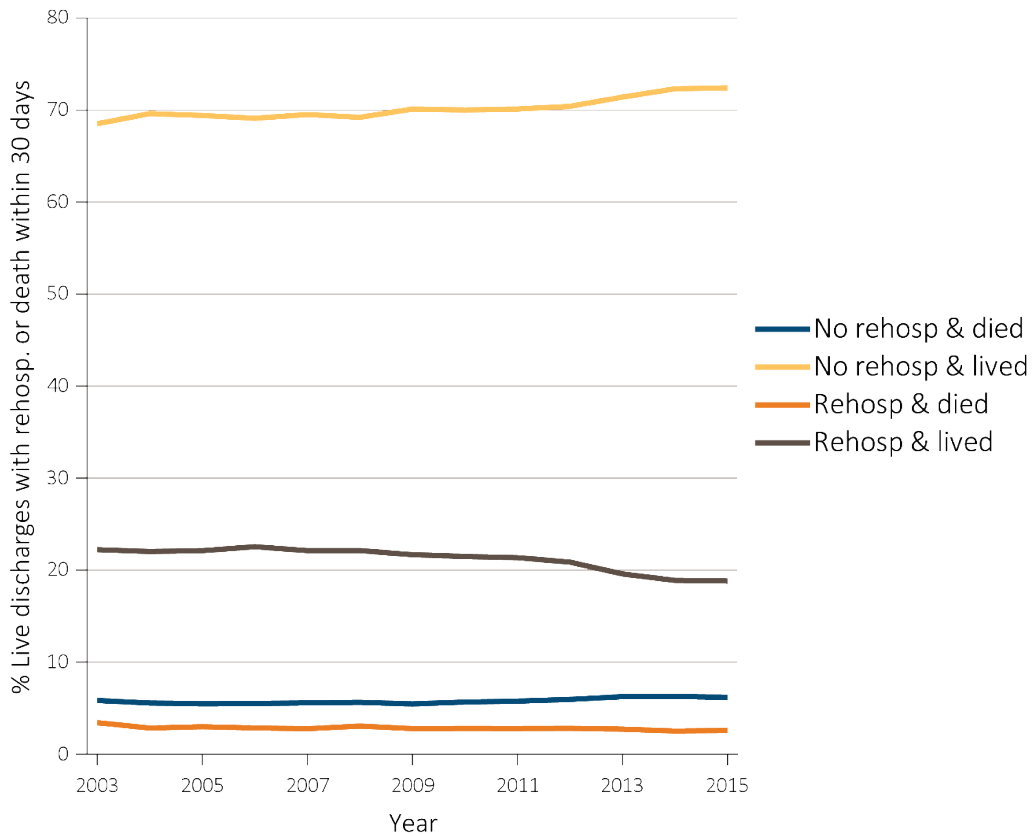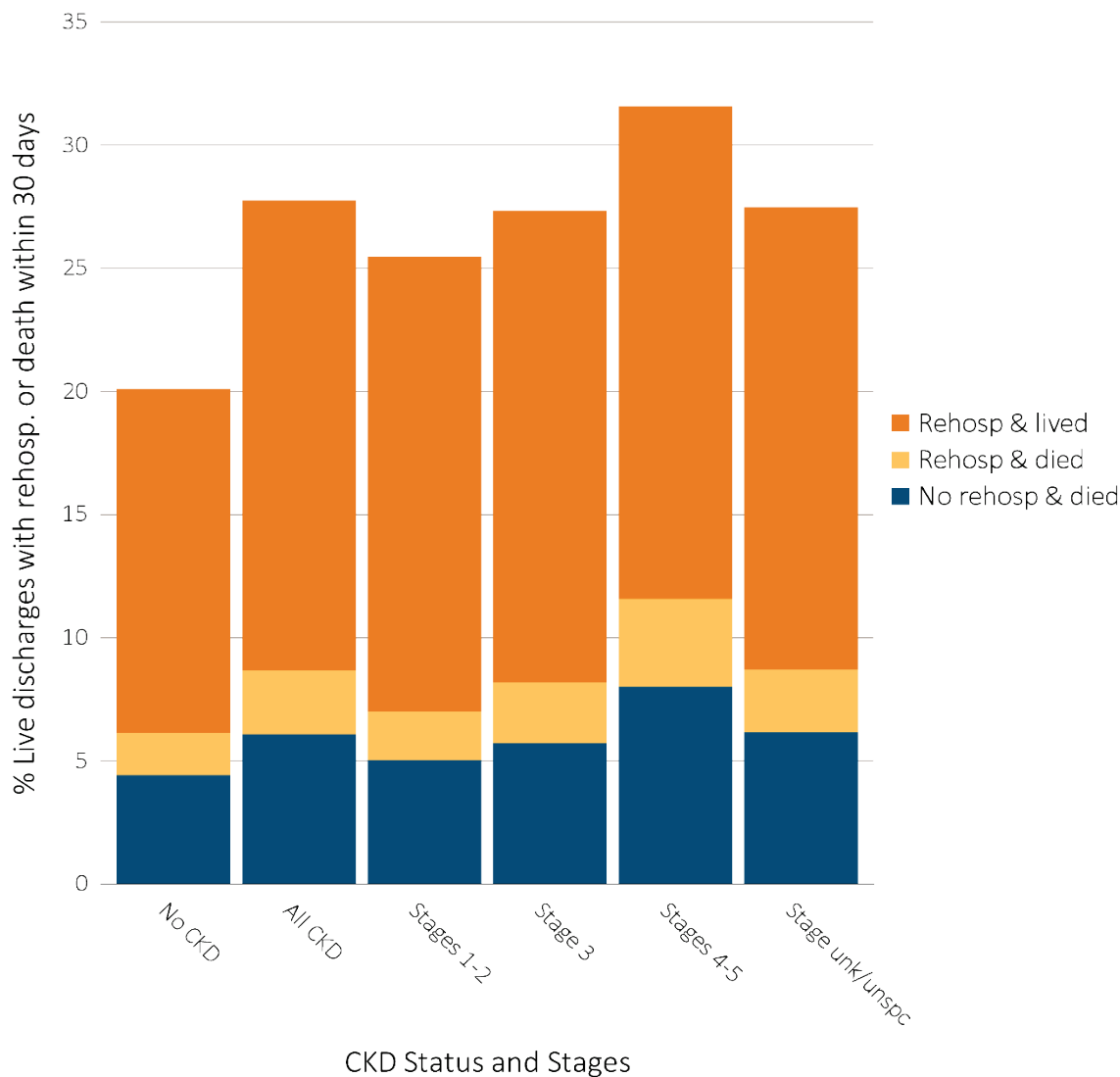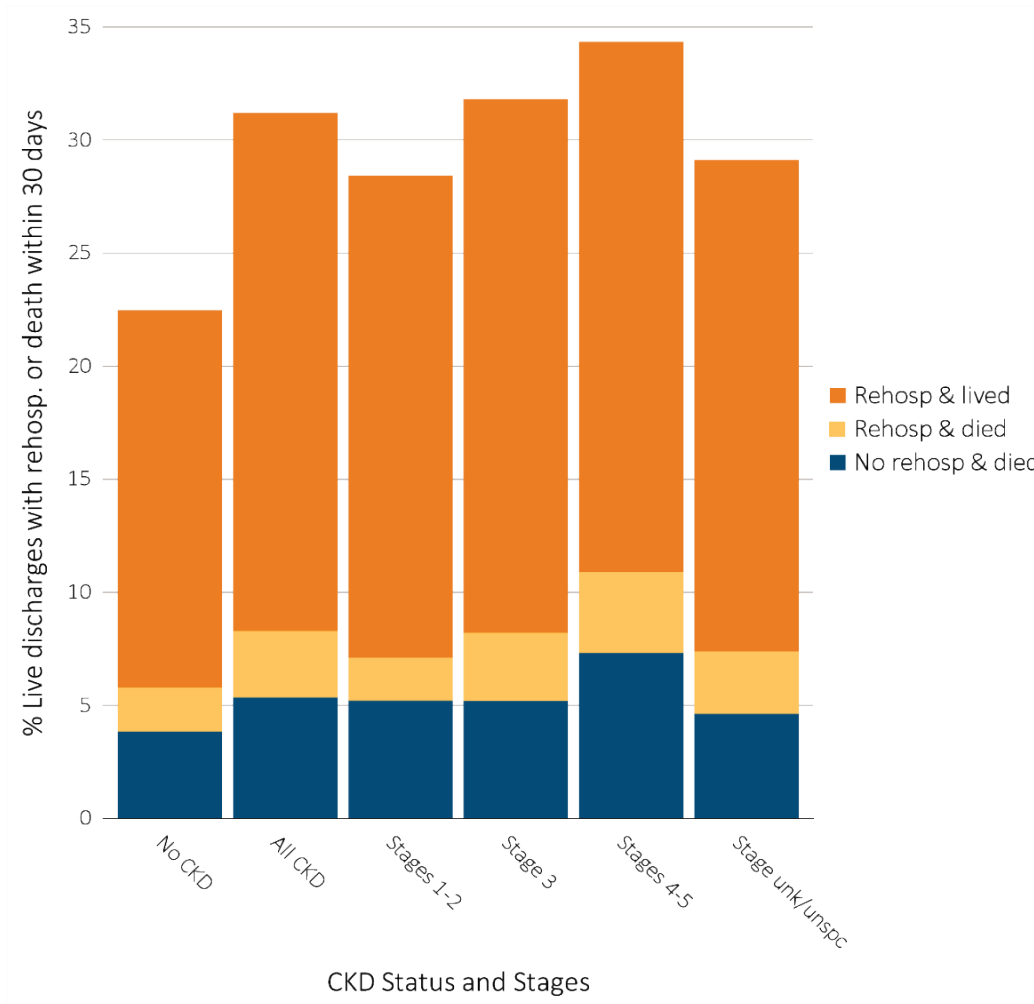

Data source: Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older with CKD (defined during the prior year), discharged alive from an all-cause index hospitalization between January 1 and December 1 of the reported year. Adjusted for age/sex/race. Standard population 2014. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized.

Figure 3.17 presents the percentages of Medicare patients who were rehospitalized and/or died, with or without rehospitalization, within 30 days of discharge following an index hospitalization. Compared to those without a diagnosis of CKD, patients with CKD had a higher proportion of live discharges linked to a rehospitalization or death.

vol 1 Figure 3.17 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by CKD status and stage, 2015

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2015, and December 1, 2015, unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Figure 3.18 shows the death and rehospitalization percentages for older Medicare patients who were discharged alive from a CVD-related index hospitalization; 18.3% of patients with CKD and 13.7% of those without required rehospitalization within 30 days. Otherwise, the magnitude and pattern of these readmission rates were similar to those for all-cause index hospitalizations.

vol 1 Figure 3.18 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from a cardiovascular-related index hospitalization between January 1 and December 1, by CKD status and stage, 2015
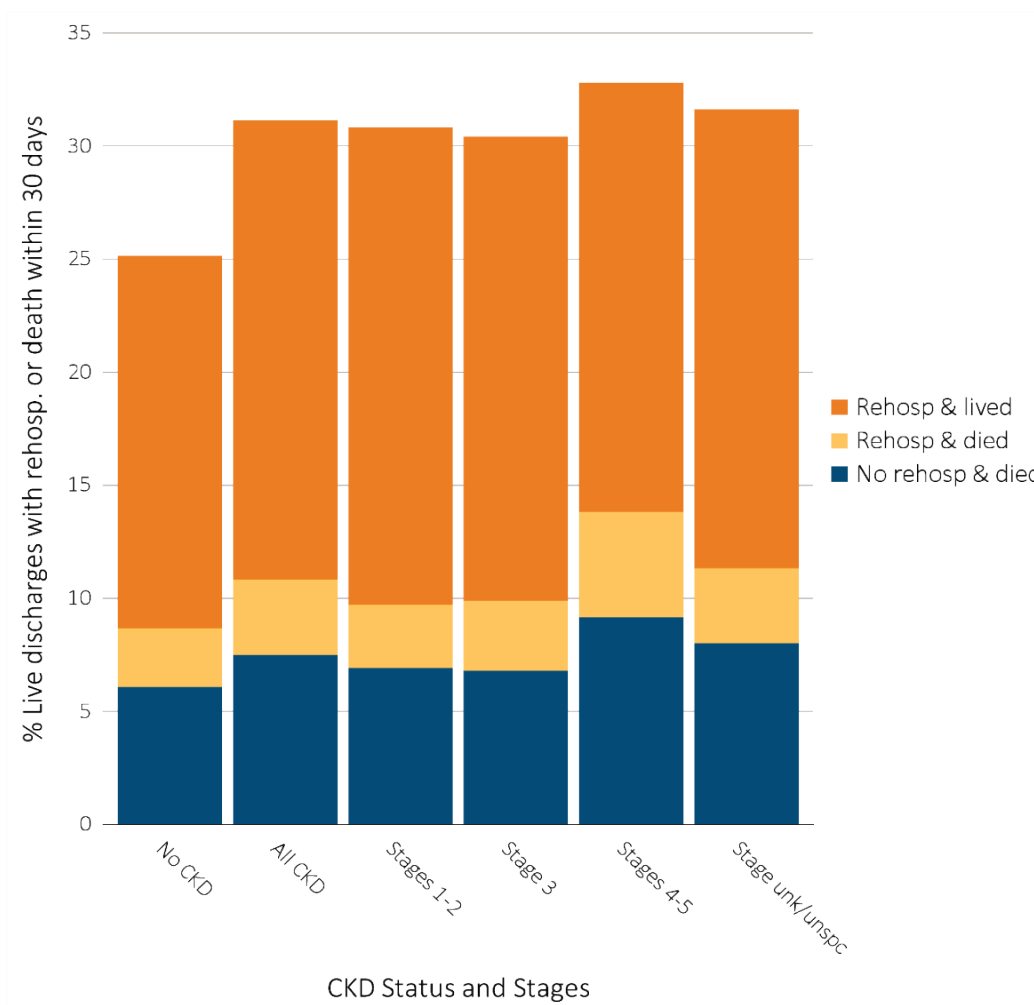

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older, discharged alive from an CVD index hospitalization between January 1, 2015, and December 1, 2015; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Of all patients without CKD who experienced an infection-related admission, 16.2% required rehospitalization (see Figure 3.19). Of these, 2.6% died following rehospitalization, and 6.2% were not rehospitalized and later died. In the CKD group, within 30 days of the initial discharge 20.0% of patients were subsequently rehospitalized and lived, an additional 3.3% died following rehospitalization, and 7.6% of patients were not rehospitalized but later died.

vol 1 Figure 3.19 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an infection-related index hospitalization between January 1 and December 1, by CKD status and stage, 2015
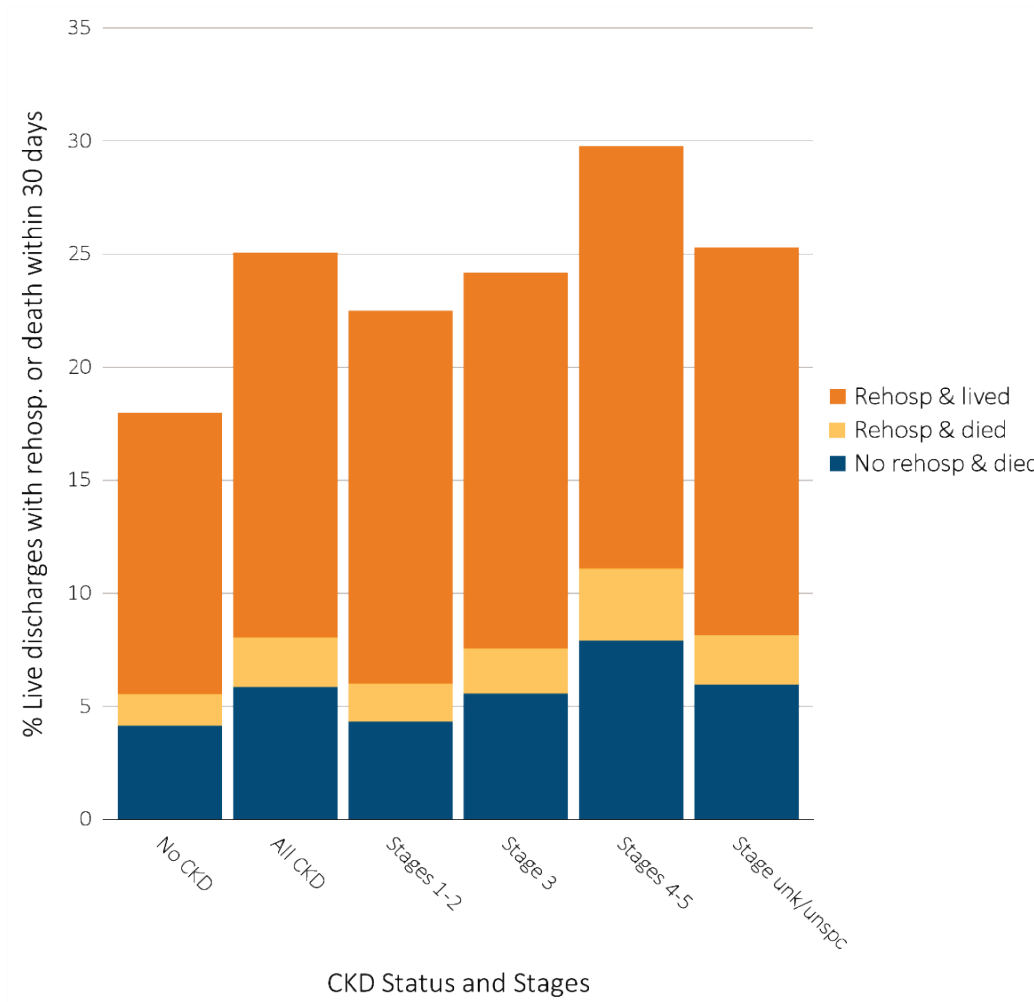

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older, discharged alive from an infection index hospitalization between January 1, 2015, and December 1, 2015, unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Figure 3.20 shows the death and rehospitalization percentages for Medicare patients aged 66 and older who were discharged alive from an index hospitalization for all causes other than CVD and infection. The patterns of these percentages were similar to those for the entire group of index hospitalizations, for all-causes. For those with CKD, 6.0% of patients were not rehospitalized but died, 2.2% were rehospitalized and died, and 16.7% were rehospitalized and lived. In the no-CKD group, these percentages were somewhat lower, at 4.3%, 1.4%, and 12.2%.

vol 1 Figure 3.20 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from a no-cardiovascular and no-infection-related index hospitalization between January 1 and December 1, by CKD status and stage, 2015
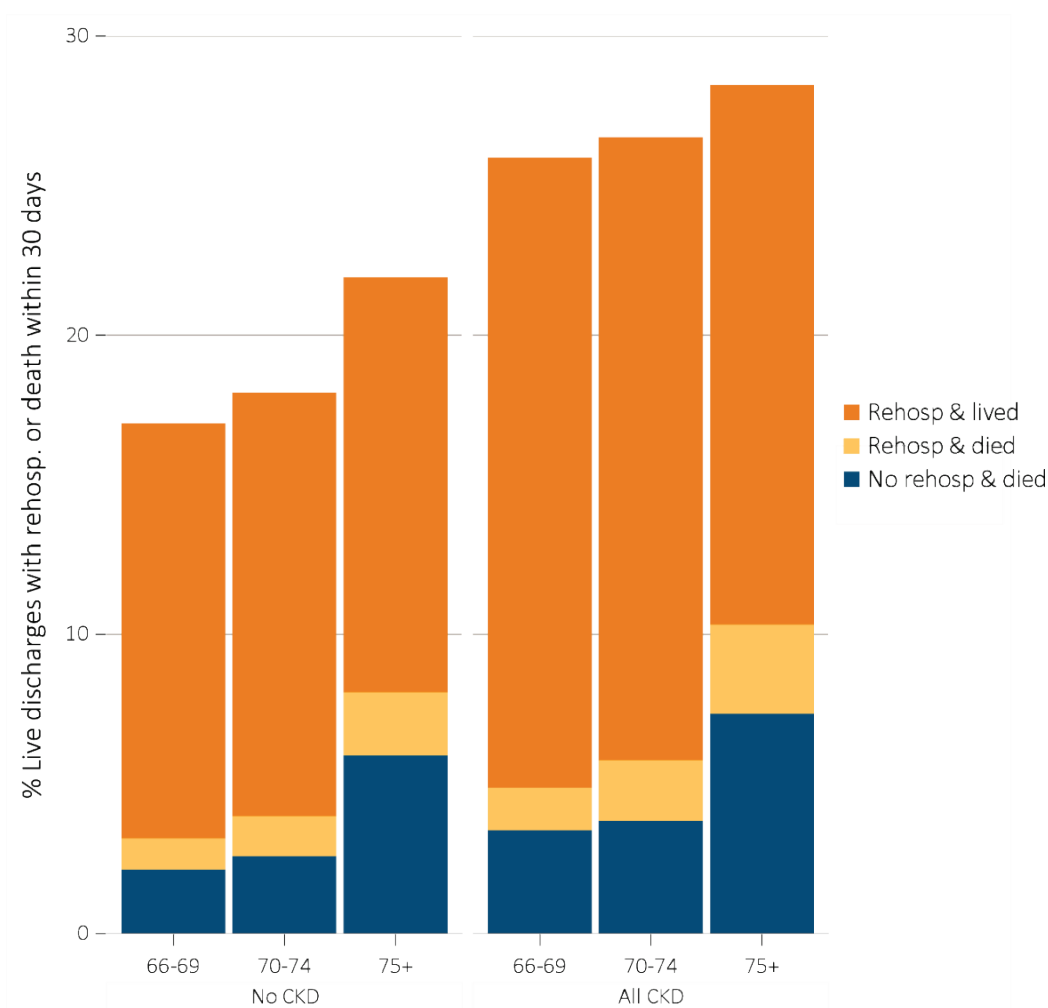

Data Source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older, discharged alive from an no-cardiovascular and no-infection index hospitalization between January 1, 2015, and December 1, 2015; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Figure 3.21 illustrates a comparison by age group and presence of CKD of the percentages of Medicare patients who were rehospitalized or died within 30 days of discharge from an all-cause, index hospitalization. In the Medicare population, rates of rehospitalization with survival decreased with increasing age across all stages of CKD. These findings were likely influenced by the competing risk of death in older age groups. Consistently, for both patients with and without CKD, the proportion returning to the hospital and dying within 30 days of discharge, or dying without rehospitalization, increased with older age.

vol 1 Figure 3.21 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by age and CKD status, 2015
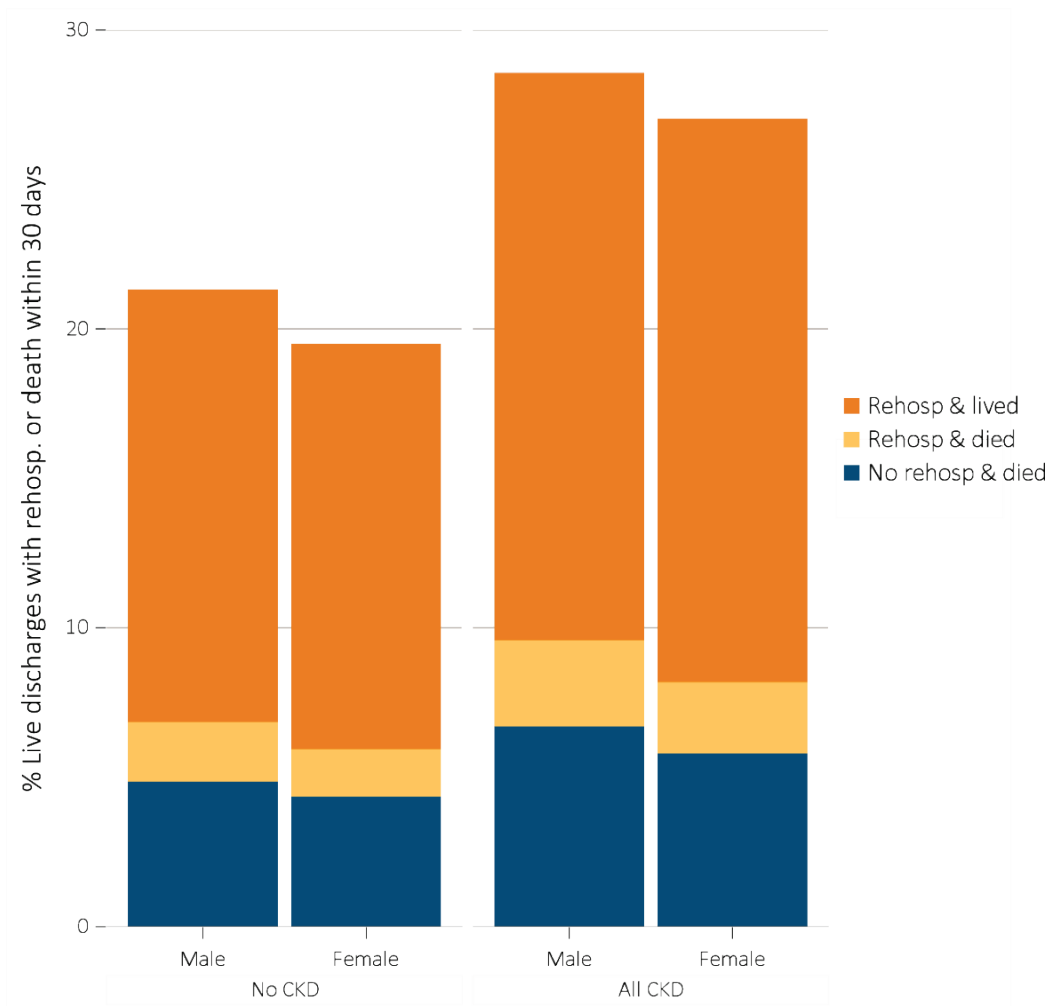

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2015, and December 1, 2015; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized.

Figure 3.22 compares the rates of all-cause hospitalization by sex. Male patients exhibited higher rates than did females in all outcome categories. Specifically, 6.8% of male CKD patients did not require rehospitalization but later died, 2.9% were rehospitalized and later died within 30 days of the initial discharge, and 18.8% were rehospitalized and lived. CKD patients in all subgroups experienced higher rates of rehospitalization than did those without CKD.

vol 1 Figure 3.22 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by sex and CKD status, 2015
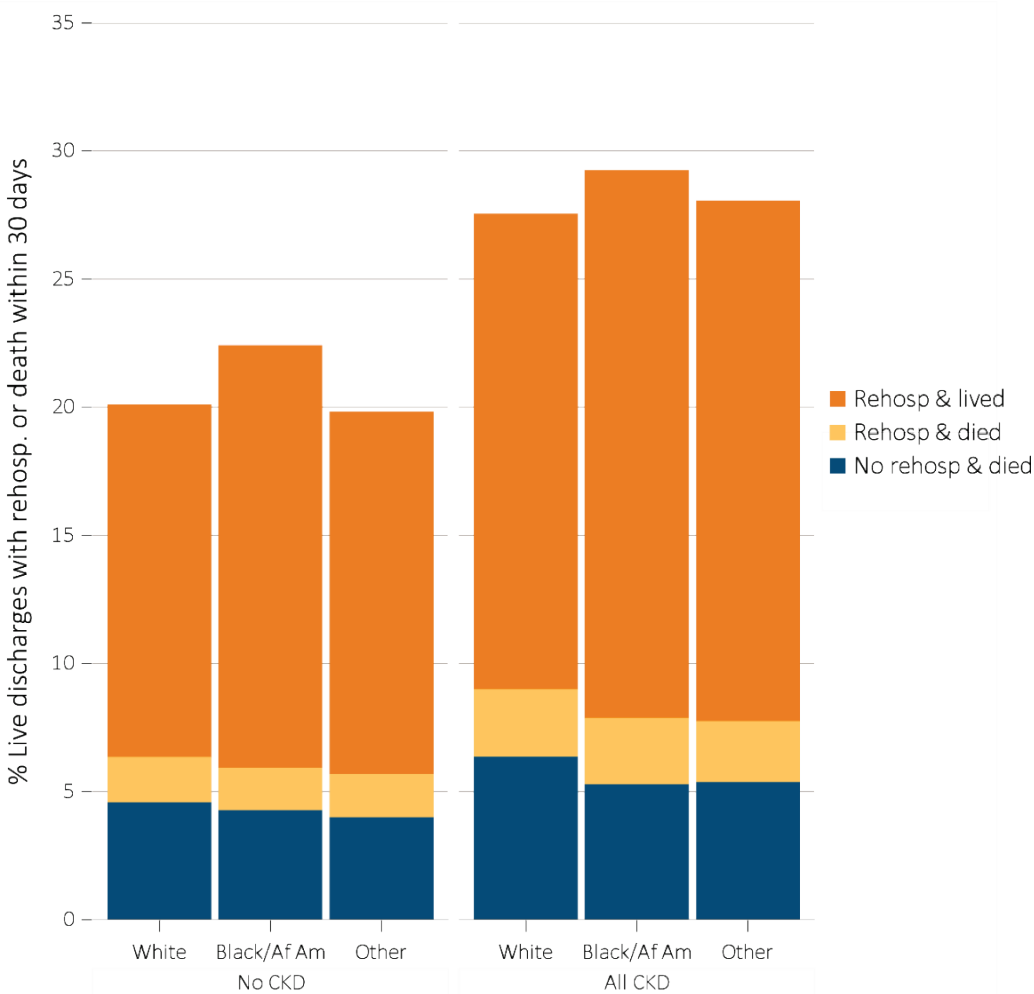

Data source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2015, and December 1, 2015; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized.

Racial trends in post-discharge outcomes were mixed. As shown in Figure 3.23, for patients without CKD, those of Black race who were rehospitalized subsequently survived at greater rates (16.2%) than did both Whites (13.5%) and patients of Other races (13.9%). For patients with CKD, Blacks survived rehospitalization at 21.1%, Whites at 18.3%, and those of Other races at 20.1%. Whites with or without CKD experienced the highest rates of death without rehospitalization (4.7% for no-CKD, 6.5% with CKD); more CKD patients of Other races were observed to have died following their rehospitalization (2.4%).

vol 1 Figure 3.23 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by race and CKD status, 2015

Data Source: Medicare 5% sample. January 1, 2015 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2015, and December 1, 2015; unadjusted. Abbreviations: Af Am, African American; CKD, chronic kidney disease; Rehosp, rehospitalized.

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