Chapter 3: Morbidity and Mortality in Patients with CKD

- In the 2018 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 2016, Medicare patients with chronic kidney disease (CKD) experienced a mortality rate of 122.6 per 1,000 patient-years. When adjusted for sex, age, and race, the rate remained more than double the 43.1 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 2004-2016 (Table 3.1 and Figure 3.1).
- Male patients without CKD experienced higher adjusted mortality rates of 48.2 per 1,000 patient-years than did females, at 39.2. This relative difference was similar among those with CKD, with an adjusted mortality rate of 114.4 per 1,000 patient-years for males and 94.9 for females (Table 3.1 and Figure 3.4).
- In 2016, Medicare age and sex adjusted mortality rates were 104.2 per 1,000 patient-years for Whites and 106.6 per 1,000 person years for Blacks/African Americans (Figure 3.5).

Hospitalization

- Adjusted hospitalization rates declined from 2015 to 2016 in both the Medicare and Optum Clinformatics™ CKD and non-CKD patients. The decline was greater for CKD patients than for patients without CKD in both populations (Figure 3.7).
- Not surprisingly, among Medicare patients, after adjustment for sex and race, rates of hospitalization in older patients were greater than for younger age cohorts. In the CKD group, hospitalization rates for those over 85 years was 39.7% higher than among those aged 66 to 69 years: 706.2 vs. 505.4 admissions per 1,000 patient-years at risk (Figure 3.12).
- For Medicare patients, racial differences in hospitalization rates were notable. Black patients with CKD had higher adjusted rates of hospitalization than did Whites and Other races (651.8 vs. 568.3 vs. 471.1 per 1,000 patient-years). Disparities in outcomes increased with disease severity (Figure 3.14).

Hospital readmission

- At 21.6%, unadjusted rates of hospital readmission in Medicare patients with CKD were higher than the 15.3% for those without CKD (Table 3.3).
- In Medicare patients without CKD, males exhibited a higher readmission rate than did females, with age and race adjusted percentages of 16.2 and 14.6 (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 stages 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 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 patient hospitalization—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 increasing CKD stage (Go et al., 2004). In general, and not surprisingly, rates of hospitalization 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 readmitted 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 only covers persons with disabilities for those under age 65, data for these persons will be unrepresentative of that age group. Therefore, 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, which provides claims data 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 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 these data are described in the *Data Sources* 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, see the section on *Chapter 3* within 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 2016 was 122.6 per 1,000 patient-years; this decreased to 103.0 per 1,000 patient-years after adjusting for age, sex, and race (standard population: 2016). 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. However, racial differences in mortality trends between Whites and Blacks with CKD decreased when adjusted for age and sex.

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, 2016

	Unadjusted		Adjusted	
	No CKD	All CKD	No CKD	All CKD
All	41.3	122.6	43.1	103.0
Age				
66–69	15.3	61.0	15.0	59.4
70–74	20.1	70.4	19.8	68.5
75–84	40.7	106.3	40.7	104.1
85+	135.7	237.4	136.3	236.0
Sex				
Male	42.0	127.6	48.2	114.4
Female	40.7	118.1	39.2	94.9
Race				
White	42.2	126.2	43.4	104.2
Black/African American	41.6	113.7	46.9	106.6
Other	27.9	88.9	33.2	78.3

Data source: Medicare 5% sample. January 1, 2016 point prevalent patients aged 66 and older. Adjusted for age/sex/race. Standard population: all patients, 2016. 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 30.0% since 2004, from 175 deaths per 1,000 patient-years to 123 deaths in 2016. For those without CKD, the unadjusted rate decreased from 51 deaths per 1,000 patient-years in 2004 to 41 deaths in 2016, a reduction of 19.3%.

When adjusted for age, race, and sex, the 2016 mortality rate for CKD patients reduced to 111 deaths per 1,000 patient-years at risk (Figure 3.1.b; standard population: 2011). Among those without CKD, adjustment for these factors resulted in a slightly higher mortality rate of 45 deaths per 1,000, as compared to the unadjusted rate of 41. 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 2016, the mean age of patients with CKD was 78.4 years, compared to 75.2 years for those without, and 75.7 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, 2004-2016

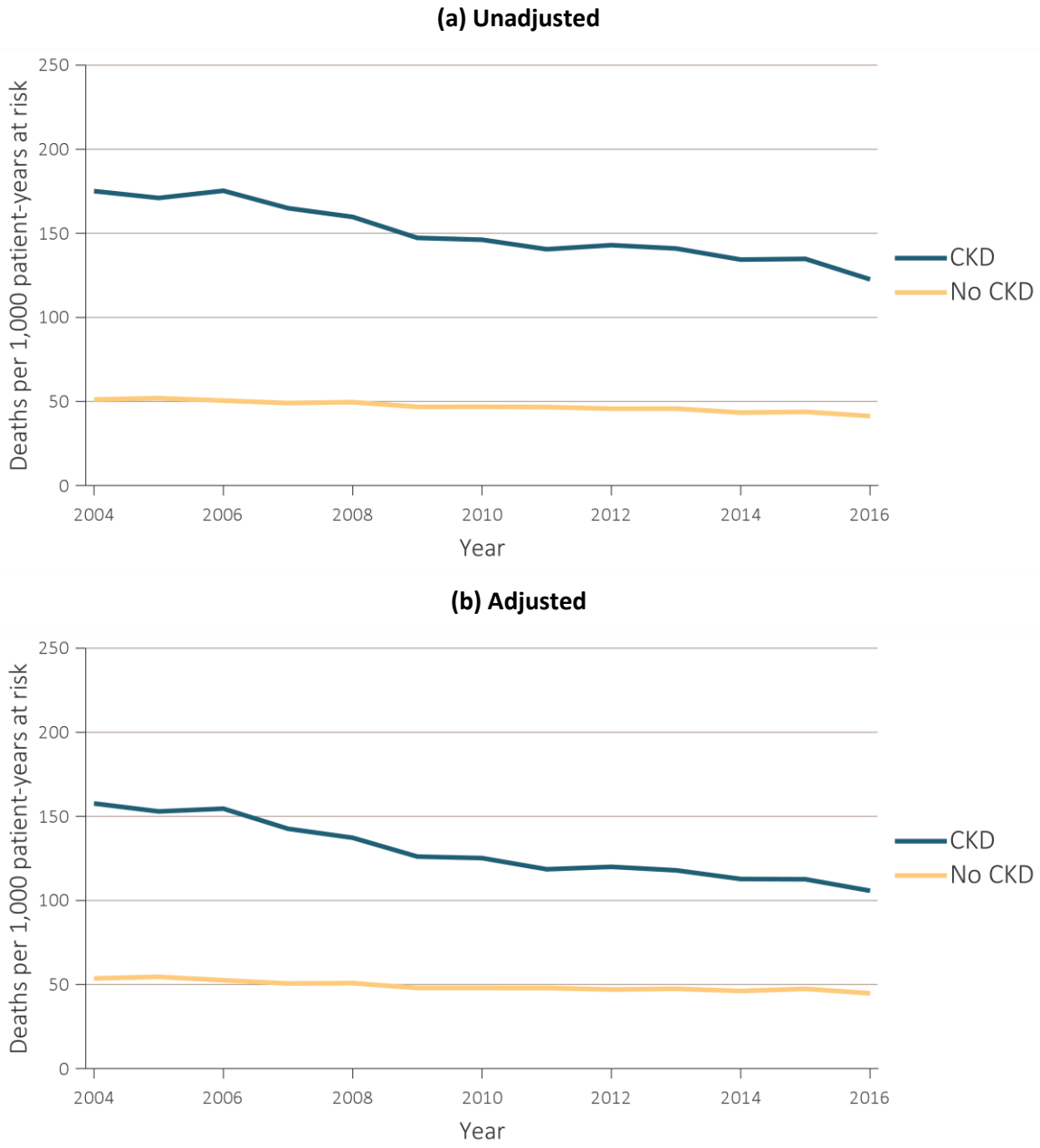


Figure 3.1 continued on next page.

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, 2004-2016 (continued)

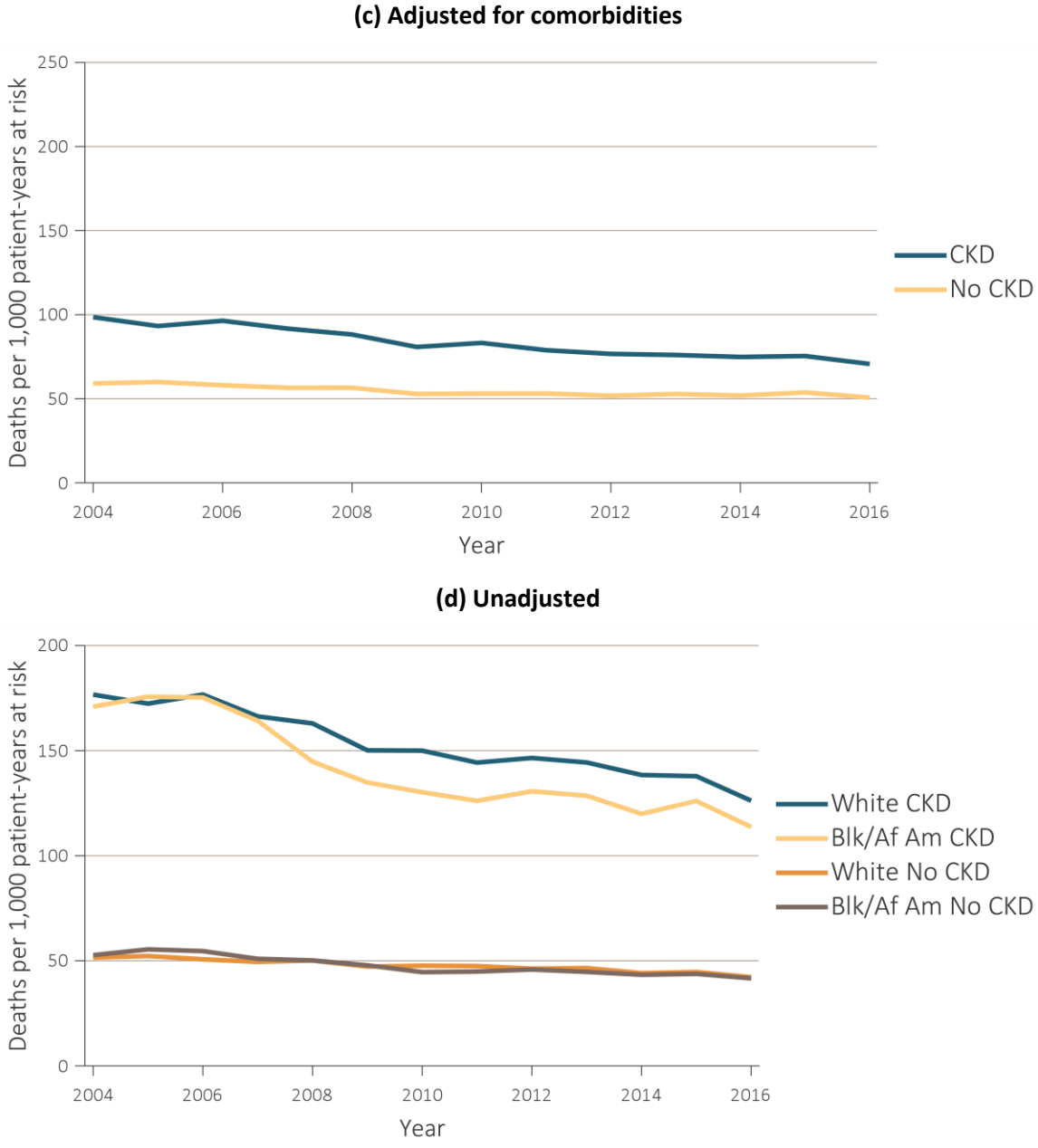
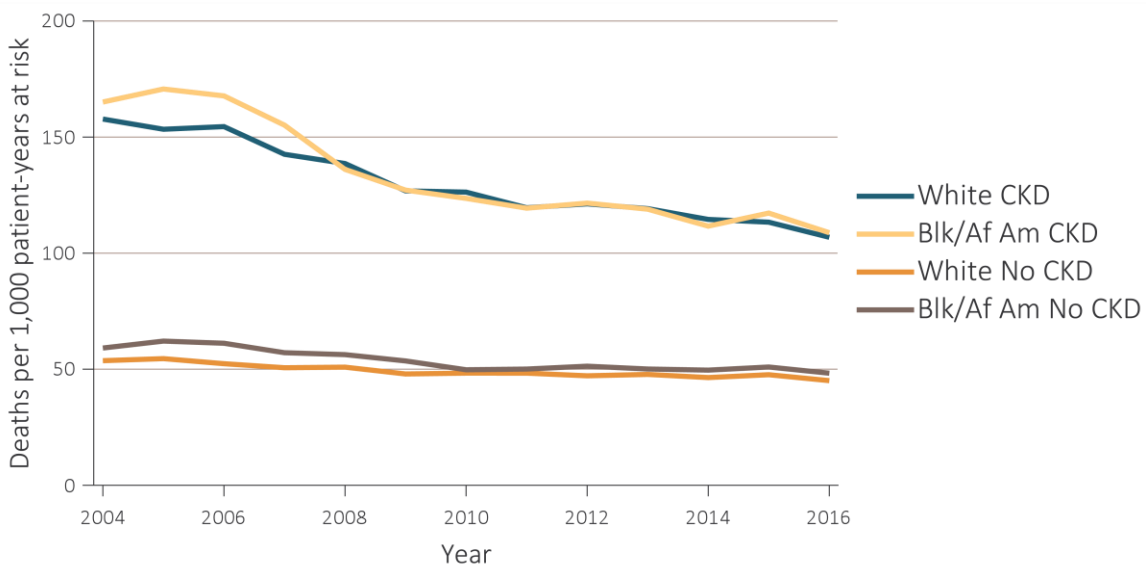


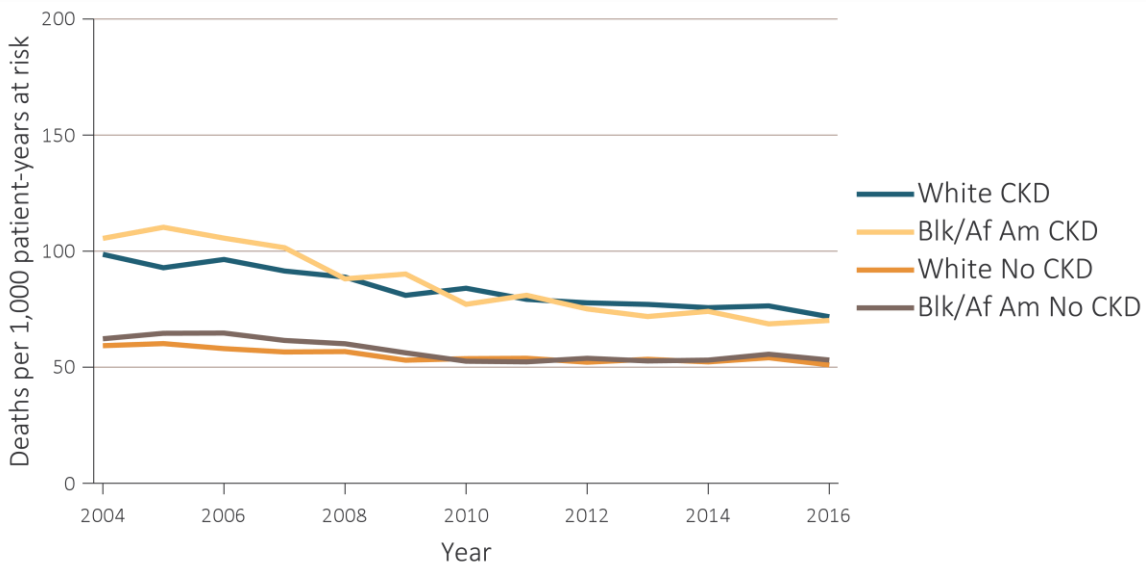
Figure 3.1 continued on next page.

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, 2004-2016 (continued)

(e) Adjusted



(f) Adjusted for comorbidities

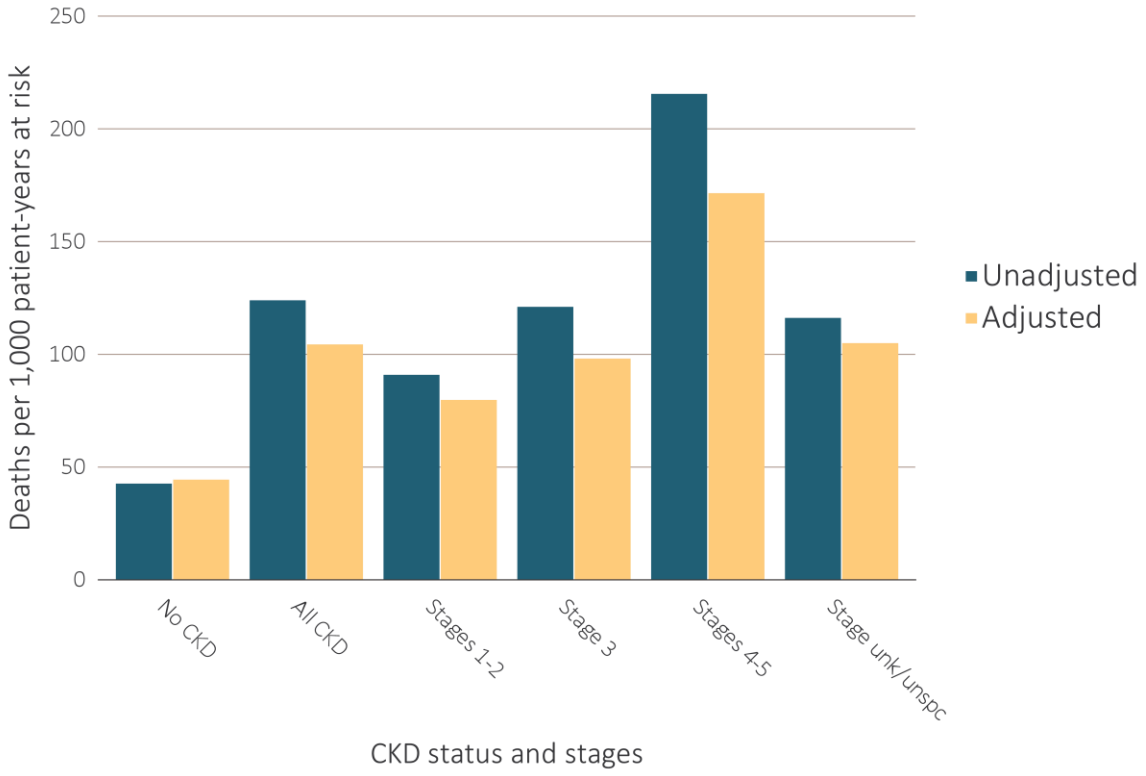


Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Panels (a) and (d) show unadjusted rates; (b) is adjusted for age/sex/race, (c) is adjusted for age/sex/race/comorbidities. (e) is adjusted for age/sex and (f) is adjusted for age/sex/comorbidities. Standard population: Medicare 2011 patients. Abbreviation: CKD, chronic kidney disease.

Mortality 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 90 deaths per 1,000 patient-years for those in Stages 1 or 2, to 120 for Stage 3, and 214 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 Stages 1 or 2 and Stage 3, at 115 deaths per 1,000 patient-years at risk.

Adjusted mortality rates for Stages 1-2, 3, and 4-5 were 79, 97, and 170 deaths per 1,000 patient-years, respectively.

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, 2016



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 2016 patients. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

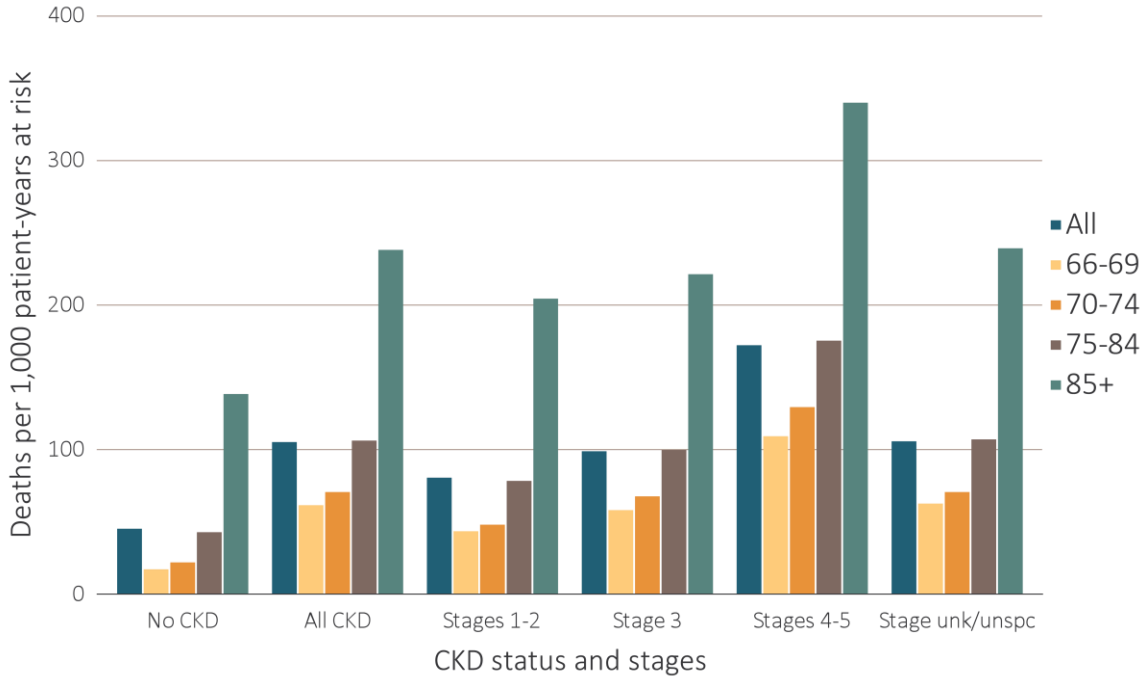
Table A. ICD-9-CM and ICD-10-CM codes for Chronic Kidney Disease (CKD) stages

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, 403.9x & others for ICD-9-CM and A18.xx, E08.xx, E11.xx, and others for ICD10-CM.

[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 2016 are shown in Figure 3.3 by CKD status, stage, and age group. As expected, the mortality rates for older patient groups were higher. Among CKD patients, those aged 66-69 years had a mortality rate of 60 deaths per 1,000 patient-years at risk, while those aged 75-84 had nearly double that, at 104 deaths. As also might be expected, patients aged 85 and older experienced the highest rates of mortality, with 236 deaths per 1,000 patient-years. As expected, the mortality rates for later CKD stage groups were higher.

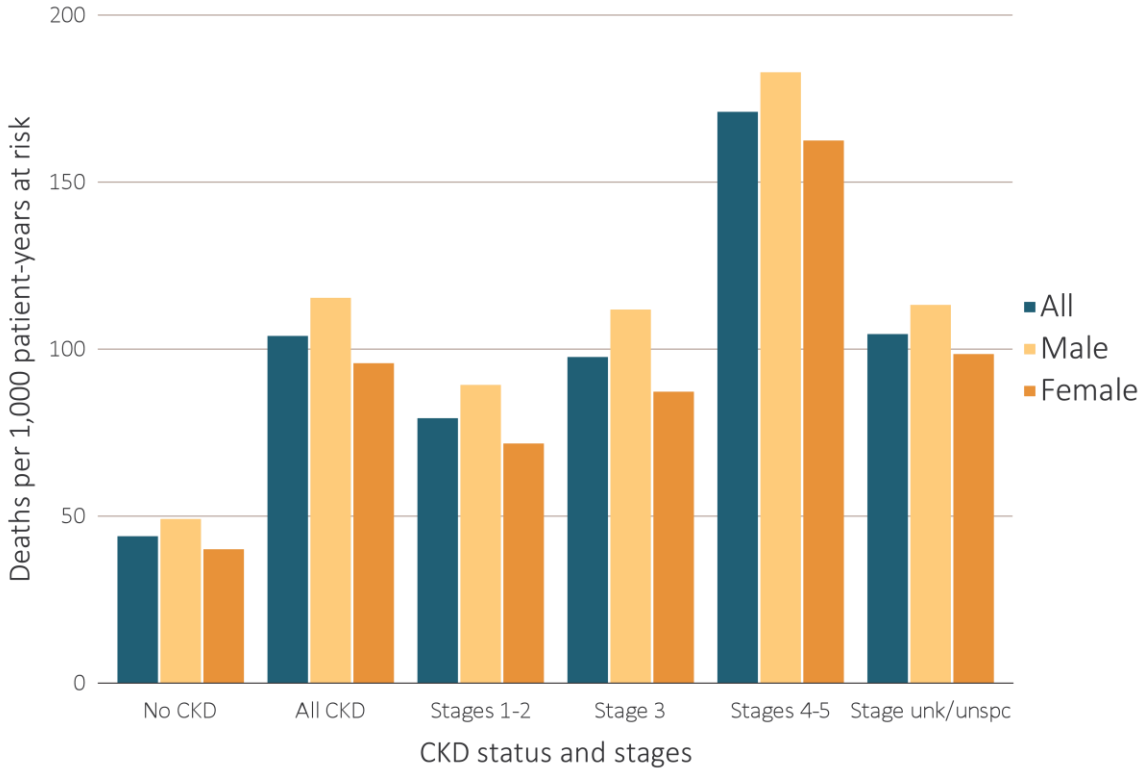
vol 1 Figure 3.3 Adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by age, CKD status, and stage, 2016



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 2016 patients. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

A comparison of adjusted 2016 mortality rates by CKD status, stage, and sex is shown in Figure 3.4. The mortality rates for males were higher than for females in all stages.

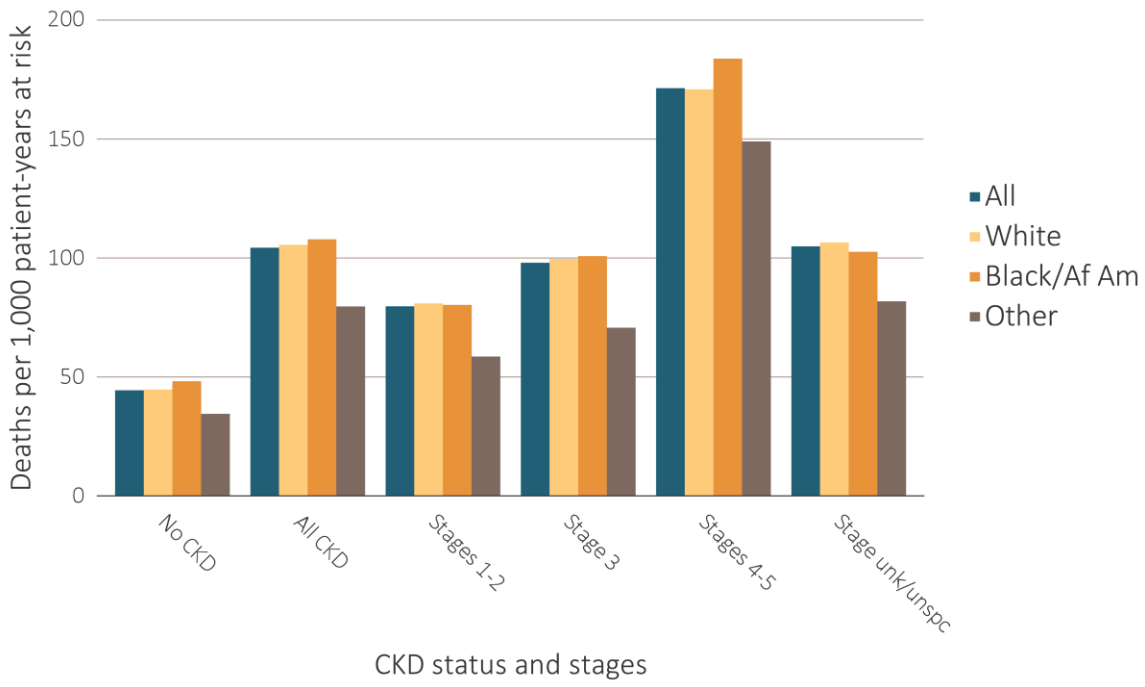
vol 1 Figure 3.4 Adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by sex, CKD status, and stage, 2016



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 2016 patients. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Figure 3.5 shows adjusted mortality rates by race, CKD status, and stage. The rates for patients with CKD were more than twice for those who had no CKD for all races. Variation by race was inconsistent across CKD stages. There were virtually no differences between Blacks and Whites in Stages 1-2 and 3. However, in Stages 4-5, Blacks had higher mortality than did Whites, with 183 and 170 per 1,000 patient-years, respectively.

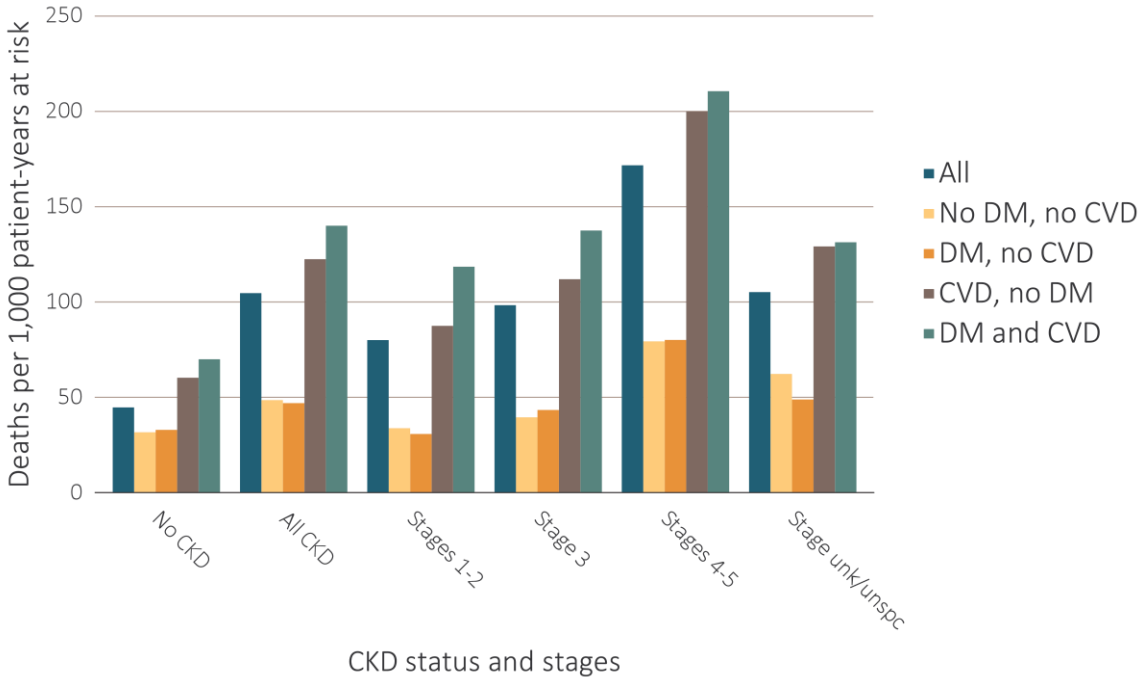
vol 1 Figure 3.5 Adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by race, CKD status, and stage, 2016



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 2016 patients. Abbreviations: Af Am, African American; CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Adjusted rates of mortality also increased with greater patient health complexity. Figure 3.6 presents adjusted mortality rates by the presence of two common comorbidities of CKD: DM and CVD. Diabetes had little effect on CKD mortality, whereas the effect of CVD was dramatic. In 2016, those with CKD but without DM or CVD had an adjusted mortality rate of 47 deaths per 1,000 patient-years at risk, while those with both DM and CVD experienced almost triple that rate, at 138 deaths per 1,000 patient-years.

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, 2016



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 2016 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 2016 for older Medicare patients and younger Optum Clinformatics™ patients, by whether they had recognized CKD during 2016. Among Medicare patients, the unadjusted rate for those with CKD was 623 hospitalizations per 1,000 patient-years at risk, 2.7 times as great as the rate of 230 for patients without CKD. Among Optum Clinformatics™ patients, the unadjusted rate for those with CKD was 312.7 hospitalizations per 1,000 patient-years at risk, compared to a much lower rate of 32 for patients without CKD.

Across all demographic characteristics, the 2016 unadjusted hospitalization rate for patients with CKD was about 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 568.0 per 1,000 patient-years at risk was 147.0% greater than for those without CKD, at 230. The hospitalization rate for Optum Clinformatics™ patients with CKD was 831% greater than for those without CKD: 326 vs. 35 per 1,000 patient-years at risk. As with mortality, the adjusted hospitalization rate increased with age for all patients, except among those 40-65 years.

In contrast to the mortality findings, however, for Medicare recipients, women with CKD had higher adjusted hospitalization rates than did men: 576 vs. 562 per 1,000 patient-years at risk. For Medicare recipients, women without CKD had lower adjusted hospitalization rates of 224 per 1,000 patient-years than did men, at 238. For Optum Clinformatics™ patients, women had higher unadjusted and adjusted hospitalization rates than men, among both 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, 2016

	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	230.1	622.5	229.9	568.0	32.3	312.7	34.9	326.2
Age								
22-39	.	.	.	.	35.8	361.8	40.0	356.6
40-65	.	.	.	.	27.7	287.3	29.4	289.8
65+	.	.	.	.	68.0	382.8	69.6	384.8
66–69	139.7	527.6	148.4	505.5	.	.	.	.
70–74	182.3	524.3	181.5	527.4	.	.	.	.
75–84	265.7	619.5	256.0	595.0	.	.	.	.
85+	419.4	759.7	399.7	706.2	.	.	.	.
Sex								
Male	222.3	611.8	238.3	562.0	20.2	299.9	22.6	295.0
Female	235.9	632.2	224.4	575.6	44.9	329.2	47.2	350.4
Race								
White	233.5	620.6	232.3	568.3	37.1	316.3	37.5	321.4
Black/African American	241.7	689.1	246.0	651.8	36.8	349.9	35.9	371.1
Other	166.4	528.7	177.3	471.1	26.6	297.3	26.8	312.3

Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2016 point prevalent Medicare patients, aged 66 and older. Standard population: all Medicare patients, 2016. 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, 2016. Adjusted for age/sex/race; rates by one factor are adjusted for the others. A dot (.) represents a zero value. Standard population: all Optum Clinformatics™ patients, 2016. Abbreviations: CKD, chronic kidney disease; ESRD, end-stage 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.

The trend in adjusted hospitalization rates from 2004 through 2016 shows a gradual decline and less variability. From 2015 to 2016, adjusted Medicare rates showed a decrease of 3.7%, from 594.8 to 573.5 per 1,000 patient-years at risk for the CKD group, and by 2.0%, from 240.3 to 235.5 per 1,000 for the no-CKD group. The adjusted Optum Clinformatics™ hospitalization rates decreased by 16.0%, from 378.5 to 326.2 per 1,000 patient-years at risk for the CKD group, and increased by 1.7%, from 34.3 to 34.9 per 1,000 for the no-CKD group.

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, 2004-2016

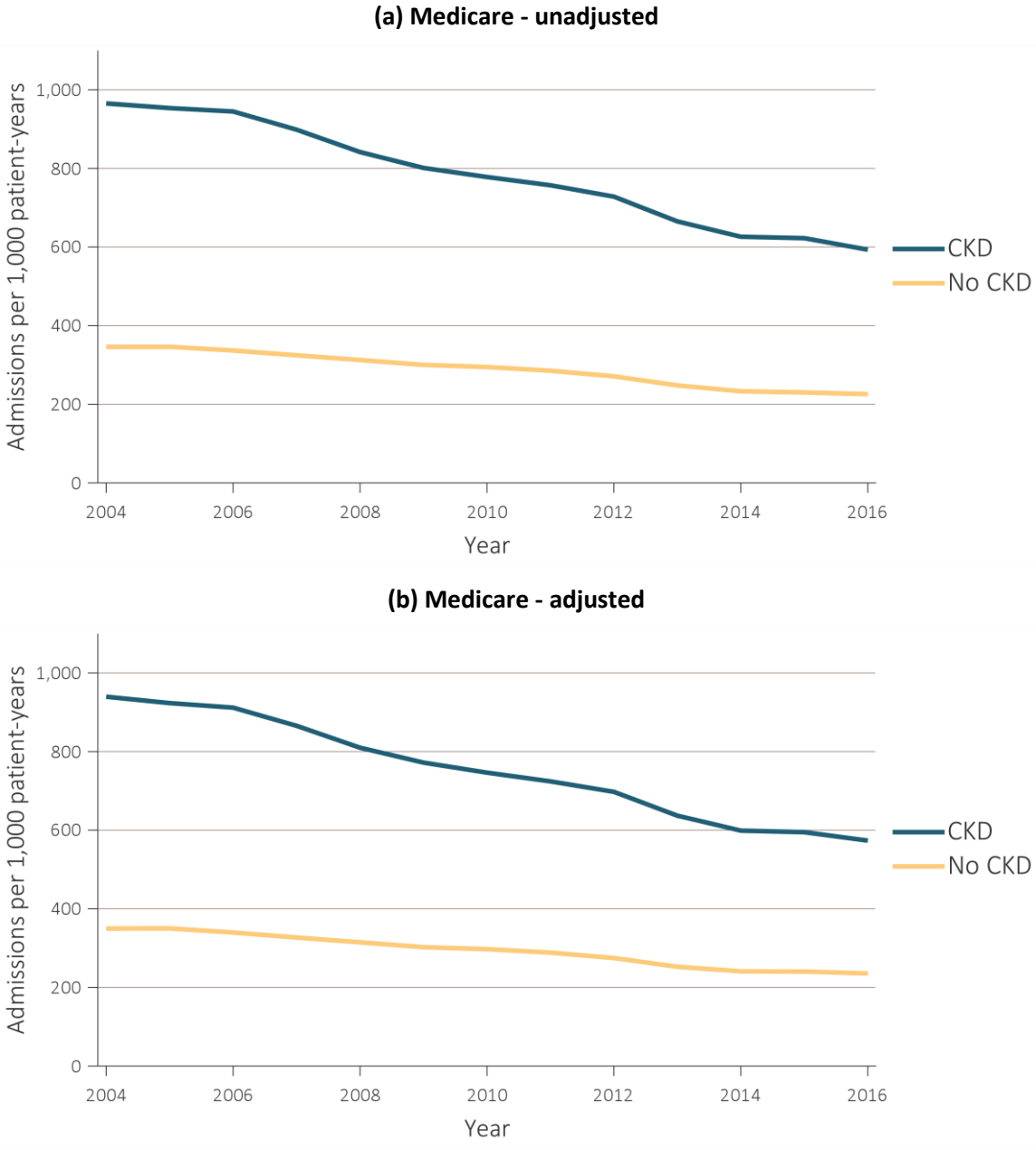
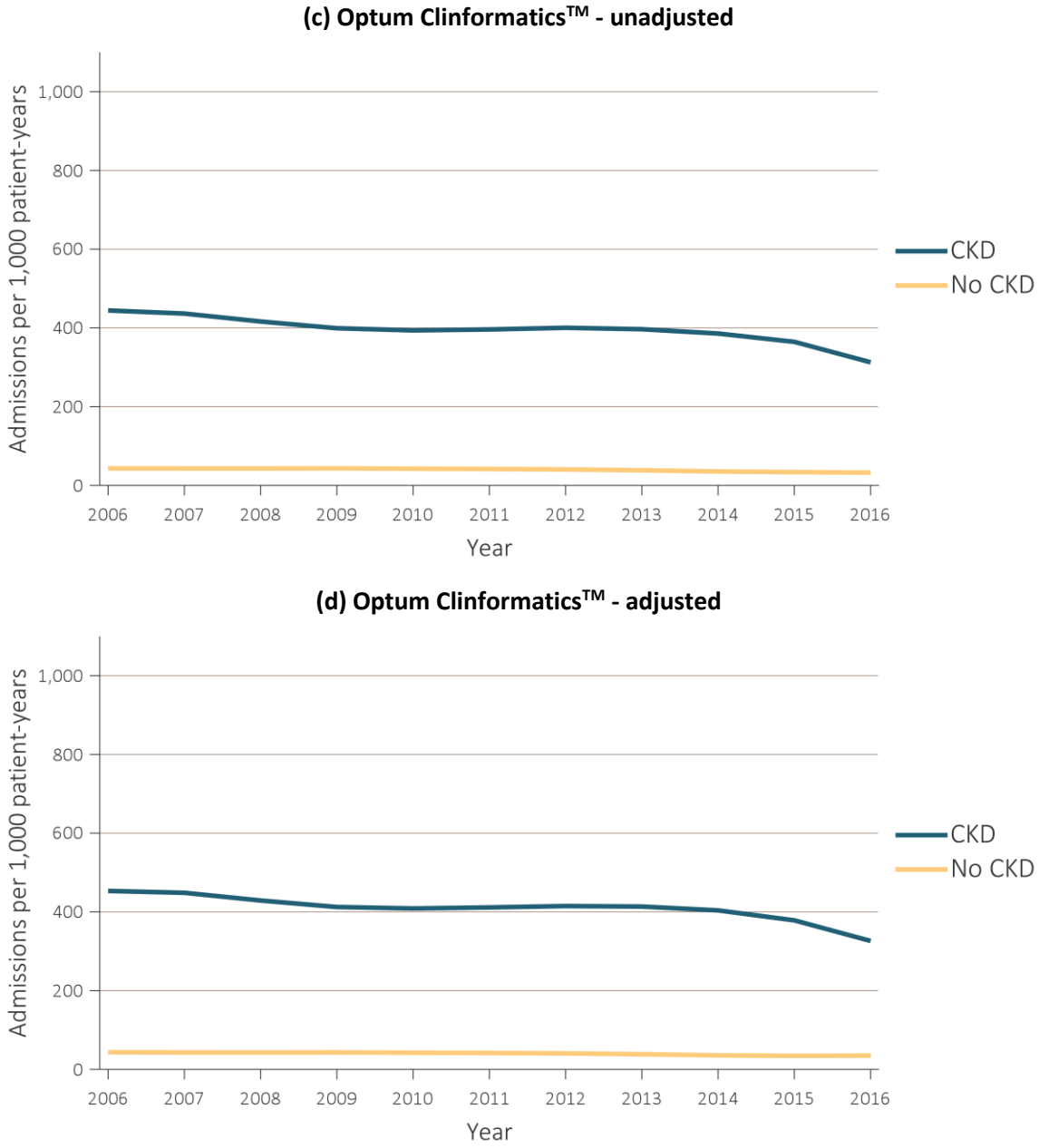


Figure 3.7 continued on next page.

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, 2004-2016 (continued)

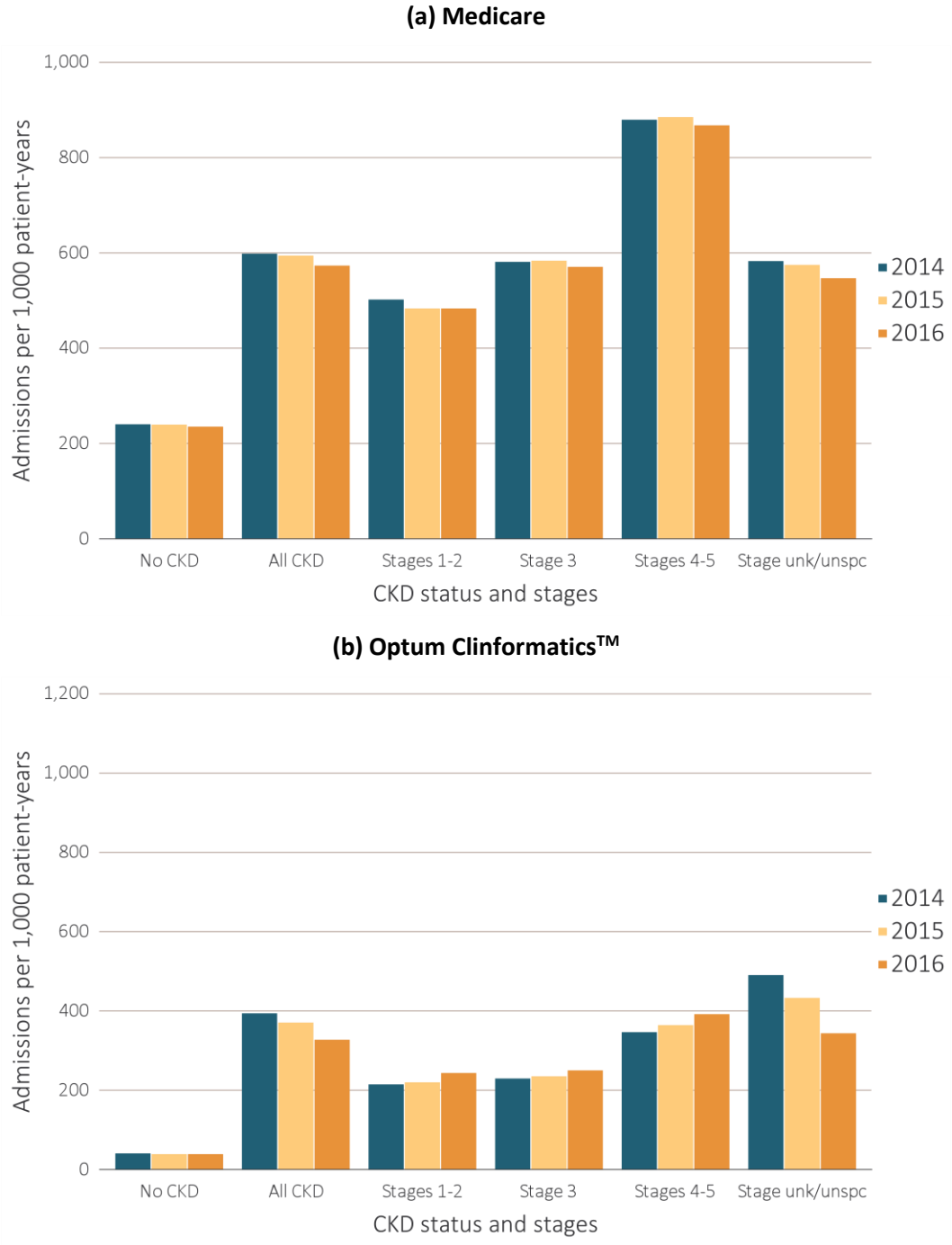


Data source: Medicare 5% sample and Optum Clinformatics™. January 1 of each reported year, point prevalent Medicare patients, aged 66 and older. Standard Medicare population: all patients, 2011. Optum Clinformatics™ commercial insurance patients aged 22 and older who were enrolled in the plan, did not have diagnoses of ESRD, and were alive on January 1 of each reported year. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard Optum Clinformatics™ population: all patients, 2011. Abbreviation: CKD, chronic kidney disease.

For patients with CKD, differences were observed in the rates of hospitalization 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 (19.7% of all-cause admissions), infection (17.8%), and from a combination of all other cause categories (62.5%). For the Optum Clinformatics™ population, we also present hospitalization rates resulting from CVD (23.0% of all-cause admissions), infection (19.0%), and all other cause categories (44.2%). 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 hospitalization in 2016 increased with disease severity, from 478 admissions per 1,000 patient-years for Medicare patients in Stages 1-2, to 565 for Stage 3, and 863 for Stages 4-5. For the Optum Clinformatics™ cohort, the rates were 237 admissions per 1,000 patient-years for those in Stages 1-2, to 244 for Stage 3, and 386 for Stages 4-5 (see Figure 3.8).

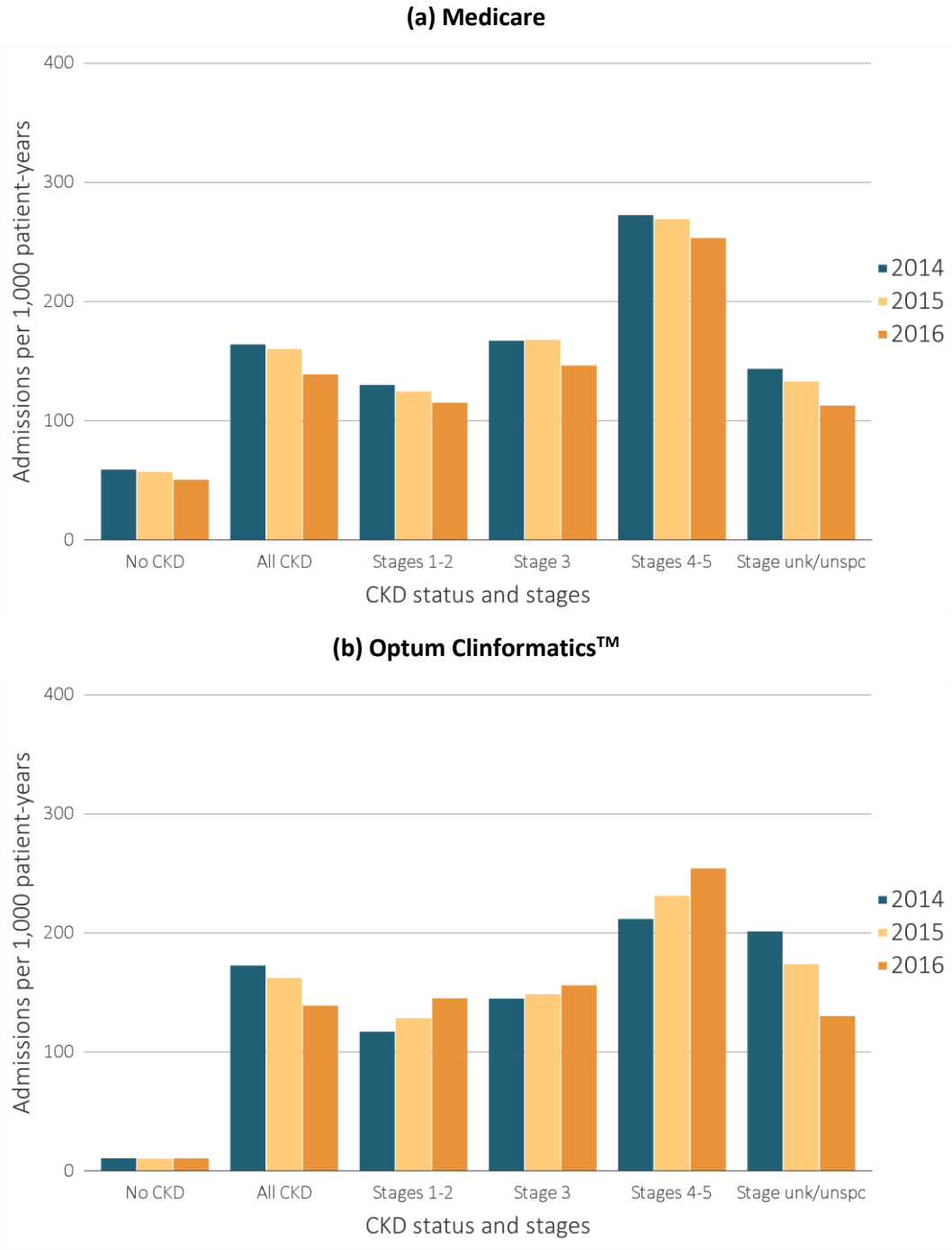
vol 1 Figure 3.8 Adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare patients aged 66 and older and Optum Clinformatics™ patients aged 22 and older, by CKD status and stage, 2014-2016



Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2016 point prevalent Medicare patients, aged 66 and older. Standard Medicare population: all patients, 2016. 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, 2016. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population: all Optum Clinformatics™ patients, 2016. Abbreviations: CKD, chronic kidney disease unk/unspc, CKD stage unidentified.

The pattern of increase for Medicare hospitalizations resulting from a primary diagnosis of CVD was similar, with rates rising from 113 admissions per 1,000 patient-years for CKD Stages 1-2, to 144 for Stage 3, and 251 for Stages 4-5. Patients in the Optum Clinformatics™ group experienced 143 admissions per 1,000 patient-years in Stages 1-2, increasing to 154 for Stage 3, and 252 for Stages 4-5 (Figure 3.9).

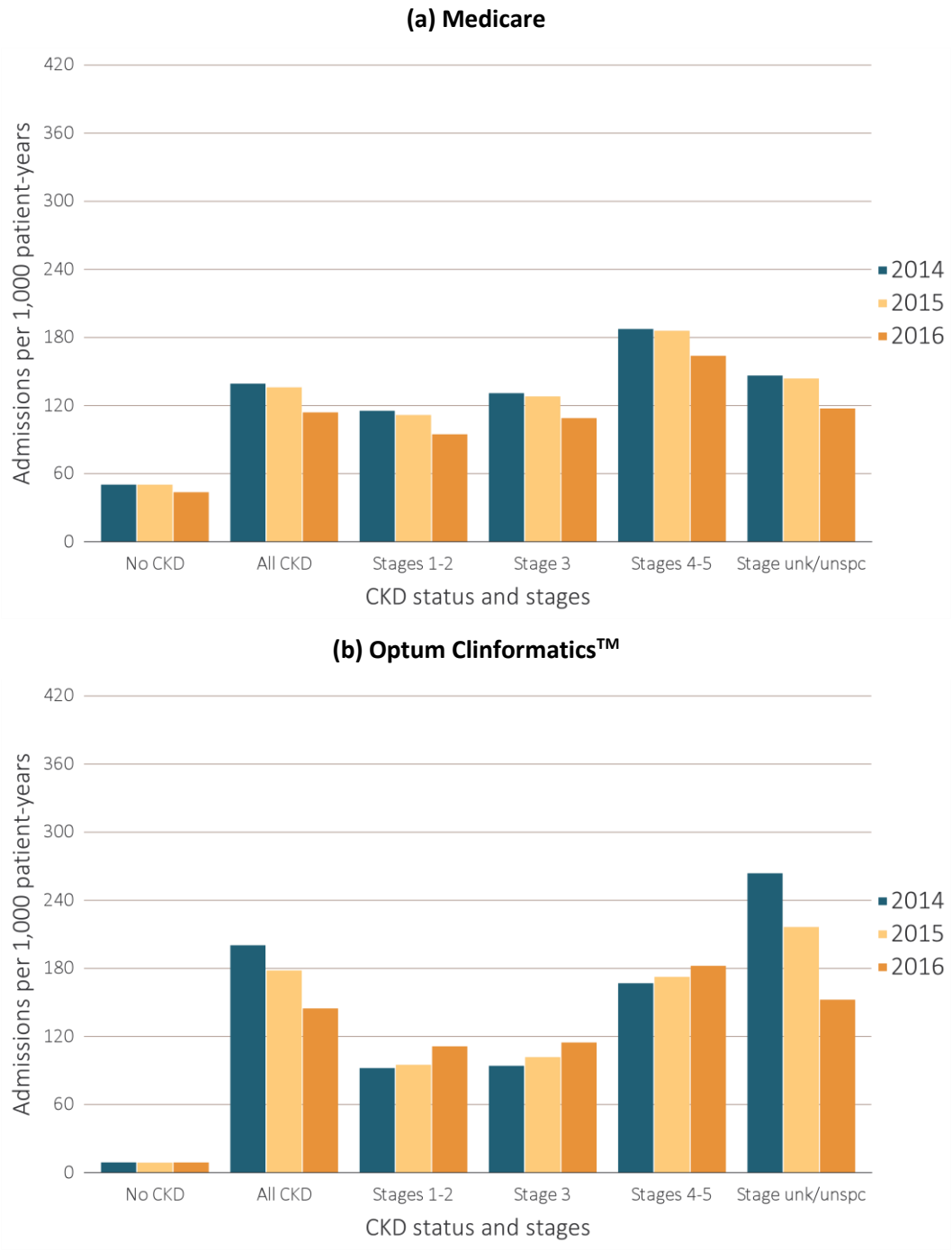
vol 1 Figure 3.9 Adjusted rates of hospitalization for cardiovascular disease per 1,000 patient-years at risk for Medicare patients aged 66 and older and Optum Clinformatics™ patients aged 22 and older, by CKD status and stage, 2014-2016



Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2016 point prevalent Medicare patients, aged 66 and older. Standard Medicare population: all patients, 2016. 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, 2016. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard Optum Clinformatics™ population: all patients, 2016. 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 among Medicare patients decreased from 2014 to 2016. However, among Optum Clinformatics™ patients, rates increased from 2014 to 2016 for Stages 1-2, Stage 3, and Stages 4-5.

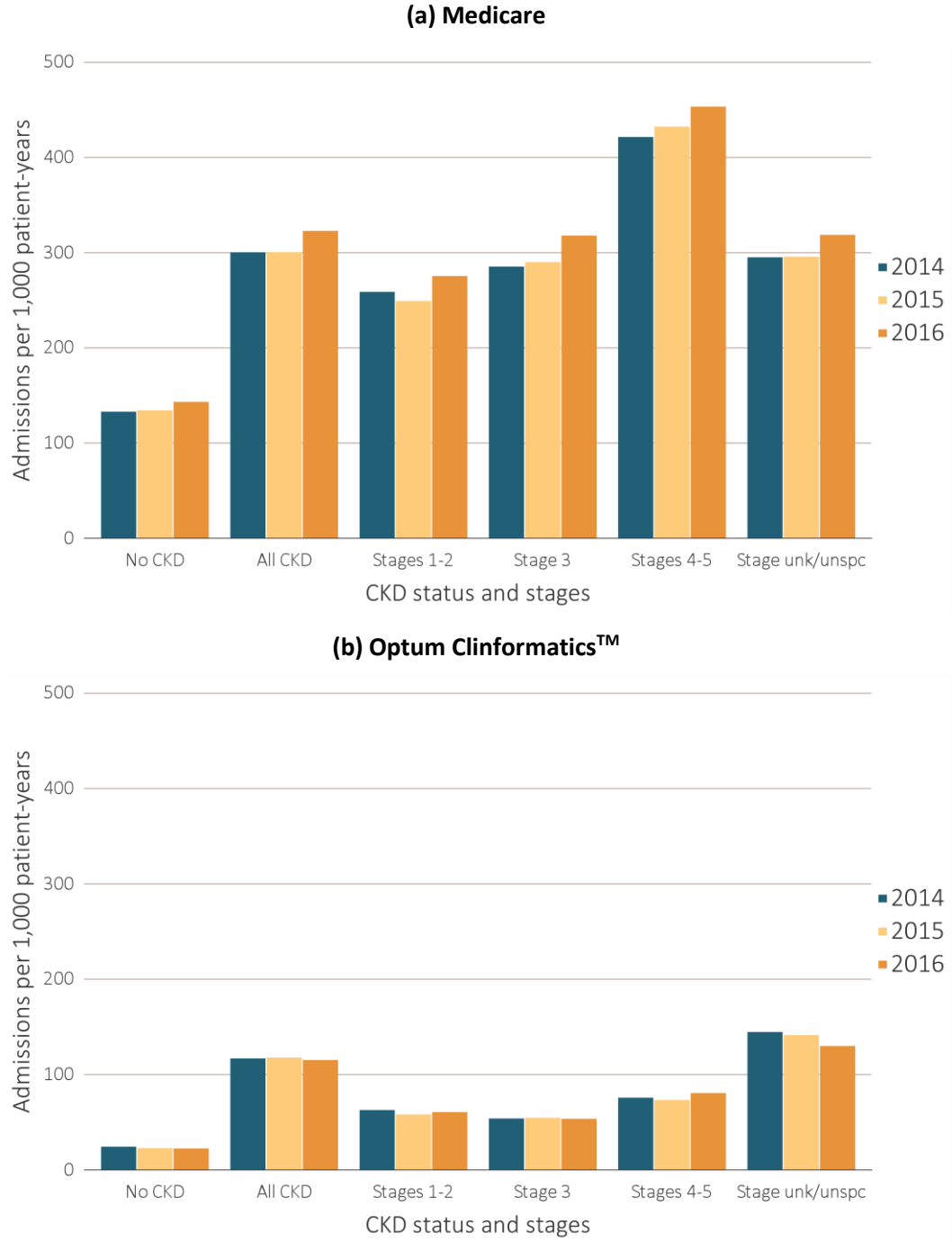
vol 1 Figure 3.10 Adjusted rates of hospitalization for infection per 1,000 patient-years at risk for Medicare aged 66 and older and Optum Clinformatics™ patients aged 22 and older, by CKD status and stage, 2014-2016



Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2016 point prevalent Medicare patients, aged 66 and older. Standard Medicare population: all patients, 2016. 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, 2016. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population: all Optum Clinformatics™ patients, 2016. 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 admission rates for Medicare patients steadily increased from 2014 to 2016.

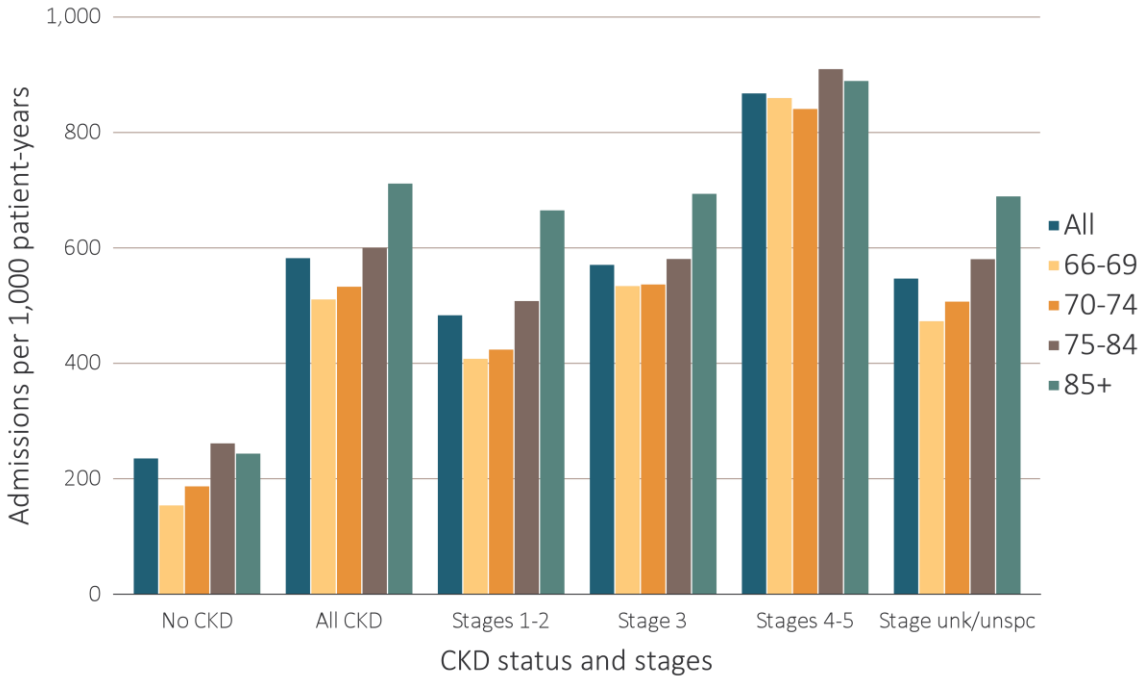
vol 1 Figure 3.11 Adjusted rates of hospitalization for causes other than cardiovascular disease and infection per 1,000 patient-years at risk for Medicare aged 66 and older and Optum Clinformatics™ patients aged 22 and older, by CKD status and stage, 2014-2016



Data source: Medicare 5% sample and Optum Clinformatics™. January 1, 2016 point prevalent Medicare patients, aged 66 and older. Standard Medicare population: all patients, 2016. 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, 2016. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard Optum Clinformatics™ population: all patients, 2016. 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 no-CKD population.

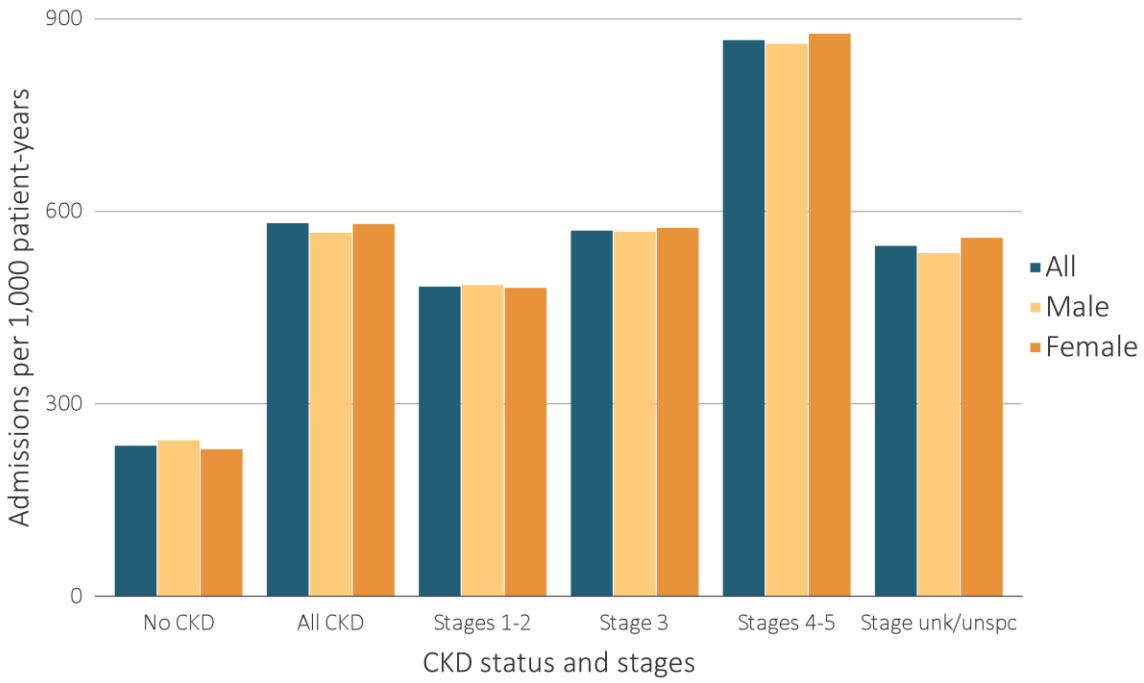
vol 1 Figure 3.12 Adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by age, CKD status, and stage, 2016



Data source: Medicare 5% sample. January 1, 2016 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, 2016. Abbreviations: CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

A comparison of adjusted 2016 all-cause hospitalization rates by CKD status and sex is shown in Figure 3.13. The rates for females in all stages of CKD were slightly higher than for males except for Stages 1-2.

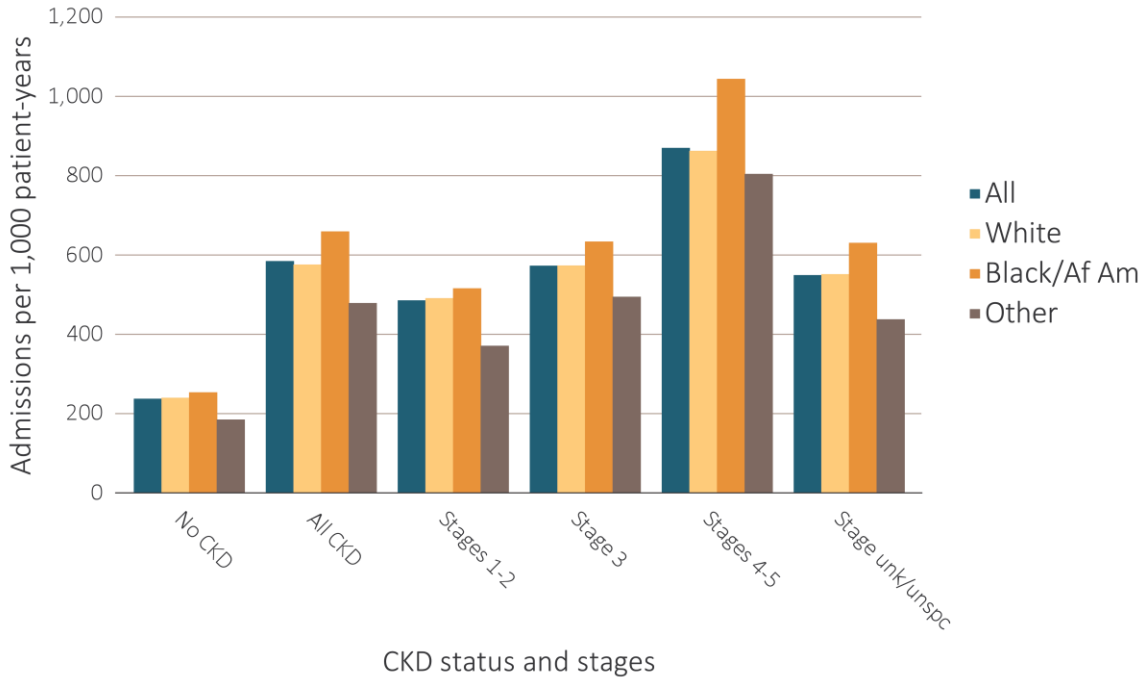
vol 1 Figure 3.13 Adjusted all-cause hospitalization rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by sex, CKD status, and stage, 2016



Data source: Medicare 5% sample. January 1, 2016 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, 2016. 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 2016, Black patients with CKD showed higher rates than did Whites or those of Other races, at 652 per 1,000 patient-years versus 568 for Whites and 471 for Other patients (Figure 3.14). This disparity decreased with disease severity; rates for Black patients were 5.0% higher than Whites in Stages 1-2 (508 vs. 484), 10.4% higher in Stage 3 (626 vs.566) and 21.3% higher in Stages 4-5 (1,037 vs. 855). 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, 2016

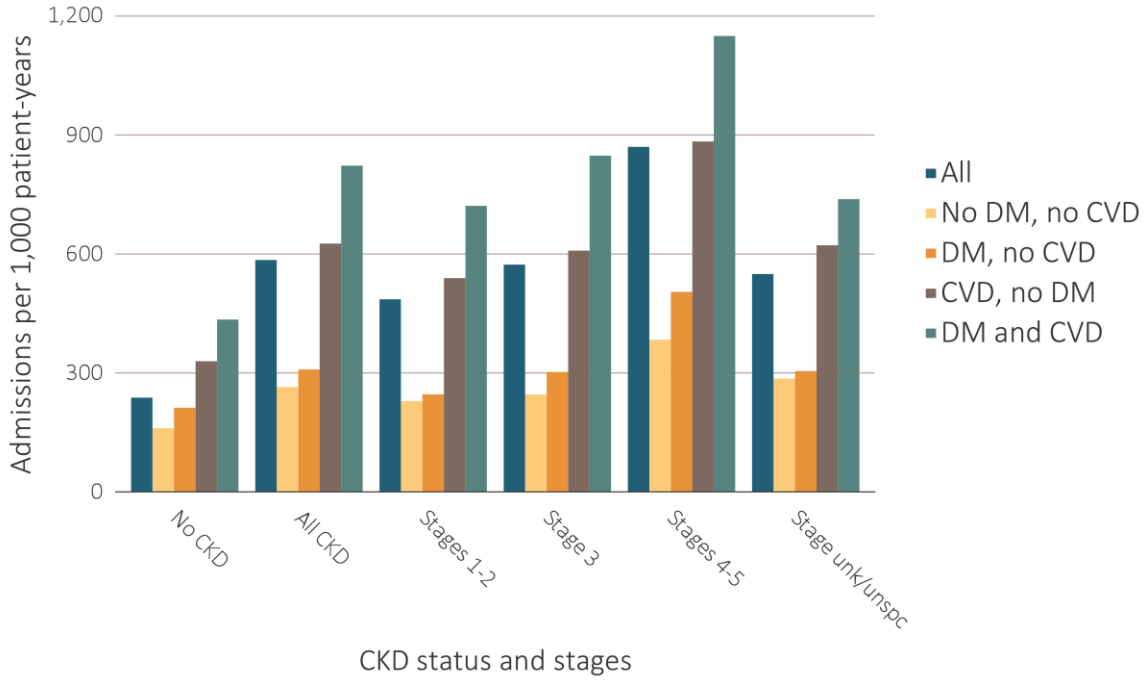


Data source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race; rates by one factor are adjusted for the others. Standard population: all patients, 2016. Abbreviations: Af Am, African American; CKD, chronic kidney disease; unk/unspc, CKD stage unidentified.

Adjusted rates of all-cause hospitalization 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 153 per 1,000 patient-years for those without DM or CVD, 204 per 1,000 for patients with DM only, 322 for those with CVD only, and 427 for patients with both DM and CVD.

In 2016, admissions per 1,000 patient-years for those with CKD increased from 257 for patients without DM or CVD, to 301 for those with only DM, and 619 with only CVD, to a high of 815 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 1,142 admissions per 1,000 patient-years, about 3 times as great as the rate of 376 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, 2016



Data source: Medicare 5% sample. January 1, 2016 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, 2016. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; unk/unspc, CKD stage unidentified.

Hospital Readmission

Reducing the rate of patient readmission within 30 days of discharge from the initial or index hospitalization is a quality assurance goal for many healthcare systems, including the Medicare program. Table 3.3 shows the distribution of unadjusted percentages of hospital readmission in the 2016 Medicare population among those with and without recognized CKD, by CKD status and 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 15.3% for those without CKD and 21.6% for those with CKD (see Table 3.3). These rates represent a slight decrease from 2015 levels except for the no-CKD group. Readmission rates were about 2% higher among Stages 4-5 patients than in lower stage CKD patients.

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, 2016

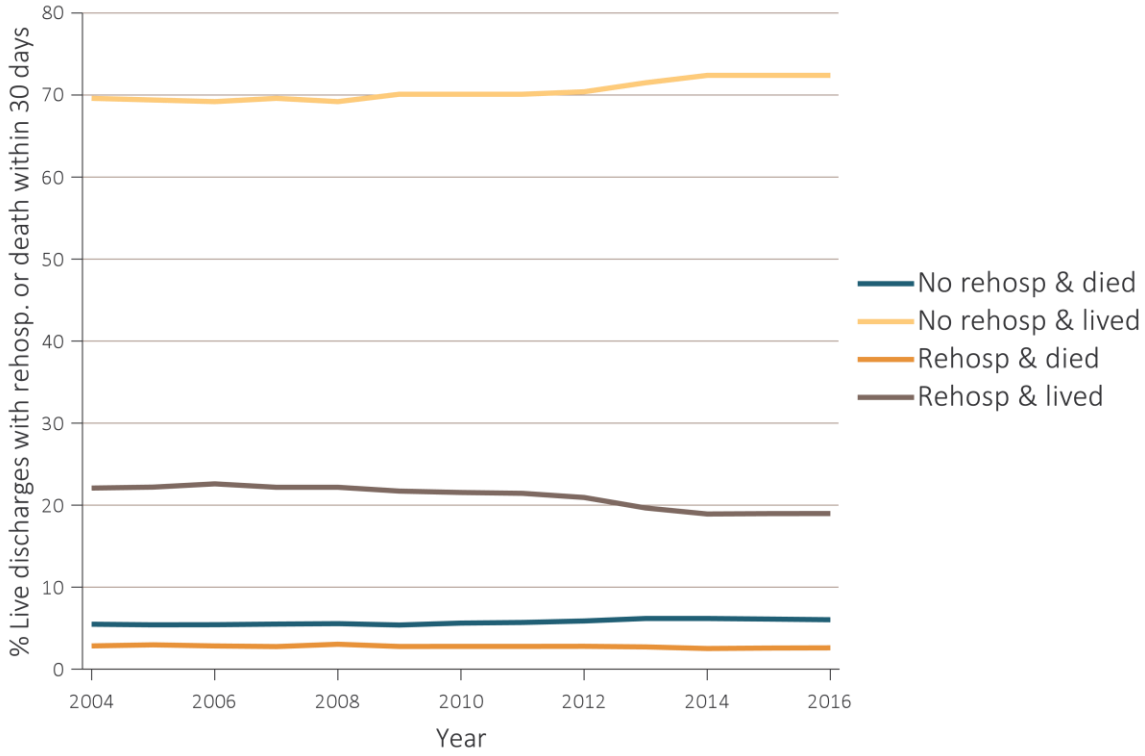
	No CKD (%)	All CKD (%)	Stages 1 or 2 (%)	Stage 3 (%)	Stages 4 or 5 (%)	Stage Unknown (%)
All	15.3	21.6	21.6	21.7	23.6	20.9
Age						
66-69	14.9	23.2	22.4	23.6	25.5	22.5
70-74	15.2	22.9	23.8	23.1	24.7	22.1
75-84	15.6	21.7	19.9	21.9	24.5	20.9
85+	15.2	19.8	22.0	19.6	21.4	18.9
Sex						
Male	16.2	22.0	21.3	22.2	23.9	21.2
Female	14.6	21.3	21.8	21.1	23.4	20.7
Race						
White	15.1	21.4	21.4	21.4	23.2	20.8
Black/African American	17.7	23.1	23.2	23.0	25.1	22.2
Other	16.0	21.7	20.2	21.7	25.3	20.9
Hospital readmission						
No readmission & died	4.5	6.0	4.9	6.0	7.6	5.7
Readmission & died	1.7	2.6	2.2	2.7	3.0	2.4
Readmission & lived	13.6	19.0	19.3	18.9	20.6	18.5

Data source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2016, and December 1, 2016; unadjusted. Abbreviation: CKD, chronic kidney disease.

The adjusted trend for Medicare readmissions occurring from 2004-2016 is shown in Figure 3.16. Results may differ from those presented in previous ADR editions, 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 readmitted to the hospital within 30 days of their initial discharge and survived declined from 22.1% in 2004 to 19.0% in 2016, a decrease of 16.3% over the 13-year period. While any reductions in readmission are encouraging, the 1.1% increase from 2015 in the proportion of patients who were readmitted and subsequently died within 30 days of the initial discharge is not considered significant. Of note, the rate of patients who were not readmitted, but died, within 30 days of the initial discharge has decreased somewhat, by 1.3% since 2015.

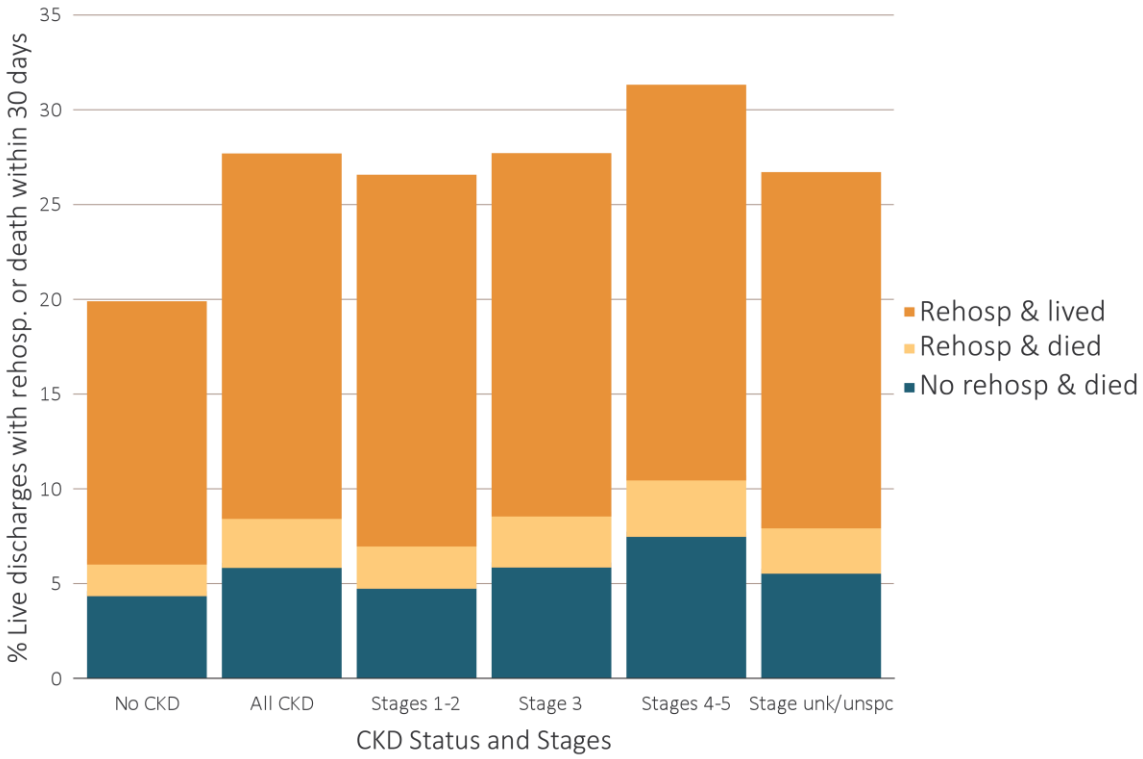
vol 1 Figure 3.16 Adjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare CKD patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by year, 2004-2016



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: 2011. 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 hospital readmission, 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 readmission or death.

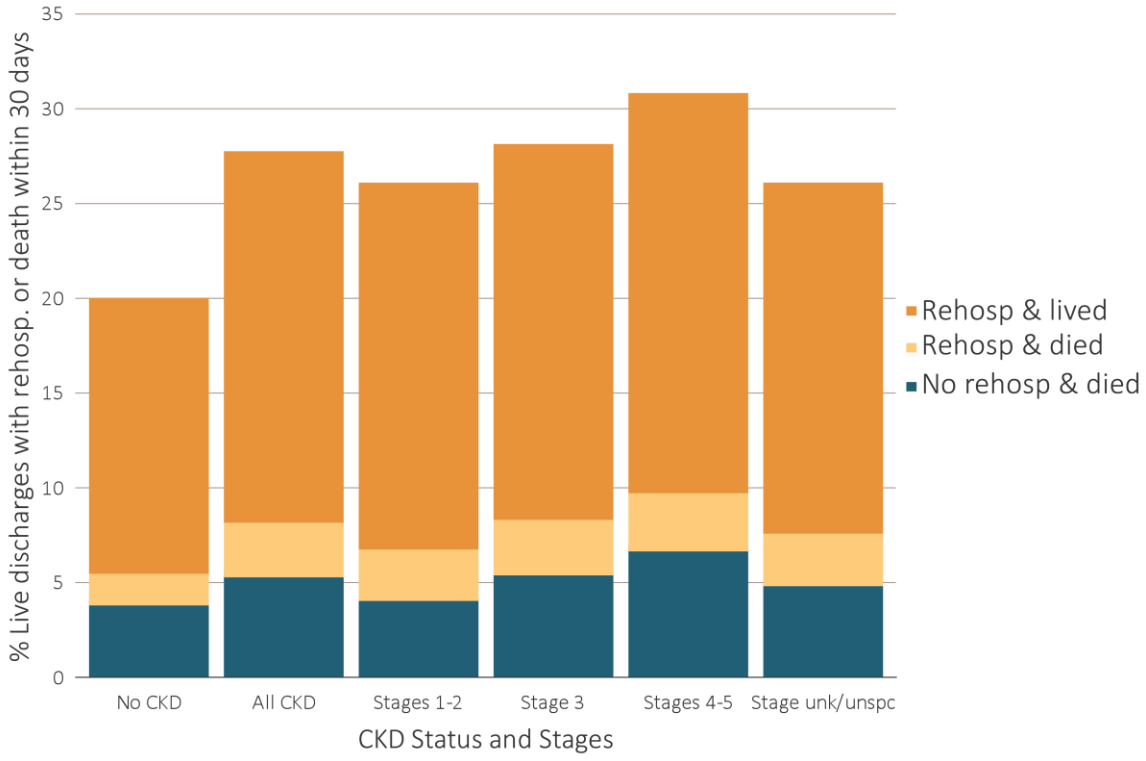
vol 1 Figure 3.17 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by CKD status and stage, 2016



Data source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2016, and December 1, 2016, unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Figure 3.18 shows the death and readmission percentages for older Medicare patients who were discharged alive from a CVD-related index hospitalization. Within 30 days of the initial discharge, 19.3% of patients with CKD were subsequently rehospitalized and lived, an additional 2.9% died following rehospitalization, and 5.4% of patients were not rehospitalized but later died. Otherwise, the magnitude and pattern of these readmission rates were similar to those for all-cause index hospitalizations.

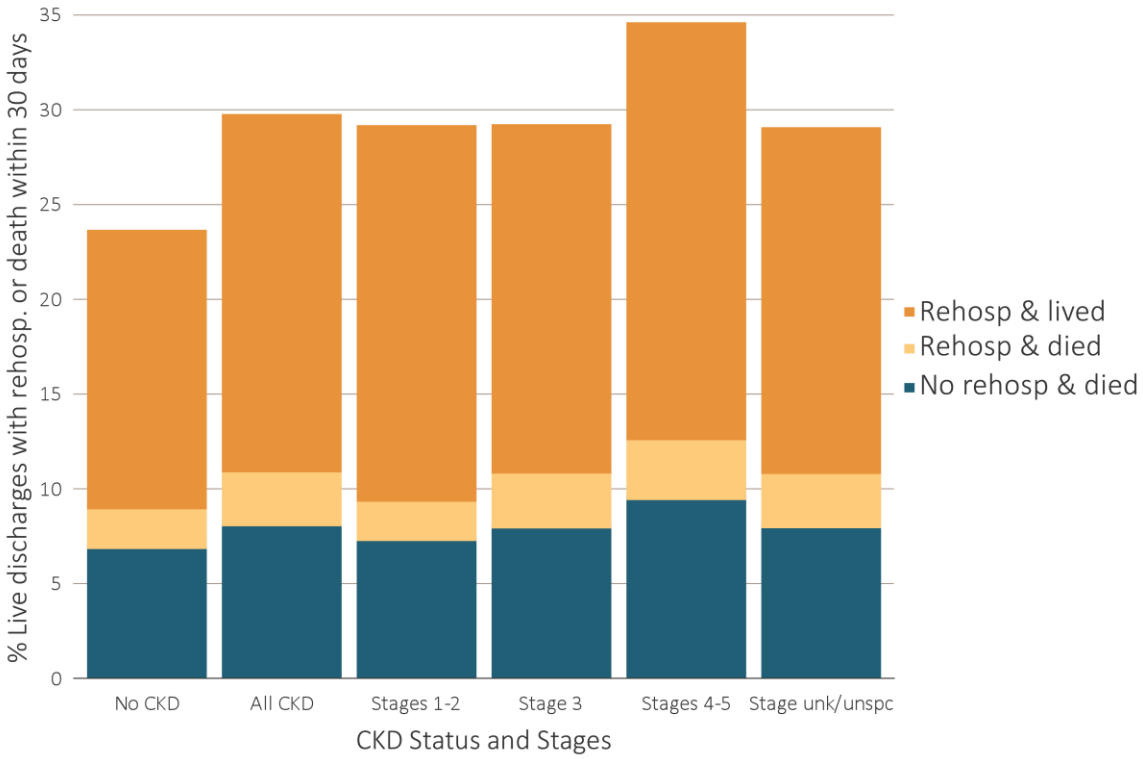
vol 1 Figure 3.18 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from a cardiovascular-related index hospitalization between January 1 and December 1, by CKD status and stage, 2016



Data source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older, discharged alive from a CVD index hospitalization between January 1, 2016, and December 1, 2016; unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Of all patients without CKD who experienced an infection-related admission, 16.6% required readmission (see Figure 3.19). Of these, 2.1% died following rehospitalization, and 7.0% were not rehospitalized and later died. In the CKD group, within 30 days of the initial discharge 18.6% of patients were subsequently rehospitalized and lived, an additional 2.8% died following rehospitalization, and 8.2% of patients were not rehospitalized but later died.

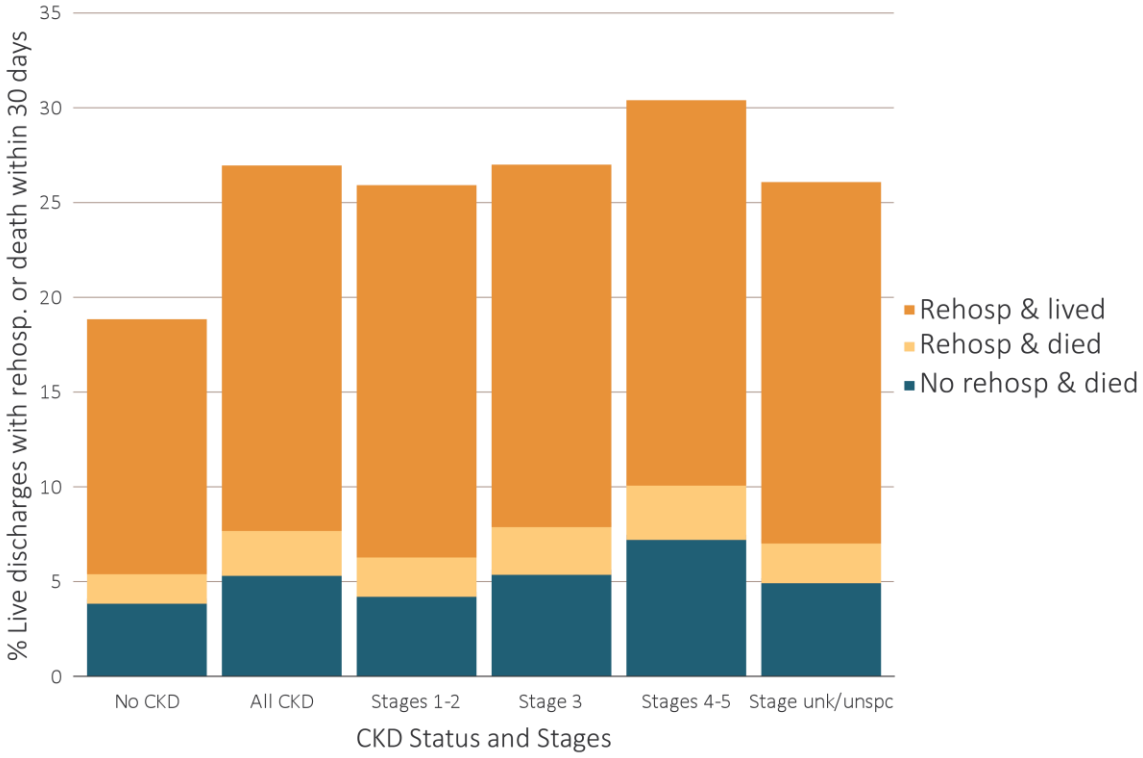
vol 1 Figure 3.19 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an infection-related index hospitalization between January 1 and December 1, by CKD status and stage, 2016



Data source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older, discharged alive from an infection index hospitalization between January 1, 2016, and December 1, 2016, unadjusted. Abbreviations: CKD, chronic kidney disease; Rehosp, rehospitalized; unk/unspc, CKD stage unidentified.

Figure 3.20 shows the death and hospital readmission 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, 5.4% of patients were not rehospitalized but died, 2.4% were rehospitalized and died, and 19.0% were rehospitalized and lived. In the no-CKD group, these percentages were somewhat lower, at 4.0%, 1.6%, and 13.2%, respectively.

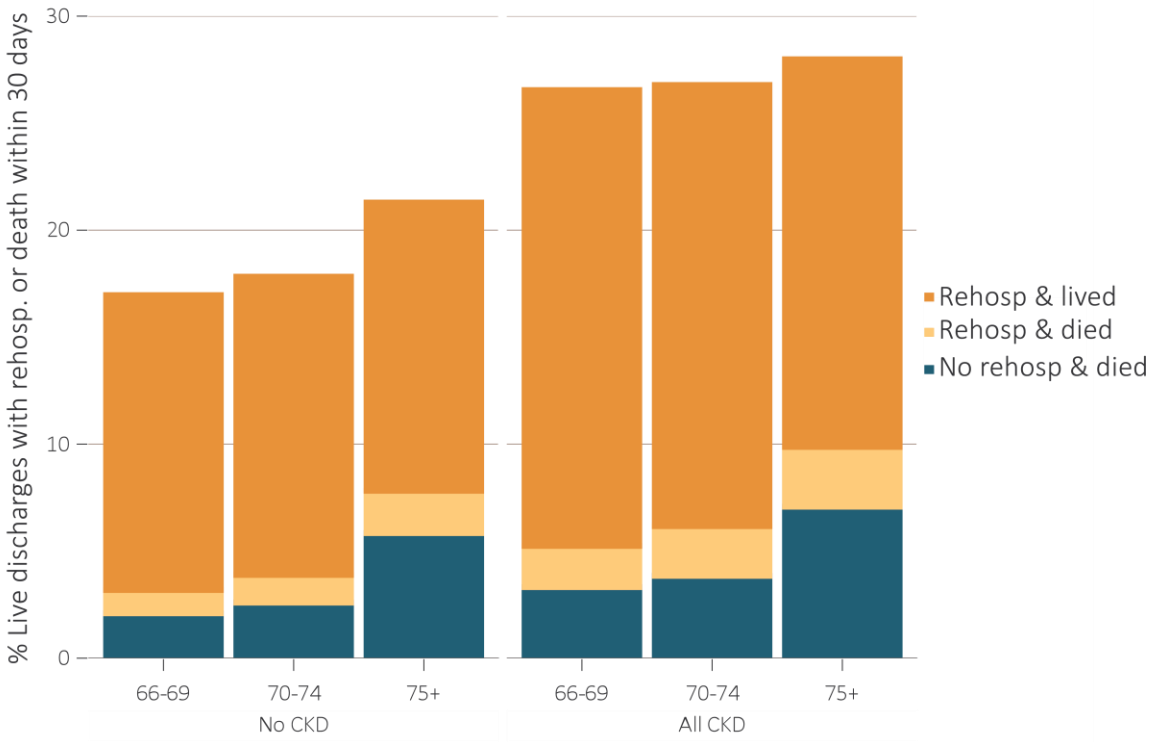
vol 1 Figure 3.20 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from a no-cardiovascular and no-infection-related index hospitalization between January 1 and December 1, by CKD status and stage, 2016



Data Source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older, discharged alive from a no-cardiovascular and no-infection index hospitalization between January 1, 2016, and December 1, 2016; 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 those Medicare patients who were readmitted 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 readmission, increased with older age.

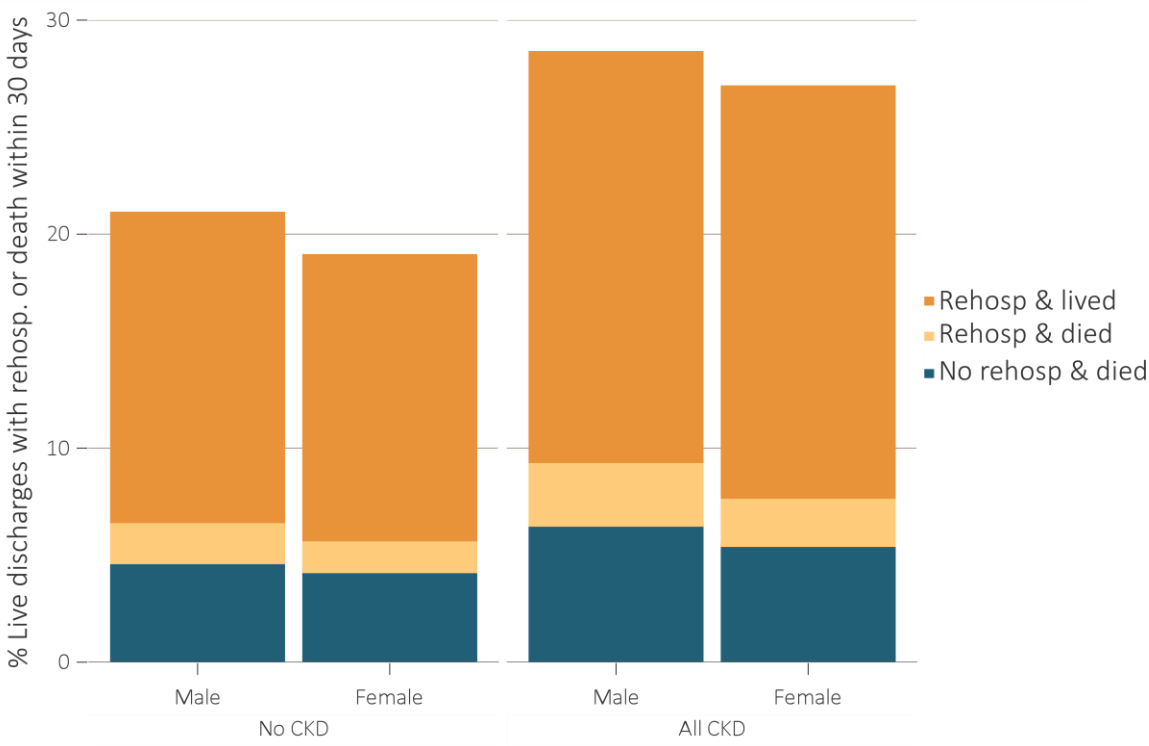
vol 1 Figure 3.21 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by age and CKD status, 2016



Data source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2016, and December 1, 2016; 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, 6.5% of male CKD patients did not require readmission but later died, 3.0% were rehospitalized and later died within 30 days of the initial discharge, and 19.0% were rehospitalized and lived. CKD patients in all subgroups experienced higher rates of readmission than did those without CKD.

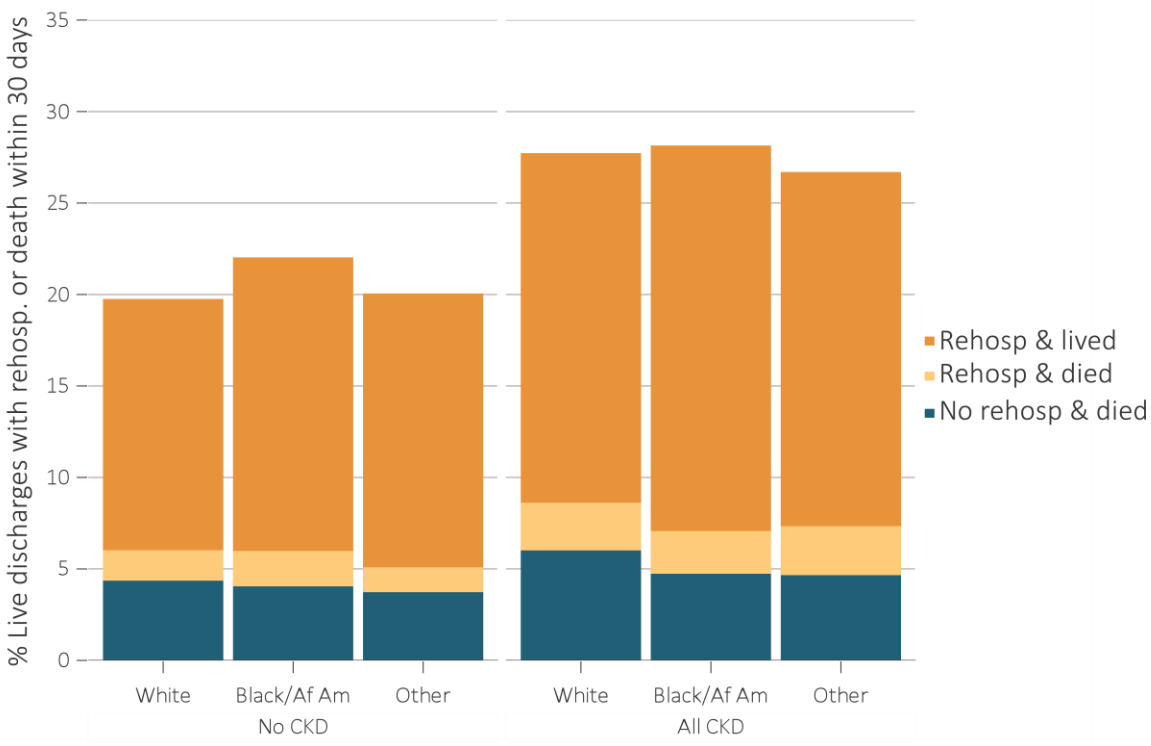
vol 1 Figure 3.22 Unadjusted percentage of patients readmitted to the hospital within 30 days of discharge, among Medicare patients aged 66 and older who were discharged alive from an all-cause index hospitalization between January 1 and December 1, by sex and CKD status, 2016



Data source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2016, and December 1, 2016; 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, Blacks who were rehospitalized subsequently survived at greater rates (15.7%) than did both Whites (13.4%) and patients of Other races (14.6%). For patients with CKD, Blacks survived hospital readmission at 20.7%, Whites at 18.8%, and those of Other races at 19.0%. Whites with or without CKD experienced the highest rates of death without readmission (4.5% for no-CKD, 6.2% with CKD); more CKD patients of Other races were observed to have died following readmission (2.7%).

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, 2016



Data Source: Medicare 5% sample. January 1, 2016 point prevalent Medicare patients aged 66 and older, discharged alive from an all-cause index hospitalization between January 1, 2016, and December 1, 2016; unadjusted. Abbreviations: Af Am, African American; CKD, chronic kidney disease; Rehosp, rehospitalized.

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Notes