Burden of Cardiovascular Hospitalizations across Different Stages of Chronic Kidney Disease: A Real-World Analysis of Texas Hospital Discharge Data

Lixian Zhong[1], Ryan Farej[2], Elena Andreyeva[1], Youssef Farag[2], Rakesh Singh[2], Sheldon Kong[2], Alina Sorescu[1], Xiying Wang[1],Wen Hsin Chen[1],Yuxian Du[2],German Guerrero[2],Robert Ohsfeldt[1],Joe Young[3],Jennifer Cameron[2],Todd Williamson[2]

1. Texas A&M University, College Station, TX, United States. 2. Bayer US. LLC, Whippany, NJ, United States. 3. Vault Bioventures, San Diego, CA, United States.

INTRODUCTION

Chronic Kidney Disease (CKD) is a prevalent chronic condition characterized by the progressive and irreversible deterioration of kidney function. CKD patients are at a higher risk of hospitalization.

CKD patients exhibit an elevated cardiovascular (CV) risk including coronary artery disease, heart failure etc. CV events make up a major cause of hospitalization among CKD patients.

Previous research has primarily concentrated on studying CV events in late/end-stage CKD. However, comprehending the distribution of CV events throughout all stages of CKD can profoundly improve patient care.

OBJECTIVE

- To assess the prevalence of CV events as coded by the principal diagnosis (CV-1Dx) among all hospitalizations with any CKD diagnosis (CKD-Hosp) and across different CKD stages in the state of Texas.
- To characterize the sociodemographic and clinical features associated with CV-1Dx and non-CV-1Dx hospitalizations with a CKD Dx.
- To compare hospitalization outcomes associated with CV-1Dx and non-CV-1Dx hospitalizations with a CKD Dx.

METHODS

- We conducted a cross-sectional analysis of the 2021 TX Hospital Inpatient Public Use Data File (PUDF), which includes encounter-based, statewide hospital discharge data with comprehensive health information.
- Hospitalizations with a CKD Dx (any position, CKD-Hosp) were identified based on ICD-10 codes and further stratified by CKD stages: I, II, III, IV, V/ESRD, and unspecified.
- CV-1Dx and non-CV-1Dx were identified based on the principal Dx.
- Sociodemographic, diagnosis, and cost information were collected for the encounters.
- Descriptive statistics and multivariable regression analysis were performed adjusting for patient characteristics.

RESULTS

Figure 1. 2021 Texas Hospital Inpatient Encounter Attrition Chart

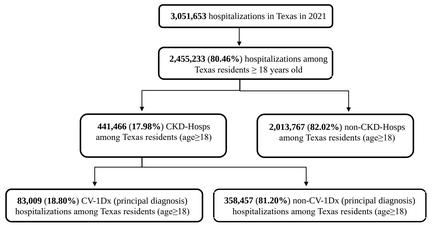


Figure 2a. The Prevalence of CKD-Hosps among all hospitalizations in Texas in 2021

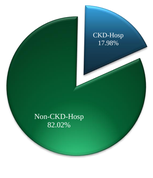


Figure 2b. The prevalence of CV-1Dx hospitalizations among all CKD-Hosps in Texas in 2021

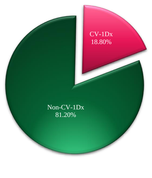
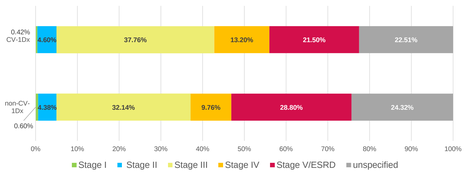


Figure 3. Distribution of CV-1Dx and non-CV-1DX hospitalizations across different CKD stages



Annotation:
Non-CKD-Hosp: Hospitalizations without any CKD diagnosis
CKD-Hosp: Hospitalizations with a CKD diagnosis at any position
Non-CV-1Dx: Hospitalizations without a CV principal diagnosis
CV-1Dx: Hospitalizations with a CV principal diagnosis

RESULTS

Figure 4a. Proportion of CV-1Dx hospitalizations within each stage of CKD-Hosps

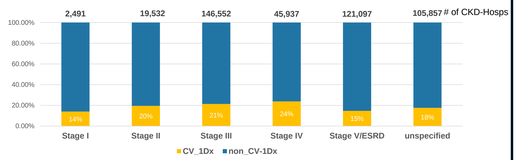


Figure 4b. Breakdown of CV events for CV-1Dx hospitalizations within each stage of diagnosed CKD

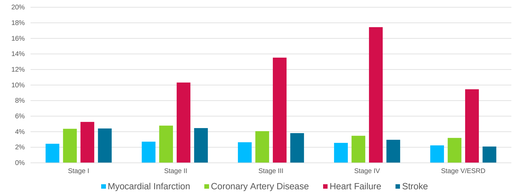


Table 1. Comparisons of socio-demographic characteristics CKD-Hosps between those with CV-1Dx and non-CV-1Dx

		All CKD-Hosps N=441,466	non-CV-1Dx N=358,457	CV-1Dx N=83,009	p-value
		N (%)	N (%)	N (%)	
Age	18-44	32,629 (7%)	28,560 (8%)	4,069 (5%)	<0.001
	45-64	129,180 (29%)	104,364 (29%)	24,816 (30%)	
	65-74	118,463 (27%)	95,604 (27%)	22,859 (28%)	
	75+	161,194 (37%)	129,929 (36%)	31,265 (38%)	
Sex	female	192,748 (44%)	158,655 (44%)	34,093 (41%)	<0.001
	male	217,179 (49%)	174,350 (49%)	42,829 (52%)	
	unknown	31,539 (7%)	25,452 (7%)	6,087 (7%)	
Race	American Indian/Eskimo/Aleut	776 (0%)	650 (0%)	126 (0%)	<0.001
	Asian or Pacific Islander	7,426 (2%)	5,884 (2%)	1,542 (2%)	
	Black	88,885 (20%)	69,580 (19%)	19,305 (23%)	
	White	292,505 (66%)	239,907 (67%)	52,598 (63%)	
	Other	51,870 (12%)	42,433 (12%)	9,437 (11%)	
	unknown	4 (0%)	3 (0%)	1 (0%)	
Ethnicity	Hispanic Origin	113,254 (26%)	93,872 (26%)	19,382 (23%)	<0.001
	Not of Hispanic Origin	326,848 (74%)	263,446 (73%)	63,402 (76%)	
	unknown	1,364 (0%)	1,139 (0%)	225 (0%)	
Insurance coverage	Medicaid	26,221 (6%)	20,717 (6%)	5,504 (7%)	<0.001
	Medicare	209,505 (47%)	172,475 (48%)	37,030 (45%)	
	private	170,191 (39%)	137,865 (38%)	32,326 (39%)	
	uninsured	25,929 (6%)	19,581 (5%)	6,348 (8%)	
	other	8,015 (2%)	6,463 (2%)	1,552 (2%)	
	unknown	1,605 (0%)	1,356 (0%)	249 (0%)	
Rurality	urban	377,804 (86%)	306,782 (86%)	71,022 (86%)	<0.001
	rural	56,148 (13%)	45,379 (13%)	10,769 (13%)	
	unknown	7,514 (2%)	6,296 (2%)	1,218 (1%)	

RESULTS

Table 2. Comparisons of comorbidities of CKD-Hosps between those with CV-1Dx and non-CV-1Dx

	Total N=441,466	non-CV-1Dx N=358,457	CV-1Dx N=83,009	
	N (%)	N (%)	N (%)	p-value
Renal Disease	411,714 (93%)	334,722 (93%)	76,992 (93%)	<0.001
Congestive Heart Failure	212,437 (48%)	144,555 (40%)	67,882 (82%)	<0.001
Diabetes with chronic complications	251,155 (57%)	201,604 (56%)	49,551 (60%)	<0.001
Myocardial Infarction	68,078 (15%)	41,949 (12%)	26,129 (31%)	<0.001
Chronic Pulmonary Disease	98,633 (22%)	76,305 (21%)	22,328 (27%)	<0.001
Cerebrovascular Disease	45,100 (10%)	26,119 (7%)	18,981 (23%)	<0.001
Peripheral Vascular Disease	46,536 (11%)	35,423 (10%)	11,113 (13%)	<0.001
Dementia	42,818 (10%)	36,605 (10%)	6,213 (7%)	<0.001
Mild Liver Disease	34,457 (8%)	29,893 (8%)	4,564 (5%)	<0.001
Hemiplegia or Paraplegia	9,906 (2%)	5,407 (2%)	4,499 (5%)	<0.001
Any malignancy	32,949 (7%)	30,026 (8%)	2,923 (4%)	<0.001
Rheumatologic Disease	16,082 (4%)	13,655 (4%)	2,427 (3%)	<0.001
Diabetes without chronic complications	9,348 (2%)	7,808 (2%)	1,540 (2%)	<0.001
Peptic Ulcer Disease	8,475 (2%)	7,726 (2%)	749 (1%)	<0.001
Moderate/severe liver disease	13,402 (3%)	12,365 (3%)	1,037 (1%)	<0.001
Metastatic solid tumor	11,544 (3%)	10,855 (3%)	689 (1%)	<0.001
AIDS/HIV	1,948 (0%)	1,706 (0%)	242 (0%)	<0.001
Charlson Comorbidity Index mean score (std. dev.)	4.79 (2.02)	4.68 (2.06)	5.28 (1.74)	<0.001
<=3	106,653 (24%)	93,982 (26%)	12,671 (15%)	<0.001
4 or 5	201,868 (46%)	167,603 (47%)	34,265 (41%)	
>=6	132,945 (30%)	96,872 (27%)	36,073 (44%)	

Table 3. Comparisons of CKD-Hosp outcomes between those with CV-1Dx and non-CV-1Dx

		CKD-Hosp N=441,466	Non-CV-1Dx N=358,457	CV-1Dx N=83,009	p-value
Cost ($)	mean (SD)	28,263 (58,495)	28,401 (57,795)	27,665 (61,422)	0.001
	median (IQR)	15,569 (8,905-29,347)	15,671 (8,905-29,540)	15,130 (8,902-28,539)	<0.001
	Total cost (billion $)	12.48	10.18	2.30	
Length-of-stay (days)	mean (SD)	7.36 (8.70)	7.48 (8.95)	6.88 (7.47)	<0.001
	median (IQR)	5.00 (3.00-9.00)	5.00 (3.00-9.00)	5.00 (3.00-8.00)	<0.001
		N (%)	N (%)	N (%)	
In-hospital mortality	Alive	441,318 (100%)	358,318 (100%)	83,000 (100%)	<0.001
	Expired	148 (0%)	139 (0%)	9 (0%)	
Discharge status	Routine discharge	203,801 (46%)	162,546 (45%)	41,255 (50%)	<0.001
	Non-routine discharge	205,258 (46%)	168,434 (47%)	36,824 (44%)	
	Excluded*	32,402 (7%)	27,473 (8%)	4,929 (6%)	
	unknown	5 (0%)	4 (0%)	1 (0%)	

Table 4. Multivariable logistic regression model to assess the associations between sociodemographic/clinical factors and having a CKD-Hosp with CV-1Dx.

CV-1Dx Hospitalization (1/0)	Odds Ratio	Std. Err.	P>z	[95% Conf.	Interval]
CKD stages (ref group: Stage V/ESRD)					
Stage I	1.02	0.064	0.78	0.90	1.15
Stage II	1.36	0.029	0	1.30	1.42
Stage III	1.47	0.017	0	1.44	1.50
Stage IV	1.69	0.025	0	1.64	1.74
Quarter (ref group: 2021Q3)					
2021Q1	1.03	0.014	0.029	1.00	1.06
2021Q2	1.18	0.016	0	1.15	1.21
2021Q4	1.10	0.015	0	1.07	1.13
Age (ref group: 18-44)					
45-64	1.41	0.033	0	1.35	1.48
65-74	1.49	0.036	0	1.42	1.56
75+	1.58	0.038	0	1.51	1.66
Sex (ref group: female)					
male	1.13	0.011	0	1.11	1.15
Race (ref group: White)					
American Indian/Eskimo/Aleut	0.87	0.100	0.21	0.69	1.08
Asian or Pacific Islander	1.19	0.042	0	1.11	1.28
Black	1.28	0.016	0	1.25	1.31
Other	1.09	0.017	0	1.06	1.13

RESULTS

Table 4. Multivariable logistic regression model to assess the associations between sociodemographic/clinical factors and having a CKD-Hosp with CV-1Dx. Cont'd

CV-1Dx Hospitalizations (1/0)	Odds Ratio	Std. Err.	P>z	[95% Conf.	Interval]
Insurance Coverage					
Medicaid	1.21	0.026	0	1.16	1.27
Medicare	0.89	0.0093	0	0.87	0.91
other	0.93	0.033	0.05	0.87	1.00
uninsured	1.59	0.034	0	1.52	1.65
Ethnicity (ref group: non-Hispanic)					
Hispanic Origin	0.92	0.011	0	0.90	0.94
Rurality (ref group: rural)					
urban	0.98	0.014	0.073	0.95	1.00
CCI score (ref group: CCI<=3)					
CCI =4 or 5	1.74	0.026	0	1.69	1.79
CCI>=6)	3.35	0.051	0	3.25	3.45
_cons	0.053	0.0016	0	0.050	0.056

RESULTS SUMMARY

- 18.8% of all hospitalizations with a CKD Dx (CKD-Hosp) had CV principal Dx (CV-1Dx) in Texas hospitals in 2021.

- The majority (~55%) of CKD-Hosps with a CV principal Dx (CV-1Dx) were observed in the earlier CKD stages (Stage II- IV).

- CKD-Hosps among stages II-IV were associated with statistically significantly higher odds (36% - 69%) of having CV-1Dx compared to late-stage (V/ESRD) hospitalizations.

- Older age, male gender, Black and Asian races, uninsured and Medicaid coverage, non-Hispanic ethnicity, and higher Charlson Comorbidity Index scores are associated with increased odds of having CV-1Dx.

LIMITATIONS

- The data is encounter-based and not patient-based.

- CKD and CV diagnosis are based on ICD-10 diagnosis codes and no lab data was available. Underdiagnosis should be taken into consideration.

CONCLUSIONS

- The data highlights the increased risk of hospitalizations due to CV events during CKD stages II-IV among hospitalizations of CKD patients.

-Timely diagnosis of CKD, underscores in these findings the critical need for heightened awareness and proactive management of cardiovascular risks, particularly during the earlier stages of CKD (II-IV) within the Texas population.

DISCLOSURES

The study was funded by Bayer. At the time of the study authors RF, YF, RS, SK, YD, GG, JC, and TW were employees of Bayer; Authors LZ, EA, AS, XW, WHC, RO were employed by Texas A&M University; Author JY was employed by Vault Bioventures.

REFERENCE

Data source: Texas Hospital Inpatient Discharge Public Use Data File, [Q1-Q4, 2021]. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas.