

INTRODUCTION

- Patients with kidney failure undergo hemodialysis (HD) as the primary form of renal replacement therapy.¹
- For patients undergoing HD, central venous catheters (CVCs) act as essential vascular access devices.²
- In fact, 80% of patients initiate HD with a CVC and approximately 20% rely on CVCs for long term access.³
- However, CVCs have an inherent risk of catheter-related bloodstream infections (CRBSIs).⁴
- CRBSIs are associated with diminished quality of life, increased hospital admissions, and greater length of stay (LOS), contributing to a significant economic burden.⁵
- To date, the overall clinical and economic burden associated with CRBSI and incremental burden of CRBSI vs. non-CRBSI is not well-established. Given this, robust estimates of the incremental healthcare resource utilization (HCRU) and cost burden of CRBSI are warranted.

OBJECTIVE

- To evaluate incremental HCRU and costs of CRBSIs in HD patients with CVCs.

METHODS

Study Design and Data Source: Retrospective, propensity score-matched case-control analysis using United States Renal Data System (USRDS), CROWNWeb (Consolidated Renal Operations in a Web-enabled Network), and Medicare claims spanning the period from 2013-2017.

Study Population:

Identification of the study population was conducted in three steps (Figure 1):

- Step 1:** All Medicare end-stage kidney disease (ESKD) patients initiating CVC-dependent HD (HD-CVC) during 2014-2016 with 1-year pre- and ≥ 1-year post-CVC insertion period were selected.
- Step 2:** Occurrence/no-occurrence date (i.e., index date) of CRBSI following CVC insertion were identified based on the following:
 - Index date - CRBSI group:** First ICD-9/10-CM diagnostic claim post-CVC-insertion for 999.32, T80211x; 999.31, or T80219x, T80218x and sepsis/bacteremia diagnosis within ±3 days of hospitalization, or sepsis/bacteremia diagnosis without occurrence for pneumonia, gangrene, or urinary tract infections within ±3 days of hospitalization.
 - Assigned index date – Non-CRBSI group:** Date of CVC insertion + Reported Median days to CRBSI in the CRBSI group.

Patients were excluded with one or more CVC or HD claims in the 6-months pre-index period or were diagnosed with sepsis/bacteremia who had pneumonia, gangrene or, urinary tract infection (UTI) greater than 3 days of hospitalization.

Step 3: CRBSI (case) and non-CRBSI (control) groups were 1:1 propensity score-matched at CRBSI index/assigned index date on age, gender, race, comorbidities, Elixhauser Comorbidity Index, dialysis setting, and diabetes medication.

Follow-up/Post-Index Period: Patients were followed for 1 year from index-date (post-index), or until database cut-off or death.

Study Outcomes & Definitions:

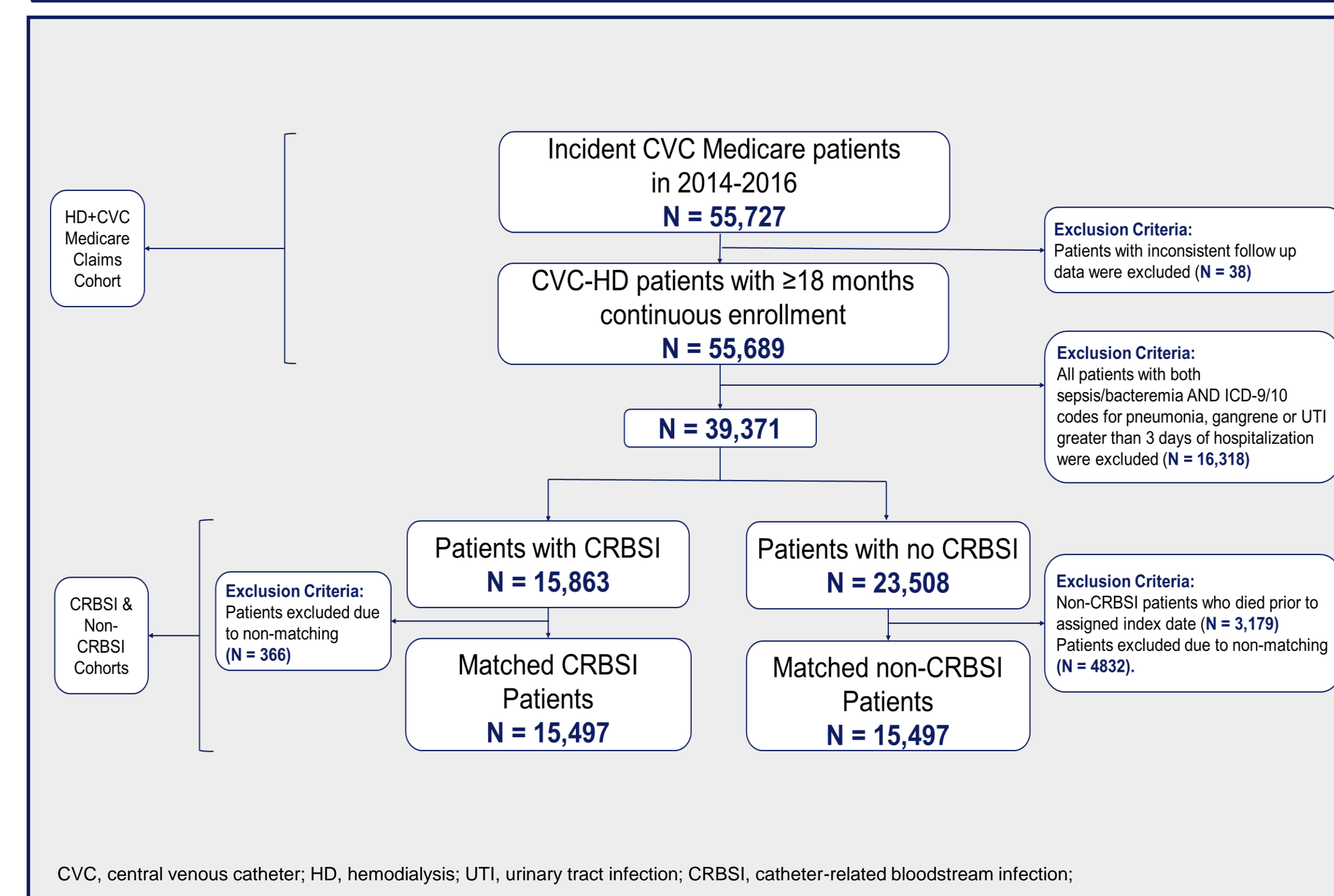
- Demographics: Age, Gender, Race, Comorbidities, Elixhauser Comorbidity Index were used to describe baseline characteristics.
- Annual HCRU (i.e., hospital admissions, LOS, outpatient visits), and annual direct costs (i.e., total direct healthcare costs, inpatient costs, outpatient costs, and pharmacy costs) were assessed.

Statistical Analysis:

- Categorical and continuous variables were described using frequencies and percentages or means, medians, and standard deviations (SD), respectively.
- Additionally, differences between CRBSI and non-CRBSI patients in terms of baseline characteristics, HCRU, and costs were compared using non-parametric tests of Cramer's V and Wilcoxon tests, as appropriate.
- Two-stage generalized linear models (GLM) with gamma log-link were used to evaluate the association between CRBSI and total, inpatient, outpatient, and pharmacy costs, along with inpatient visits, outpatient visits, and LOS.

METHODS (Cont.)

Figure 1. Patient Selection



RESULTS

- From the total study population, matched CRBSI (n=15,497) and non-CRBSI (n=15,497) patients were identified.
- Mean age was similar and half the population was female in both CRBSI and non-CRBSI groups.
- Descriptive statistics for the matched groups are displayed in Table 1.

Table 1. Patient Demographics

	CRBSI (n=15,497)	Non-CRBSI (n=15,497)	SMD	Cramer's V
Mean Age, in years (SD)	66.79 (13.8)	67.07 (13.5)	0.021	0.090
Female, n (%)	7,179 (46.3)	7,181 (46.3)	<0.001	< 0.01
Race, n (%)			0.023	0.01
White	10,391 (67.0)	10,539 (68.0)		
African American	4,434 (28.6)	4,275 (27.6)		
Other / Unknown	676 (4.4)	687 (4.4)		
Comorbidities, n (%)				
CHF	8,204 (52.9)	8,469 (54.6)	0.034	0.017
COPD	1,832 (11.8)	1,981 (12.8)	0.029	0.015
CVA / TIA	1,575 (10.2)	1,683 (10.9)	0.023	0.011
Diabetes	8,865 (57.2)	8,926 (57.6)	0.008	0.004
GFR MDRD (Stage 5)	13,121 (84.7)	12,805 (82.6)	0.055	0.028
Hypertension	4,982 (32.1)	5,063 (32.7)	0.011	0.006
Metastatic Cancer	242 (1.6)	290 (1.9)	0.024	0.012
Polycystic Disease	33 (0.2)	37 (0.2)	0.005	0.003
AIDS / HIV	125 (0.8)	181 (1.2)	0.037	0.018
Elixhauser Comorbidity Index, n (%)			0.113	0.113
< 0	11,573 (74.7)	11,691 (75.4)		
0	27 (0.2)	26 (0.2)		
1-5	1,066 (6.9)	1,027 (6.6)		
6-13	2,431 (15.7)	2,374 (15.3)		
>14	404 (2.6)	383 (2.5)		
Body Mass Index			0.030	0.015
Underweight	503 (3.3)	324 (2.8)		
Normal	4,247 (27.6)	3,179 (27.4)		
Overweight	3,973 (25.8)	2,982 (25.7)		
Obese	6,674 (43.3)	5,123 (44.1)		

CRBSI, catheter-related bloodstream infections; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disorder; CVA, cerebrovascular accident; TIA, transient ischemic attack; GFR MDRD, Glomerular Filtration Rate at Stage 5 (i.e., ESKD) using Modification of Diet in Renal Disease equation; AIDS, Acquired immunodeficiency syndrome; HIV, Human Immunodeficiency Virus; SMD, standardized mean difference; SD, standard deviation

RESULTS (Cont.)

Table 2. Annual HCRU results for CRBSI & non-CRBSI Patients

	CRBSI (n=15,497)		Non-CRBSI (n=15,497)		p-value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Hospital Admissions	2.41 (2.63)	0.58 (1.25)	2.41 (2.63)	0.58 (1.25)	< 0.001
LOS, in days	20.72 (26.38)	3.44 (9.53)	20.72 (26.38)	3.44 (9.53)	< 0.001
Outpatient Visits	18.73 (13.69)	16.97 (11.4)	18.73 (13.69)	16.97 (11.4)	< 0.001

HCRU, healthcare resource utilization; CRBSI, catheter-related bloodstream infections; LOS, length of stay; SD, Standard deviation

HCRU outcomes

- HCRU means for both CRBSI and non-CRBSI groups are reported in Table 2.
- Patients with CRBSI had a significantly higher proportion of hospital admissions (2.41 vs. 0.58), greater LOS (24.9 vs. 5.87), and higher outpatient visits (18.73 vs. 16.97) compared to non-CRBSI patients.
- GLM results showed a 34% greater risk of hospital admissions and a 113% greater risk of higher LOS among patients with CRBSI. (Table 3).

Table 3. HCRU and Cost associations with CRBSI*†

HCRU	HR	95% CI	p-value
Hospital Admissions	1.34	1.29, 1.39	< 0.001
LOS	2.13	2.01, 2.27	< 0.001
Outpatient Visits	0.98	0.92, 1.04	0.44
Cost			
Total Costs	1.83	1.76, 1.90	< 0.001
Inpatient	1.62	1.57, 1.67	<0.001
Outpatient	0.63	0.61, 0.65	<0.001
Pharmacy	0.71	0.69, 0.74	<0.001

HCRU, healthcare resource utilization; LOS, length of stay; HR, hazard ratio; CI, confidence interval

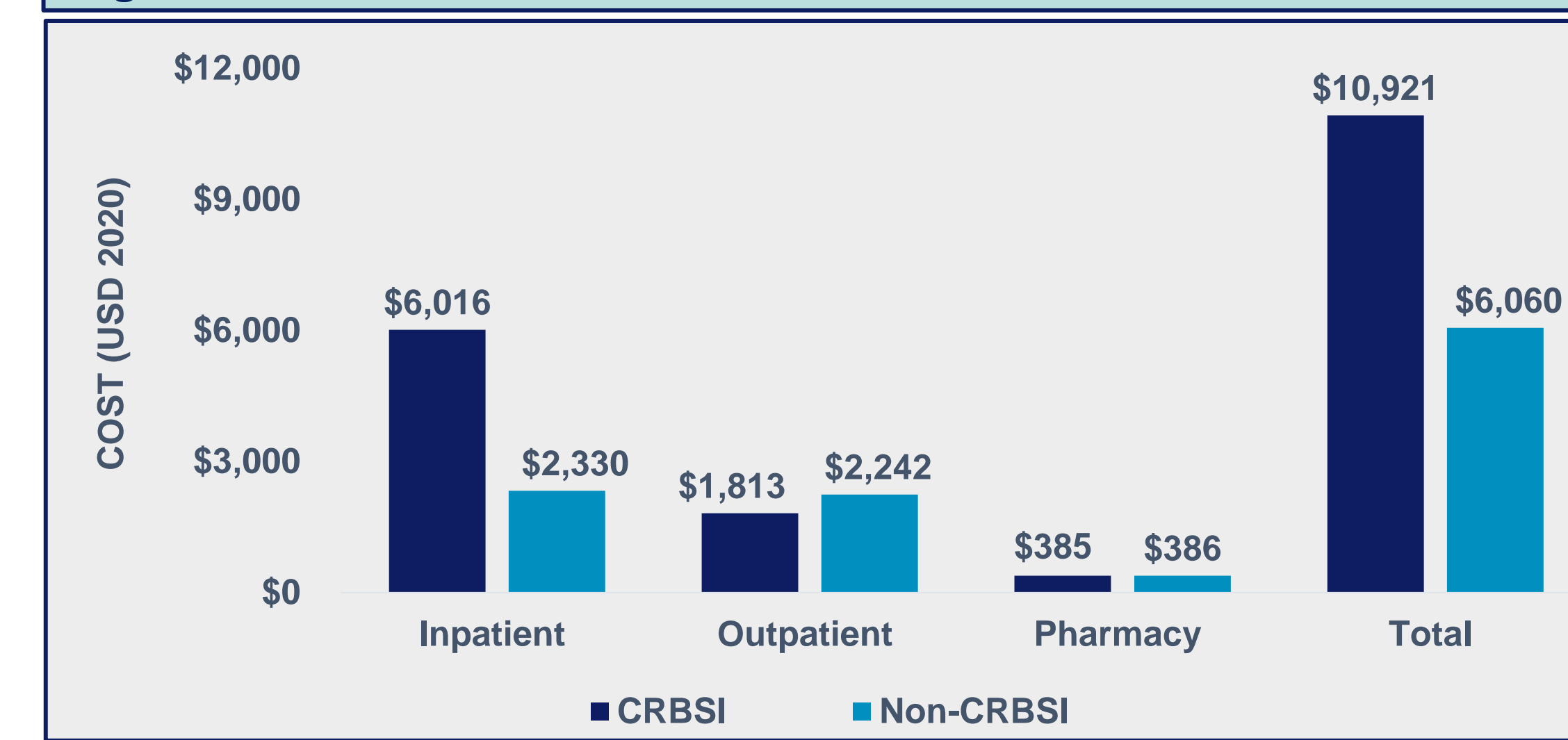
*All GLM models were adjusted for covariates of age, body mass index (BMI), chronic heart failure (CHF), comorbidities (as measured by Elixhauser comorbidity index), chronic obstructive pulmonary disorder (COPD), cerebrovascular accident (CVA)/trans ischemic attack (TIA), gender, hypertension, metastatic cancer, other causes of ESKD than hypertension, diabetes, and polycystic kidney disease, oral medication for diabetes

†Only covariates that were significant in the model with a p-value < 0.05 were included in the model.

Cost Outcomes

- The total mean per-patient-per-month (PPPM) costs were \$10,921 for CRBSI and \$6,016 for non-CRBSI patients, while PPPM inpatient costs were \$6,016 and \$2,330 in the CRBSI and non-CRBSI patients, respectively, in the year following index date.
- Figure 2a reports PPPM direct healthcare costs for one-year post-index date.
- The annual total mean per-patient-per-year (PPPY) costs for CRBSI (\$132,878) and non-CRBSI (\$73,732) groups are reported in Figure 2b.

Figure 2a. Mean CRBSI & Non-CRBSI PPPM Costs for 1 Year Post-Index



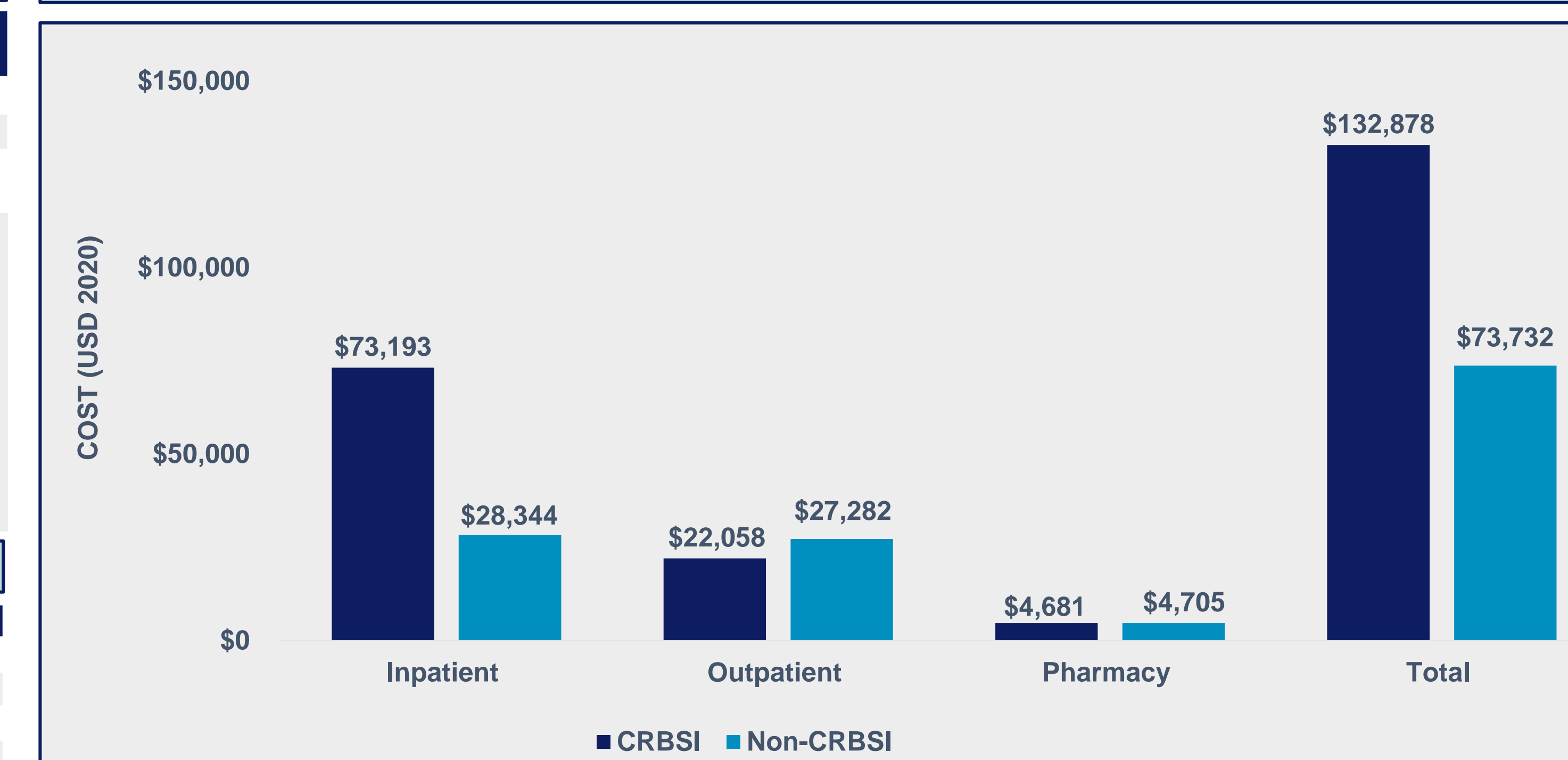
PPPM, Per-Patient-Per-Month; CRBSI, catheter-related bloodstream infections; USD United States Dollar

*Total healthcare costs consisted of inpatient, outpatient, nursing home, home health, hospice, physician supplier claims, prescription drugs, and durable medical equipment costs.

- CRBSI was associated with higher total [1.83 (95% CI:1.76, 1.90)] and inpatient costs [1.62 (95% CI:1.57, 1.67)], but lower outpatient visit costs [0.63 (95% CI: 0.61, 0.65)], and pharmacy costs [0.71 (95% CI:0.69, 0.74)] (Table3).

RESULTS (Cont.)

Figure 2b. Mean Annual CRBSI & Non-CRBSI PPPY Costs



PPPY, Per-Patient-Per-Year; CRBSI, catheter-related bloodstream infections; USD United States Dollar

*Total healthcare costs consisted of inpatient, outpatient, nursing home, home health, hospice, physician supplier claims, prescription drugs, and durable medical equipment costs.

LIMITATIONS

- The identification algorithm for CRBSI, which uses proxy determinates of disease, has the potential to misclassify the cause of bacteremia in patients.
- Due to the methodology, we were unable to determine whether patients had CVC still inserted at the time of the CRBSI occurrence; however, the majority of CRBSI events occurred within 6 months following CVC insertion.

CONCLUSIONS

- Hospital admissions and LOS among CRBSI patients are over four-fold and five-fold higher compared to non-CRBSI patients, respectively.
- In the year following incidence of CRBSI, total and inpatient costs were found to be almost double for CRBSI patients as compared to matched non-CRBSI patients.
- At one-year post-index, mean PPPM cost of inpatient visits and total visits for CRBSI was almost 0.8 and 1.6 times higher compared to non-CRBSI patients.
- Incremental total PPPY costs for CRBSI vs. matched non-CRBSI patients was \$59,146.
- Among kidney failure patients undergoing HD, those with CRBSI incur a vastly greater clinical and economic burden as compared to non-CRBSI patients, suggesting a public health imperative to prevent CRBSIs.

REFERENCES

- Chronic Kidney Disease Initiative- Centers for Disease Control and Prevention. <https://www.cdc.gov/kidneydisease/basics.html>. Accessed 09.19.2021.
- Santoro, D., Benedetto, F., Mondello, P., Pipitò, N., Barillà, D., Spinelli, F., ... & Buemi, M. (2014). Vascular access for hemodialysis: current perspectives. Int J Nephrol Renovasc Dis, 7, 281.
- Lee T, Allon M. Reassessing Recommendations for Choice of Vascular Access. Clin J Am Soc Nephrol. 2017;12(6):865-867.
- Gahlot, R., Nigam, C., Kumar, V., Yadav, G., & Anupurba, S. (2014). Catheter-related bloodstream infections. Int J Crit Illn Inj Sci, 4(2), 162.
- Brunelli, S. M., Turenne, W., Sibbel, S., Hunt, A., & Pfaffle, A. (2016). Clinical and economic burden of bloodstream infections in critical care patients with central venous catheters. J. Crit. Care, 35, 69-74.

