

## Introduction

- Vascular access type used for hemodialysis (HD) has profound consequences for patient outcomes.
- Central venous catheter (CVC) use is associated with greater morbidity, mortality, and healthcare utilization compared to other access types.<sup>1,2</sup>
- CVC use adversely impacts clinical outcomes as a consequence of complications such as blood stream infections (BSI) and catheter occlusions.<sup>3,4</sup>
- BSI and catheter occlusions may necessitate hospitalizations, procedures, and physician visits, which in turn can substantially increase costs to the payor.

## Objective

To quantify the clinical and economic burden associated with catheterrelated BSI and catheter occlusions among patients receiving dialysis using a CVC.

## Methods

- This study was a retrospective, observational analysis of patients undergoing in-center HD at a large dialysis organization (LDO). Data were derived from LDO electronic health records and Medicare Part A and Part B claims data available in the United States Renal Data System (USRDS).
- Eligible patients were at least 18 years old at study entry, received HD at LDO facilities, used a CVC for HD access, and were enrolled in Medicare Parts A and B.
- Study patients were classified as prevalent or incident based on length of time on dialysis (HD vintage) at time of study entry. Prevalent patients were those who continuously met eligibility criteria for a minimum period of 3 months as of 01 January 2011. Incident patients were those who started HD between 01 January 2011 and 30 June 2011 and met eligibility criteria as of dialysis initiation. Study entry date for incident patients was the day of first dialysis.
- Patients who developed BSI or catheter occlusion during the period 01 January 2011 to 30 June 2011were matched 1:1 to eligible controls based on incident/prevalent status.
- For BSI/occlusion patients, index date was the date of the qualifying BSI or occlusion.
- For control patients, index date was ascribed as the date of the exposure in the corresponding matched BSI/occlusion patient.
- BSI/occlusion patients and matched controls were followed forward in historical time from index date for 6 months or until censoring for modality change, transfer away from the LDO, loss of Medicare eligibility, or death.
- Clinical outcomes assessed were hospital admission rate and vascular access-related ambulatory procedure rates, derived from Medicare Part A and Medicare Part B claims, respectively.
- Medicare billed costs were identified from USRDS claims and were assessed over each month of follow up for each patient.
- Rate outcomes were formally compared using negative binomial models. Costs were compared using linear mixed models. In both cases, adjusted models contained covariate terms for characteristics that were imbalanced at baseline (P < 0.1).

# Economic Burden to Medicare of Central Venous Catheter-Related Blood Stream Infections and Occlusions among Hemodialysis Patients

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## Results

- Baseline characteristics of BSI/CVC occlusion patients and controls are shown in Table 1
- After adjustment for baseline differences, BSI was associated with 1.07 incrementally more hospital admissions per patient year, and 2.87 incrementally more vascular access-related procedures per patient year (Table 2 and Figure 1).
- After adjustment for baseline differences, CVC occlusion was associated with 0.29 incrementally more hospital admissions per patient year, and 4.00 more vascular access-related procedures per patient year (Table 2 and Figure 1).
- Adjusted costs were \$2624 greater per month for each of the 6 months following BSI (Table 2).
- Increased costs were due in large part to greater Medicare Part A costs, driven largely by hospitalization costs (Figure 2).
- Adjusted costs were \$2354 greater per month for each of the 6 months following CVC occlusion (Table 2).
- Increased costs were driven by both increased Part A and Part B costs and were primarily attributable to greater ancillary service and vascular access-related procedure costs (Figure 2).

#### Table 1: Demographic and Baseline Characteristics of CVC Patients with or without BSI and CVC Patients with or without Occlusion

		CVC without BSI N = 1413	<b>CVC</b> <b>with BSI</b> N = 1413	<b>P-Value</b>	CVC without Occlusion N = 793	CVC with Occlusion N = 793	<i>P</i> -Value
<b>Age</b> , years me	mean ± SD edian [p25, p75]	66.6 ± 14.5 68 [58, 78]	63.1 ± 15.5 65 [53, 75]	< 0.001	66.9 ± 14.5 68 [58, 78]	65.0 ± 14.5 66 [56, 76]	0.007
<b>Sex</b> Female	n (%)	736 (52.1)	749 (53.0)	0.62	407 (51.3)	438 (55.2)	0.12
Race/Ethnicity White Black Hispanic Other Unknown	n (%)	659 (46.6) 495 (35.0) 165 (11.7) 41 (2.9) 53 (3.8)	640 (45.3) 560 (39.6) 154 (10.9) 26 (1.8) 33 (2.3)	0.01	379 (47.8) 286 (36.1) 81 (10.2) 21 (2.7) 26 (3.3)	318 (40.1) 342 (43.1) 97 (12.2) 21 (2.7) 15 (1.9)	0.005
<b>Etiology of ESRD</b> Diabetes Hypertension Other	n (%)	644 (45.6) 432 (30.6) 337 (23.9)	660 (46.7) 406 (28.7) 347 (24.6)	0.56	369 (46.5) 248 (31.3) 176 (22.2)	385 (48.6) 238 (30.0) 170 (21.4)	0.72
Incident status Incident Prevalent	n (%)	412 (29.2) 1001 (70.8)	412 (29.2) 1001 (70.8)	NA <sup>a</sup>	267 (33.7) 526 (66.3)	267 (33.7) 526 (66.3)	NA <sup>a</sup>
<b>Vintage</b> , months me	mean ± SD edian [p25, p75]	28.1 ± 43.3 10 (4, 38)	33.1 ± 45.0 12 (3, 49)	0.04	27.8 ± 41.6 9 [4, 35]	25.8 ± 41.6 8 [4, 31.5]	0.30
Postdialysis weight, kg							
me	mean ± SD edian [p25, p75]	76.1 ± 21.3 72.8 [61.4, 86.8]	79.9 ± 24.6 75.0 [62.6, 92.2]	< 0.001	77.1 ± 22.8 72.5 [61.5, 88.2]	79.8 ± 24.5 75.1 [62.2, 92.5]	0.02
CCI score me	mean ± SD edian [p25, p75]	6.0 ± 1.8 6 [5, 7]	5.7 ± 1.9 6 [4, 7]	< 0.001	6.1 ± 1.8 6 (5, 7)	5.8 ± 1.9 6 (5, 7)	0.02
Diabetes	n (%)	1008 (71.3)	1029 (72.8)	0.38	568 (71.6)	568 (71.6)	1.0
Congestive heart f	ailure n (%)	189 (13.4)	180 (12.7)	0.62	111 (14.0)	103 (13.0)	0.56
Coronary artery dis	sease n (%)	112 (7.9)	112 (7.9)	1.0	68 (8.6)	44 (5.6)	0.02
Cerebrovascular d	isease n (%)	6 (0.4)	14 (1.0)	0.07	6 (0.8)	12 (1.5)	0.15
Peripheral vascula	r diseasen (%)	38 (2.7)	57 (4.0)	0.05	35 (4.4)	29 (3.7)	0.44
Serum albumin, g/dL							
me	mean ± SD edian [p25, p75]	3.65 ± 0.51 3.7 [3.4, 4.0]	3.52 ± 0.53 3.6 [3.2, 3.9]	< 0.001	3.65 ± 0.50 3.7 [3.4, 4.0]	3.63 ± 0.51 3.7 [3.4, 4.0]	0.31
<b>nPCR,</b> g/kg/day me	mean ± SD edian [p25, p75]	0.91 ± 0.32 0.88 [0.69, 1.10]	0.86 ± 0.32 0.83 [0.65, 1.05]	< 0.001	0.90 ± 0.34 0.87 [0.69, 1.09]	0.92 ± 0.35 0.89 [0.68, 1.12]	0.54

<sup>a</sup> Cohorts matched on indicent/prevalent status and are therefore identical such that formal statistical tests do not apply. Abbreviations: BSI, blood stream infection; CCI, Charlson comorbidity index; ESRD, end-stage renal disease; nPCR, normalized protein catabolic rate; SD, standard deviation.

#### Figure 1: Comparative Hospital Admission and Vascular Access-Related **Ambulatory Procedure Rates**



ialysis weight, Charlson comorbidity index score, serum albumin, normalized protein catabolic rate, and periphera

Adjusted for age, race, postdialvsis weight. Charlson comorbidity index score

obreviations: aIRD, adiusted incidence rate difference: BSI, bloodstream infection: CI, confidence interval: CVC, central venous catheter.

#### Figure 2: Comparative Medicare Cost Components



### Conclusions

- BSI and catheter occlusions in HD patients using CVC for dialysis access have significant deleterious effects on patient outcomes and, consequently, are costly to the healthcare payor.
- Total incremental costs to Medicare over the 6-month time frame approximate to:
- \$16,000 per episode for BSI
- \$14,000 per episode for CVC occlusion
- Risk mitigation strategies to prevent BSI and catheter occlusions should therefore prove to reduce systemic health care costs.

#### Table 2: Hospital Admissions, Vascular Access-Related Ambulatory **Procedures, and Medicare Costs Among CVC Patients with or without BSI** and Among CVC Patients with or without Occlusion

	CVC without BSI	CVC with BSI	CVC without Occlusion	CVC with Occlusion					
	N = 1413	N = 1413	N = 793	N = 793					
Time at-risk, patient-years	518.1	501.2	357.5	381.8					
Hospital Admissions									
Number of admissions	1418	2159	1042	1212					
Unadjusted incidence rate, admissions per patient-year	2.74	4.31	2.93	3.18					
Adjusted incidence rate, admissions per patient-year	2.60 a	3.67 a	2.80 <sup>b</sup>	3.10 <sup>b</sup>					
Adjusted incidence rate difference (95% CI)	0 (ref)	1.07 ª (0.82, 1.24) <i>P</i> < 0.001	0 (ref)	0.29 <sup>b</sup> (0.02, 0.66) <i>P</i> < 0.001					
Vascular Access-Related Ambulatory Procedures									
Number of procedures	1615	3044	1057	2641					
Unadjusted incidence rate, procedures per patient-year	3.13	5.94	2.96	6.94					
Adjusted incidence rate, procedures per patient-year	3.55 <sup>a</sup>	6.42 <sup>a</sup>	3.05 <sup>b</sup>	7.10 <sup>b</sup>					
Adjusted incidence rate difference (95% CI)	0 (ref)	2.87ª (2.31, 3.21) <i>P</i> < 0.001	0 (ref)	4.00 <sup>b</sup> (3.27, 4.74) <i>P</i> < 0.001					
Medicare Costs									
<b>Part A total costs</b> , USD per patient per month mean ± SD median [p25, p75]	7736 ± 9570 4707 [2769, 9504]	10,500 ± 11,186 8035 [4337, 13,271]	7740 ± 7803 4971 [2923, 9566]	8798 ± 6921 6741 [3833, 11,953]					
Part B total costs, USD per patient per month mean SD median [p25, p75]	1829 ± 1998 1048 [528, 2301]	2472 ± 2167 1713 [959, 3312]	1804 ± 1900 1126 [603, 2141]	2575 ± 2296 1800 [1034, 3371]					
<b>Unadjusted monthly total Medicare costs,</b> USD per patient per month mean SD median [p25, p75]	9565 ± 10,670 6194[3580, 12,373]	12,971 ± 12,386 10,299 [5663, 16,333]	9544 ± 9123 6603 [3769, 11,807]	11,372 ± 8029 9266 [5370, 15,235]					
Adjusted monthly total Medicare costs, USD per patient per month	10,284	13,721	10,367	11,866					
Adjusted mean difference in monthly costs (95% CI)	0 (Ref)	+2624 (1951, 3479)	0 (Ref)	+2354 (1583, 3376)					

<sup>a</sup> Adjusted for age, race, vintage, postdialysis weight, Charlson comorbidity index score, serum albumin, normalized protein catabolic rate, and peripheral vascular disease.

*P* < 0.001

<sup>b</sup> Adjusted for age, race, postdialysis weight, Charlson comorbidity index score.

#### Abbreviations: BSI. bloodstream infection: CI. confidence interval: ref. referent: USD. United States dollars.

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*P* < 0.001