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## A Six-Year Follow-Up of Bloodstream Infections in Hemodialysis Facilities in the United States, National Healthcare Safety Network, 2020

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### Abstract

**Background**—Approximately 500,000 people in the United States undergoing hemodialysis are at risk of bloodstream infections (BSIs). The Centers for Disease Control and Prevention's National Healthcare Safety Network conducts surveillance for BSIs among outpatient hemodialysis facilities in the United States. Quality improvement initiatives encourage these facilities to adopt evidence-based interventions to decrease the incidence of BSI in patients. We

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Disclosures

Disclosure forms, as provided by each author, are available with the online version of the article at <http://links.lww.com/CJN/B941>.

Supplemental Material

This article contains the following supplemental material online at <http://links.lww.com/CJN/B940>.

Supplemental Table 1. Blood stream infection events (numerator), patient-months (denominator), pooled mean rate, and 95% confidence intervals stratified by vascular access type and year, National Health Care Safety Network, 2014<sup>4</sup> and 2020.

describe the incidence of BSI among patients at outpatient hemodialysis facilities in the United States during 2020, stratified by state or territory.

**Methods**—Outpatient hemodialysis facilities report BSI events to the National Healthcare Safety Network. Pooled mean rates with 95% confidence interval (CI) were calculated overall and for each type of vascular access (arteriovenous [AV] fistula, AV graft, or a central venous catheter). Standardized infection ratios (SIRs) were calculated as observed BSI events divided by the predicted number of events on the basis of national aggregate data. Median facility-level SIRs and 95% CIs were stratified by state and US territory.

**Results**—During 2020, 7183 outpatient hemodialysis facilities reported data for 5,235,234 patient-months with 15,181 BSI events. Pooled mean rates per 100 person-months were 0.29 (95% CI, 0.29 to 0.30) overall, 0.80 (95% CI, 0.78 to 0.82) for central venous catheter, 0.12 (95% CI, 0.12 to 0.12) for AV fistula, 0.21 (95% CI, 0.20 to 0.22) for AV graft, and 0.28 (95% CI, 0.19–0.40) for other access types. The national SIR was 0.40 (95% CI, 0.39 to 0.41). South Dakota had a SIR significantly higher than one (1.34; 95% CI, 1.11 to 1.62). Fifty-one of 54 states and territories had BSI SIR significantly lower than one.

**Conclusions**—In 2020, the median SIR for BSI in US outpatient hemodialysis facilities was lower than predicted overall and in almost all states and territories. An elevated SIR was identified in South Dakota.

## Introduction

In 2020, nearly 500,000 people in the United States received treatment with hemodialysis.<sup>1</sup> Because of impaired immune function and repeated vascular access, infection is a major cause of morbidity and mortality in this population.<sup>2–4</sup> Infections cause patients and families significant pain, suffering, death, and financial burden because of additional treatments, procedures, and lost wages.<sup>5–7</sup> Quality improvement initiatives, including the Centers for Disease Control and Prevention's (CDC) Making Dialysis Safer Coalition, established in 2016, encourage dialysis facilities to adopt evidence-based interventions to decrease the incidence of bloodstream infections (BSIs) in patients.<sup>8</sup>

To monitor the effectiveness of infection prevention measures and to facilitate quality improvement,<sup>9–11</sup> the CDC conducts surveillance for BSI and related events in hemodialysis patients<sup>12</sup> through the National Healthcare Safety Network (NHSN).<sup>13</sup> To allow for a comparison of rates of BSI among populations, over time, and across facilities, NHSN calculates a risk-adjusted standardized infection ratio (SIR) for BSI events on the basis of a 2014 baseline. SIR is calculated as the ratio of the actual number of observed events divided by the predicted number of events on the basis of national aggregate data. NHSN recommends using the standardized incidence ratio instead of crude rates because the SIR allows for direct comparison with the expected number of events among populations with differing risk profiles, including differing infection incidence across the access types.<sup>14</sup> This surveillance allows CDC to monitor national trends and inform national infection prevention and control strategies.

The most recent report from NHSN regarding surveillance for BSIs and related events in hemodialysis patients was published in 2017 using data collected in 2014.<sup>15</sup> This report

found a median SIR of 0.84 for BSI events. The aim of this surveillance report is to describe the incidence of BSI among patients at outpatient hemodialysis facilities in the United States during 2020, stratified by state or territory.

## Methods

### Data Source

NHSN is a web-based surveillance system that collects information of outpatient hemodialysis BSIs. Dialysis facilities report to NHSN in compliance with the ESKD Quality Incentive Program.<sup>15</sup> Patient-level data collected include demographic characteristics, symptoms related to health care–associated infections, and patient outcomes. Three types of hemodialysis events are reportable to NHSN: BSI, intravenous antibiotic starts, and pus, redness, or increased swelling at the access site. This study focuses on one of the three event types, BSI.

BSI is defined as any positive blood culture collected from an outpatient or within one calendar day of a hospital admission. To prevent the reporting of multiple blood culture results for a single infection episode, 21 or more days must elapse between two positive blood cultures. If fewer than 21 days have passed since the last reported blood culture, it is not reportable to NHSN. Vascular access is also reported and categorized as arteriovenous (AV) fistula, AV graft, or a central venous catheter (CVC) (tunneled or nontunneled). For patients with multiple access types, a risk strata is applied and only the higher risk access is reported, with nontunneled CVC>tunneled CVC>other vascular access>AV graft AV fistula.<sup>14,16</sup> Up to three unique pathogens, identified through blood culture, may be recorded for each BSI. The ten most frequently reported pathogens were presented. Additional information collected for each BSI includes patient-level data, such as demographic characteristics, hospitalization, death, and other outcomes. Each reporting facility implements blood culture collection in accordance with their own protocols. Outpatient dialysis facilities are encouraged to follow blood culture collection standardization guidelines set by the American Society of Nephrology.<sup>17</sup> The clinical distinction between BSI and a false positive result due to contamination is decided and reported by each individual dialysis provider.

### Facility Characteristics

Outpatient dialysis facilities report the total number of patients receiving dialysis by access type during the first two working days of each month, which enables the calculation of a denominator in patient-months for each facility, stratified by access type.<sup>18</sup> Annually, facilities also report characteristics including size, ownership, and affiliation with a hospital or hospital group. Facility size is determined by the median number of hemodialysis stations at each location. Facilities with fewer than 16 stations are classified as small facilities, 17–22 are medium-sized facilities, and facilities with 23 or more are considered large facilities. Ownership is categorized as government-owned, not-for-profit, or for-profit. Hospital affiliation is categorized as freestanding, hospital-based, or hospital-affiliated. A freestanding clinic is not affiliated with a hospital. A hospital-based clinic is one that is both

affiliated with a hospital and attached to, or part of, the hospital. A hospital-affiliated clinic is owned by a hospital but not attached to the affiliated hospital.<sup>19</sup>

### Data/Statistical Analysis

BSI events from all facilities were totaled to generate overall BSI events as the numerator. Denominators were expressed as total patient-months. Number of events and patient-months were stratified by vascular access type. The percent of total BSI events contributed by each access type and the percent of the overall denominator contributed by each access type were also calculated. Pooled mean rates and 95% confidence intervals (CIs), overall and by access type, were calculated by combining data from all the facilities. Overall rate and rates by access type were expressed as events divided by denominator per 100 patient-months. Overall and access type-specific 95% CIs were calculated using the mid-P method.

The main parameter of interest was the 2020 SIR. The SIR is calculated as the ratio of the actual number of observed events over the predicted number of events on the basis of national aggregate data. Predicted BSI values were generated by multiplying the standardized rates for each access type by the number of patients with that access type from the NHSN dialysis event data on the basis of the 2014 standard. Predicted BSI values for each access type were then summed to generate an overall total expected BSI.<sup>14,20</sup> The frequency of BSI was tabulated overall and then stratified by the US states and territories. States or territories with fewer than five reporting facilities were suppressed to prevent the possibility of attributing a SIR to any facility. For each state or territory, we presented actual number of BSI events, expected BSI events, and the SIR with 95% CI derived using the mid-P method.<sup>21</sup> If a state reported more BSIs than predicted, the SIR was greater than one. If a state reported fewer BSIs than predicted, the SIR was less than one. Data were analyzed using SAS 9.4 (SAS Institute, Cary, NC). This activity was reviewed by the CDC, deemed not to be research, and conducted consistently with applicable federal law and CDC policy.

### Results

A total of 7183 outpatient hemodialysis facilities reported to the NHSN in 2020; the majority of facilities, 6688 (93.1%), were characterized as large facilities. The median number of dialysis stations was 17 (interquartile range [IQR], 13–24), and the median number of monthly patients per facility was 58 (IQR, 37–94). Most of these facilities were owned by for-profit entities (6307; 87.8%), whereas 844 (11.8%) were non-profit and 32 (0.5%) were government-owned facilities. Almost 93% of these facilities were free-standing clinics, while the remaining were hospital-based clinics or free-standing clinics owned by a hospital (Table 1). The number of facilities varied by state or territory, from one facility in American Samoa to 704 facilities in Texas.

A total of 5,235,234 patient-months were observed, including 3,158,055 (59.8%) contributed by fistula, 1,195,670 (22.8%) CVC, 901,467 (17.2%) graft, and 10,042 (0.2%) other access types. BSI events by access type included 9548 (62.9%) from CVC, 3708 (24.4%) from fistula, 1897 (12.5%) from graft, and 28 (0.2%) from other access types. Pooled mean rates per 100 patient-months were 0.29 (95% CI, 0.29 to 0.30) overall, 0.80 (95% CI, 0.78 to

0.82) for CVC, 0.12 (95% CI, 0.12 to 0.12) for fistula, 0.21 (95% CI, 0.20 to 0.22) for graft, and 0.28 (95% CI, 0.19 to 0.40) for other access types (Table 2).

The national SIR was 0.40 (95% CI, 0.39 to 0.41). The median number of BSI events per state/territory was 160.5 (IQR, 48.5–329). SIRs varied among states and territories from 0.20 (95% CI, 0.16 to 0.25) in Nevada to 1.34 (95% CI, 1.105 to 1.62) in South Dakota. Only South Dakota had a SIR significantly greater than one. Fifty-one of the 54 states/territories had BSI SIR significantly lower than one (Table 3). Overall, 13,275 (87.5%) BSI events had one pathogen listed, 1526 (10.1%) had two pathogens listed, and 380 (2.5%) had three pathogens listed. Almost half (46.6%) of all the infections were attributed to a *Staphylococcus* species, and nearly 32% were *Staphylococcus aureus* (Table 4).

## Discussion

In 2020, the median BSI SIR among outpatient hemodialysis facilities in US states and territories was 0.40, which was a decrease from the 2014 median SIR of 0.84, as reported previously. Compared with the 2014 numbers, our analysis also found lower pooled mean rates of BSI overall and among patients with every vascular access type (Supplemental Table 1).<sup>15</sup> This indicates that BSI in hemodialysis patients improved between 2014 and 2020. However, residual BSI events exist; BSIs continue to cause morbidity and mortality in hemodialysis patients, and efforts to decrease incidence should continue.

The decreased incidence of BSIs observed between 2014 and 2020 was a welcome improvement in care observed during a period of increased quality improvement efforts such as CDC's Making Dialysis Safer for Patients Coalition. This coalition was launched in 2016 and encourages adoption of a set of interventions that have been shown to sustainably reduce BSI.<sup>8,22</sup> This set of interventions includes a protocol for preparing catheter hubs before accessing the catheter for hemodialysis. Use of this approach has been shown to reduce BSI among patients with CVC vascular access, who are at highest risk of BSI.<sup>23</sup> However, outpatient hemodialysis facilities may be challenged to implement optimal infection control interventions due to high patient-to-staff ratios and high staff turnover.<sup>24</sup> These challenges may be difficult to address due to the ongoing shortage of nurses that has been amplified by the coronavirus disease 2019 (COVID-19) pandemic.<sup>25</sup>

Although the Making Dialysis Safer for Patients Coalition also recommends reducing the proportion of patients receiving hemodialysis through CVC vascular access, we observed that the proportion of patients receiving hemodialysis through CVC vascular access increased between 2014 and 2020.<sup>15</sup> This suggests that reduction in CVC use did not account for the decrease in SIR between 2014 and 2020. Our findings are consistent with numbers reported by the United States Renal Data System, which show that the proportion of patients receiving hemodialysis through CVC stayed constant from 2012 to 2019 and increased slightly in 2020.<sup>1</sup> Efforts to increase staffing and decrease the proportion of patients with CVC vascular access may have the potential to further reduce the rate of BSIs.

The COVID-19 pandemic may have affected the incidence of BSIs during the study period. Although hygiene measures implemented in response to the COVID-19 pandemic had

the potential to reduce health care–associated infections, previous studies of NHSN data collected in acute care hospitals did not find a reduction in health care–associated infections during the pandemic.<sup>26,27</sup> This is a cross-sectional study using 2020 surveillance data. Future longitudinal analyses focusing on the change in BSI SIRs could shed light on the effect of the COVID-19 pandemic on BSI incidence.

Differences in SIRs between individual states and territories were identified and warrant further assessment. SIRs were greater than one in South Dakota.

The data presented in this report are subject to a few limitations. Although Centers for Medicare & Medicaid Services reimbursement to facilities is based on BSI reporting, data submitted to NHSN are self-reported by facilities and not typically subject to external validation. Previous studies have found that both over-reporting and under-reporting of BSI by dialysis facilities to NHSN occur.<sup>28</sup> Any biases due to missing data would be at the facility level, and we do not expect the magnitude of missing data in any one facility to influence missing data from any other in that state. There is evidence that the COVID-19 pandemic contributed to reduced completeness and quality of health care–associated infections data submitted by acute care hospitals to NHSN in 2020,<sup>29</sup> but it is unclear whether the pandemic similarly affected BSI data submissions among dialysis facilities. In addition, the SIR compares rates with a national baseline from 2014. Given the declines in BSI rates and changes in health care practices during this time, a new baseline would more accurately depict rates compared with a national standard.

In conclusion, this report presents NHSN BSI surveillance data for 2020. Overall, SIRs were lower than in previous years, coinciding with quality improvement initiatives.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Funding

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

## Data Sharing Statement

Data cannot be shared. Data are part of NHSN surveillance and not publicly available.

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**Key Points**

- In 2020, 7183 hemodialysis facilities in the United States reported bloodstream infection data for over five million patient-months to the Centers for Disease Control and Prevention's National Healthcare Safety Network.
- Pooled mean bloodstream infection rates per 100 patient-months ranged from 0.12 among patients with arteriovenous fistulas to 0.80 among patients with central venous catheters.
- Rates of bloodstream infection were lower than predicted overall and in almost all states and territories.

**Table 1.**

Characteristics of 7183 outpatient hemodialysis facilities reporting to the National Health Care Safety Network, United States, 2020

Characteristics	Outpatient Hemodialysis Facility (N=7183)
<b>Large facility<sup>a</sup>, <i>n</i> (%)</b>	
No	495 (6.9)
Yes	6688 (93.1)
<b>Facility ownership, <i>n</i> (%)</b>	
Government	32 (0.5)
Not for profit	844 (11.8)
For profit	6307 (87.8)
<b>Facility location, <i>n</i> (%)</b>	
Freestanding clinic	6672 (92.9)
Freestanding clinic owned by hospital	229 (3.2)
Hospital-based clinic	282 (3.9)
No. of facilities reporting 12 mo of data, <i>n</i> (%)	6849 (95.4)
No. of facilities reporting six or fewer months of data, <i>n</i> (%)	144 (2.5)
No. of stations, median (IQR)	17 (13–24)
No. of patients per month, median (IQR)	58 (37–94)

IQR, interquartile range.

<sup>a</sup> A large facility has ≥ 23 stations at each location.

Table 2.

Distribution of blood stream infection events (numerator), patient-month (denominator), percent of total for all events, percent of total patient-months, pooled mean rate, and 95% confidence interval among patients at outpatient hemodialysis facilities, National Healthcare Safety Network, United States, 2020

BSI Access Type	No. of Events	Denominator	Percent of Total Events	Percent of Total Denominator	Pooled Mean Rate (95% CI) <sup>a</sup>
All BSI	15,181	5,235,234	NA	NA	0.29 (0.29 to 0.30)
CVC <sup>b</sup>	9548	1,195,670	62.90	22.80	0.80 (0.78 to 0.82)
Fistula	3708	3,128,055	24.40	59.80	0.12 (0.12 to 0.12)
Graft	1897	901,467	12.50	17.20	0.21 (0.20 to 0.22)
Other access	28	10,042	0.20	0.20	0.28 (0.19 to 0.40)

BSI, blood stream infection; CI, confidence interval; CVC, central venous catheter; NA, not applicable.

<sup>a</sup> Pooled mean rate=(total number of events/total number of patient-months) ×100.

<sup>b</sup> Central venous catheter includes both tunneled and nontunneled central venous catheter.

**Table 3.**

Blood stream infection standardized infection ratio, number of events, expected events, and 95% confidence interval among patients at outpatient hemodialysis facilities, stratified by state or territory, National Healthcare Safety Network, 2020

State or Territory	No. of BSI Events <sup>a</sup>	Expected BSI Events	SIR	95% CI Lower	95% CI Upper	State or Territory	No. of BSI Events	Expected BSI Events	SIR	95% CI Lower	95% CI Upper
AK	19	43.39	0.44	0.27	0.67	MS	342	502.76	0.68	0.61	0.76
AL	262	639.96	0.41	0.36	0.46	MT	29	62.96	0.46	0.31	0.65
AR	147	385.90	0.38	0.32	0.45	NC	587	1305.31	0.45	0.41	0.49
AS	NA	NA	NA	NA	NA	ND	64	56.04	1.14	0.89	1.45
AZ	235	741.40	0.32	0.28	0.36	NE	58	133.74	0.43	0.33	0.56
CA	1866	5020.2	0.37	0.36	0.39	NH	28	95.38	0.29	0.20	0.42
CO	121	310.20	0.39	0.33	0.46	NJ	394	1001.21	0.39	0.36	0.43
CT	124	285.10	0.43	0.36	0.52	NM	93	252.88	0.37	0.30	0.45
DC	37	109.84	0.34	0.24	0.46	NV	81	400.42	0.20	0.16	0.25
DE	33	121.10	0.27	0.19	0.38	NY	977	2123.09	0.46	0.43	0.49
FL	1106	2512.6	0.44	0.41	0.47	OH	626	1418.86	0.44	0.41	0.48
GA	572	1428.7	0.40	0.37	0.43	OK	170	407.60	0.42	0.36	0.48
GU	39	81.39	0.48	0.35	0.65	OR	76	320.83	0.24	0.19	0.29
HI	202	283.90	0.71	0.62	0.81	PA	664	1382.89	0.48	0.44	0.52
IA	72	203.62	0.35	0.28	0.44	PR	261	625.55	0.42	0.37	0.47
ID	37	93.99	0.39	0.28	0.54	RI	61	76.49	0.80	0.62	1.02
IL	434	1497.6	0.29	0.26	0.32	SC	252	645.39	0.39	0.34	0.44
IN	295	763.38	0.39	0.34	0.43	SD	106	78.96	1.34	1.10	1.62
KS	68	195.87	0.35	0.27	0.44	TN	351	864.99	0.41	0.36	0.45
KY	151	434.26	0.35	0.30	0.41	TX	1336	3890.54	0.34	0.33	0.36
LA	329	699.54	0.47	0.42	0.52	UT	34	106.73	0.32	0.22	0.44
MA	243	498.38	0.49	0.43	0.55	VA	329	973.81	0.34	0.30	0.38
MD	316	870.81	0.36	0.32	0.40	VI	NA	NA	NA	NA	NA
ME	35	85.49	0.41	0.29	0.56	VT	16	33.98	0.47	0.28	0.75
MI	391	1099.8	0.36	0.32	0.39	WA	215	538.80	0.40	0.35	0.46
MN	189	389.19	0.49	0.42	0.56	WI	296	552.61	0.54	0.48	0.60
MO	277	611.62	0.45	0.40	0.51	WV	76	221.45	0.34	0.27	0.43

State or Territory	No. of BSI Events <sup>a</sup>	Expected BSI Events	SIR	95% CI Lower	95% CI Upper	State or Territory	No. of BSI Events	Expected BSI Events	SIR	95% CI Lower	95% CI Upper
MP	NA	NA	NA	NA	NA	WY	19	30.02	0.63	0.39	0.97
MS	342	502.76	0.68	0.61	0.76	US	15,181	37,542.4	0.40	0.40	0.41

BSI, bloodstream infection; CI, confidence interval; NA, not applicable; SIR, standardized infection ratio.

<sup>a</sup>Data from states and territories with <5 facilities were suppressed.

**Table 4.**

Ten most frequently reported pathogens for dialysis bloodstream infection events reported to the National Health Care Safety Network, United States, 2020

Pathogen Type	<i>n</i>	%
<i>Staphylococcus aureus</i>	5252	32.0
<i>Staphylococcus epidermidis</i>	1506	9.2
<i>S. coagulase negative</i>	891	5.4
<i>Enterococcus faecalis</i>	815	5.0
<i>Escherichia coli</i>	739	4.5
<i>Klebsiella pneumoniae</i>	518	3.2
<i>Pseudomonas aeruginosa</i>	473	2.9
<i>Enterobacter cloacae complex</i>	405	2.5
<i>Serratia marcescens</i>	339	2.1
<i>Proteus mirabilis</i>	232	1.4