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RESEARCH ARTICLE

A COMPARISON OF STANDARDIZED BLOODSTREAM INFECTION RATIOS ACROSS END STAGE RENAL DISEASE NETWORKS

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ABSTRACT

Background: Individuals receiving hemodialysis are at an increased risk of infection including bloodstream infections (BSIs). Numerous factors may impact a patient's risk of having a BSI including vascular access type and geographic location. The End Stage Renal Disease Quality Incentive Program (ESRD QIP) was established by the Centers for Medicare and Medicaid Services (CMS) and utilizes a network of 18 geographically defined ESRD agencies that serve all U.S. and territories. The main objective of this study was to evaluate the regional/geographical impact on risk of dialysis patients' BSI rates and the BSI Standardized Infection Ratio (SIR) performance of facilities in each of the 18 ESRD Network regions across a four-year span (2019-2022). **Methods:** Datasets were created using original data obtained from the National Healthcare Safety Network from each of the performance years (2019-2022). A mean SIR was calculated for each of the 18 ESRD Network regions per performance year and then ranked from lowest to highest SIR to evaluate performance. Yearly changes in rank were also identified for each region across the four performance years. Each of the 18 ESRD network locations were anonymized to remove identifiable information using a letter of the alphabet to identify individual ESRD network regions. **Results:** More than 7,000 outpatient hemodialysis facilities were analyzed with a total of 24,415 BSI SIRs analyzed. Geographically, the analysis found that Network region B remained among the top six networks all four years, whereas Network regions O and R remained in the bottom six networks for those same four years. This study's results provide geographic specificity in BSI prevalence for further examination on regional disparities. Future evaluation of infection prevention measures among the 18 ESRD networks would be beneficial.

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INTRODUCTION

In 2021, end-stage renal disease (ESRD) affected over 786,000 people in the United States and approximately 558,000 (71%) of them received hemodialysis treatments¹. Hemodialysis is a process of filtering waste and water from a person's blood, replacing the function of properly working kidneys². Individuals receiving hemodialysis are at an increased risk of infection including bloodstream infections (BSIs)³. According to the Centers for Disease Control and Prevention (CDC), more than 14,000 BSIs were reported in dialysis patients in 2020⁴. Factors that impact a patient's risk of having a BSI include vascular access type and socioeconomic factors such as gender, race, ethnicity, and geographic location⁵⁻⁹. Surveillance of BSIs in hemodialysis patients has been part of CDC's healthcare associated infections (HAI) reporting since 1999^{10,12}

and has been conducted through the National Healthcare Safety Network (NHSN) since 2006^{11,13-14}. Beginning in 2014, facility-level BSI standardized infection ratios (SIRs), calculated using NHSN data, have been used by the Centers for Medicare and Medicaid Services (CMS) to assess dialysis facility performance¹¹ and determine incentive payments/reimbursement amounts. The SIR, which compares the number of BSIs reported by a facility to the number of BSIs predicted for that facility based on national aggregate data, has been monitored by CMS since 2012 through its ESRD Quality Incentive Program (ESRD QIP). The ESRD QIP, established by CMS to help assess and improve dialysis patient care, utilizes a network of 18 geographically defined ESRD agencies throughout the U.S that serve all U.S. and territories. These agencies, who contract with CMS through the ESRD QIP, work to improve the quality of patient care, including the

reduction of BSIs, by providing care coordination, education and access to resources. To receive QIP incentive payments, individual dialysis facilities must regularly report dialysis BSI data into NHSN. In the past, annual reports of BSI crude rates have been produced, however, the SIR performance of individual ESRD regions has not been examined. The main purpose of the study is to evaluate the regional/geographical impact on risk of dialysis patients' BSI rates. This study investigated the BSI SIR performance of facilities in each of the 18 ESRD Network regions across a four-year span (2019-2022). This research will assist in understanding how ESRD Network Organizations perform individually and collectively regarding BSI SIRs and inspire further evaluation of infection prevention measures.

MATERIALS AND METHODS

Study Population and Data Source: The datasets utilized included files containing individual facility SIRs that were sent to CMS for individual performance years (2019, 2020, 2021, 2022). Variables used in this analysis included performance year, state, number of reported BSIs in the performance year, number of expected BSIs per performance year, number of patients reported in the performance year, the SIR, ESRD network regions, and the upper and lower SIR 95% confidence interval. Each ESRD region was anonymized to remove identifiable information and the 18 ESRD regions were divided into tertiles of six ESRD regions per tertile to examine performance levels within the top, middle and bottom thirds.

Standardized Infection Ratio: BSI data were reported by individual dialysis facilities using CDC's NHSN, an online application used for the reporting and tracking of HAIs. Per ESRD QIP requirements, dialysis facilities report patient BSIs collected in either the outpatient setting or within one day of admission to a hospital facility.

Annually, dialysis facilities participating in CMS's ESRD QIP are scored based on the total number of reported BSIs compared to the calculated expected number of BSIs. This is known as the BSI SIR, a score calculated using national BSI event baseline data established by CDC in 2014 through stratified infection rates across various vascular access types. SIR scores are classified as low, high, and expected. A score of less than one indicates less infections than expected, a score greater than one indicates more infections than expected, and a score equal to one indicates that the observed number of infections is what would be expected¹⁵.

Positive Blood Cultures: Blood cultures were collected, and all positive blood cultures were reported to NHSN by individual dialysis facilities as required by CMS. Facilities may not report multiple positive blood cultures from the same individual less than 21 days apart. This is to prevent the overreporting of positive blood cultures that may stem from the same source.

Statistical Analysis: Datasets were created using previously generated annual BSI SIR files from each of the performance years (2019, 2020, 2021, 2022) with all original data obtained from the NHSN application. Facilities were evaluated by their annual BSI SIR performance score from 2019-2022. All facilities were assigned to their ESRD Network region based on a CMS provided roster.

A mean SIR was calculated for each ESRD Network region per performance year and then ranked from lowest SIR to highest SIR to evaluate performance. Yearly changes in rank were also identified for each region across the four performance years. An overall mean BSI SIR was also calculated for each performance year and the performance years ranked from lowest to highest. All ESRD Network regions were identified using letter labels in place of network number. All analysis was conducted using Statistical Analysis System (SAS) software (version 9.4; SAS Institute).

RESULTS

This study analyzed standardized infection ratios and ranks of SIR performance among the 18 ESRD network regions across a four-year time span (2019-2022). We examined which networks' BSI SIR scored best each year, which showed consistent BSI SIR scoring over the four-year period, and which showed significant changes in BSI SIR score rankings over the years. Datasets were analyzed from over 7000 dialysis facilities using previously generated annual BSI SIR files from performance years 2019-2022. A total of 24,415 BSI SIRs were analyzed, with years 2019, 2021, and 2022 files all containing over 6,000 scored facilities out of the 7,000 total facilities each year. The 2020 file however contained only 4,379 scored facilities out of the 7,199 total facilities present in the 2020 file. This disparity in the number of scored facilities in 2020 was due to an exception offered by CMS for facilities to opt-out of reporting without penalty. Each of the 18 ESRD regions were anonymized to remove identifiable information and were labeled from A to R. Network regions C, F, and G had the highest representation of scored facilities, each having over 2,000 calculated BSI SIRs across the four-year period. Network regions J, C, and A had the lowest representation amongst scored facilities, each having less than 900 calculated BSI SIRs across the four-year period. Of these networks, Network region F had the highest total number of BSI SIR scores across the four-year period (n=2,532) and Network region J had the lowest (n=703). Table 1 below shows the mean/median SIR and number of facilities used in SIR calculations for each ESRD region from 2019 through 2022. The median pooled SIR for each year was 0.51, 1.21, 0.51, 0.49 respectively. Mean SIRs for each year, respectively, were 0.64, 0.95, 0.42, and 0.38. In 2019, 2021 and 2022 SIRs were lower than expected. Only in 2020 was the median SIR higher than expected. Table 2 shows the ESRD regions and their performance ranks from 2019 to 2022. Only Region B was among the top third (n=6) SIR scores all four years; this region had the lowest SIR for three years (2020, 2021, 2022) and second lowest for the remaining year. The largest changes in rank position were exhibited by Network A, which dropped by 10 positions from 2021 to 2022 and by 14 positions over the four-year span and Network P which rose by 7 positions from 2019 to 2020 and by 11 positions over the four-year span. Table 3 below shows the ESRD regions that were in the top third and bottom third for four years, three years, two years, one year and never.

DISCUSSION

This study investigated the BSI SIR performance of the 18 ESRD Network regions across a four-year span (2019-2022) to understand the potential regional/geographical impact on risk of dialysis-related BSIs. In 2019, 2021 and 2022 SIRs were

lower than expected. The only year in which the median BSI SIR was higher than expected was 2020. Geographically, the analysis found that Network B remained among the top six networks all four years, whereas Networks O and R remained in the bottom six networks for those same four years.

patients utilizing a central venous catheter as their only access¹⁶. This along with continued primary prevention measures may be one potential explanation of overall consistently decreasing SIR scores across all geographic regions from 2020-2022.

Table 1. Mean SIRs/Number of Facilities by ESRD Region and Year, National Healthcare Safety Network, 2019-2022

Network Label ^a	2019		2020		2021		2022	
	Mean SIR ^c	N	Mean SIR	N ^b	Mean SIR	N	Mean SIR	N
A	0.55	194	0.80	158	0.38	281	0.44	276
B	0.55	260	0.68	402	0.33	398	0.30	354
C	0.56	220	0.84	414	0.39	670	0.36	375
D	0.56	367	0.69	244	0.39	344	0.33	401
E	0.56	261	1.07	116	0.46	216	0.42	305
F	0.58	689	0.81	444	0.39	242	0.36	659
G	0.59	655	0.70	144	0.36	386	0.34	442
H	0.59	400	0.71	224	0.35	717	0.34	416
I	0.63	428	1.04	208	0.40	312	0.35	556
J	0.65	188	1.23	355	0.48	429	0.52	234
K	0.66	423	1.07	170	0.44	329	0.34	682
L	0.66	339	0.90	307	0.38	437	0.31	269
M	0.67	325	1.14	148	0.42	582	0.45	285
N	0.68	575	1.00	249	0.44	294	0.35	283
O	0.70	266	1.17	196	0.44	267	0.43	216
P	0.75	318	0.95	189	0.40	191	0.34	317
Q	0.78	307	1.02	136	0.53	297	0.43	451
R	0.84	463	1.24	275	0.57	457	0.47	188
Overall	0.64	6678	0.95	4379	0.42	6849	0.38	6709

Note: N represents the number of scored facilities attributed to the region.
a.ESRD Regional Networks have been pseudonymized.
b.Green cells represent a lower SIR than expected. Red cells represent a higher SIR than expected.
c.SIR (Standardized Infection Ratio) refers to bloodstream infections in dialysis facilities.

Table 2. Numbers and Mean SIRs by ESRD Region, National Healthcare Safety Network, 2019-2022

Network Label ^a	2019		2020		2021		2022	
	Rank	SIR ^b	Rank	SIR	Rank	SIR	Rank	SIR
A	1		5		5		15	
B	2		1		1		1	
C	3		7		6		10	
D	4		2		7		3	
E	5		13		15		12	
F	6		6		8		11	
G	7		3		3		6	
H	8		4		2		4	
I	9		12		10		8	
J	10		17		16		18	
K	11		14		12		7	
L	12		8		4		2	
M	13		15		11		16	
N	14		10		13		9	
O	15		16		14		14	
P	16		9		9		5	
Q	17		11		17		13	
R	18		18		18		17	

Note: Rank SIR: determined using the yearly mean SIR per region.
Note: Green cells represents ESRD Network regions who consistently ranked high when compared to their peers. Red cells represent ESRD Network regions who consistently ranked low when compared to their peers.
a.ESRD Regional Networks have been pseudonymized.
b.SIR (Standardized Infection Ratio) refers to bloodstream infections in dialysis facilities.

Long-term catheter use increases the risk of BSIs. Reducing central venous catheter (CVC) usage has an effect on the number of BSIs in dialysis patients and the overall SIR scores. During the period of January 1, 2019 and June 30, 2019, the ESRD networks increased their quality improvement activities (QIAs) such as facility staff and patient education and quality improvement interventions, and saw a reduction of over 3,300 BSIs during this time period. During the period of the first nine months of 2020, across the 18 ESRD networks, reduction in long-term CVC usage resulted in a decrease of over 32,000

Networks R and O's consistent rankings could result from a variety of factors impacting their serviced regions. Network R reported facility staff shortages in their serviced region in both the 2020 and 2021 performance years. This potentially has had long term impacts on patient care, as Network R has reported receiving patient and staff grievances disproportionately associated with facility concerns in the 2020-2021 performance years. Network R also reported a significantly higher African American and Native American population when compared to all other ESRD regions^{20,21}. This may impact BSI rates, as prior

research has identified racial health disparities impacting rates of HAI in African American patient populations^{9,22}. Network B, which consistently ranked highest, reported only 23% of their patient grievances were related to facility concerns compared to Network R's 70% in the same timeframe. Network B also reported servicing regions with about 90% urbanicity compared to Network R and O's 70% urbanicity^{23,24}. Prior research has shown barriers to healthcare access present in rural areas when compared to urban areas²⁵. Dedicated prevention programs may also contribute to Network B's consistent ranking. Network B, having remained in the top one-third of all ESRD network regions in SIR scores over the four-year period, saw a decrease of over 20% in pooled mean BSIs with a reduction of 157 BSIs during the time period of January 1, 2020 through June 30, 2020 in the facilities that had been ranked highest in BSIs during the 2019 performance year²⁶.

A limitation of this study is the disparity in sample size in 2020 compared to the other three years. This occurred because CMS issued reporting waivers allowing facilities to voluntarily opt-out of reporting that year due to the Coronavirus (COVID-19) pandemic. This resulted in only 4,379 facilities being scored for 2020, creating a significant disparity in scoring when compared to other analyzed performance years. Also, scores were calculated only for facilities that reported data for all 12 months of the year. Consequently, the results only included the subset of facilities who met the 12-month reporting requirement and omitted facilities not reporting all 12 months for various reasons including closure due to natural disaster, renovations, or reporting issues/challenges. This study's results showed how ESRD Network regions performed individually and collectively regarding BSI SIRs. These results provide geographic specificity in BSI prevalence to enable more specific allocation of resources and provide insight for further examination on regional disparities.

Quality improvement activities such as hand hygiene and surface disinfection practices, obtaining direct patient feedback on staff performance of hand hygiene, and utilization of the various tools created by patients for patients are a place to begin. As the COVID-19 pandemic caused the QIAs across the 18 ESRD regions to be suspended, utilizing the 2019 QIAs implemented by the 18 ESRD regions and the success of fewer BSIs as a starting point, further evaluation of these infection prevention measures would be beneficial.

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