American Journal of Infection Control 47 (2019) 793–797

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

# Three years' experience of dialysis event surveillance

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*Key Words:*
End-stage renal disease
Infection control
Central venous catheter
Arteriovenous fistula
Vascular site infection
Intravenous antibiotic start

***Background:*** The main study aim was to track infections, evaluate performance, and identify opportunities for improved practice since infections, especially those associated with multidrug-resistant organisms, are the second most common cause of death among end-stage renal disease patients.
***Methods:*** This study describes the establishment of baseline dialysis event surveillance at a large dialysis center. Every month, the dialysis center staff reported the total number of maintenance hemodialysis patients to the department of infection control and hospital epidemiology. The surveillance system for dialysis events included monthly monitoring of hemodialysis patients in outpatient settings for positive blood cultures, intravenous antimicrobial initiation, and local vascular access infections.
***Results:*** We calculated the pooled mean rates of positive blood cultures, intravenous antimicrobial initiation, and local vascular access infections during the period from June 1, 2014 to September 30, 2017. Results indicated more dialysis events were attributed to the CVC than any other dialysis vascular access. Regardless of vascular access type, intravenous antimicrobial initiation was the most commonly reported dialysis-associated event.
***Conclusions:*** Dialysis events surveillance can be used to produce a decrease in both morbidity and mortality rates in hemodialysis patients.


As reported in 2017, a total of 10,203 patients were on hemodialysis in Saudi Arabia.[1] Infections are the second leading cause of death among hemodialysis patients, with an attributed mortality rate of 14%.[2] Hemodialysis patients are at high risk of infection because of recurrent hospital visits, invasive devices, exposure to antibiotics, and immunocompromised status. Bacteremia is more common in hemodialysis patients, whereas peritoneal dialysis patients are at a higher risk of peritonitis.[3–5] The single most frequent site of infection in hemodialysis patients is the vascular access site.[6] Hemodialysis patients are at high risk of infection with multidrug-resistant organisms, but the ratio of resistant bacteria in hemodialysis patients compared with the general population remains unclear.[7]

The type of vascular access directly affects the risk of developing infections and is the most important risk factor in the development of bacteremia and vascular access infections. Access methods include several types that can be rated from lowest to highest risk: (1) arteriovenous (AV) fistulas, (2) endovascular prostheses, (3) tunneled catheters, and (4) nontunneled catheters.[8] Avoiding the use of central venous catheters (CVCs) in favor of access types with lower associated bloodstream infection (BSI) risk is one of the most important strategies for controlling infection risk in hemodialysis patients. When CVCs are used, adherence to evidence-based catheter insertion and maintenance practices can positively influence BSI rates.[9] Studies have indicated that antibiotic lock and guidewire catheter exchange present advantages over systemic antibiotic therapy.[10]

In 2000, the National Healthcare Safety Network (NHSN) developed a surveillance system for dialysis events for use in outpatient hemodialysis centers in the United States. The program enables monitoring and benchmarking of 3 events stratified by vascular access types. The aim of this project was to track infections, evaluate performance, and identify areas needing improvement.

## METHODS

Dialysis events were monitored in a large dialysis center located in an advanced tertiary care referral hospital in Riyadh, Saudi Arabia, that includes more than 1,000 active hospital beds.

We monitored 3 dialysis events for 39 months (June 1, 2014 to September 30, 2017) using NHSN definitions, including BSI,

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Conflicts of interest: None to report.
Ethics approval and consent to participate: Ethical approval for this study was granted by the local institutional review boards on July 18, 2018.

https://doi.org/10.1016/j.ajic.2018.12.011
0196-6553/

intravenous (IV) antimicrobial initiation, and local site infections. Dialysis events included in the study were classified using several categories: (1) IV antimicrobial initiation (IV antibiotic or antifungal, but not antiviral, initiated in an outpatient setting, regardless of the reason for administration and regardless of the duration of treatment, with initiation defined as a single outpatient dose or first outpatient dose of a course), (2) positive blood culture (all positive blood cultures from specimens collected as an outpatient or collected within 1 calendar day after a hospital admission), and (3) local access infection (pus, redness, or increased swelling at the vascular access site, with indication of site where symptom or symptoms occurred).[11]

Twenty-one days or more had to exist between 2 dialysis events of the same type for the second occurrence to be reported as a separate dialysis event. If <21 days had passed since the last reported event of the same type, the subsequent event of the same type was not considered a new dialysis event and was therefore not included. The 21-day rule applied across calendar months. If multiple dialysis events occurred together as part of the same patient's problem, they were considered 1 event.[11] Denominator data consisted of the number of hemodialysis outpatients treated at the facility during the first 2 working days of each month. We calculated dialysis event rates stratified by vascular access type: (1) AV fistula, (2) AV graft, or (3) CVC. Infection control and dialysis staff were responsible for data collection. Data were collected as a result of patient chart review of all dialysis patients receiving maintenance hemodialysis at our hospital's hemodialysis outpatient unit, including only the adult population and excluding pediatric patients, acute renal failure requiring hemodialysis, and inpatient hemodialysis maintenance. . Dialysis events were monitored by an experienced, certified infection control practitioner and then validated by the hospital epidemiologist. We described patient demographics, type of vascular access, pathogens identified among BSIs, and the most commonly used IV antibiotics. Data were reported as dialysis event rate per 100 patient-months, and results were stratified by all 3 types of vascular access and benchmarked against NHSN published rates.

## RESULTS

Five thousand two hundred thirty-one patient-months were reviewed for dialysis events during the 39-month study period. A total of 163 dialysis events were reported, with a cumulative incidence rate of dialysis events of 3.1 per 100 patient-months. Fistulas, grafts, and CVCs were used for 57.73%, 25.85%, and 16.42%, respectively, of vascular access routes (Table 1). There were 163 dialysis events that occurred in 158 patients, including 83 IV antimicrobial initiations (incidence, 1.6 per 100 patient-months), 39 positive blood cultures (incidence, 0.75 per 100 patient-months), and 41 local access site infections (incidence, 0.78 per 100 patient-months). The median age of patients with a defined dialysis event was 51.2 years (interquartile range, 35.3-69.7 years), and 61.1% were men. Among dialysis events, the proportion of IV antimicrobial initiations was 51%, whereas the proportion of BSI and local access infections was 24% and 25%,

**Table 1**
Utilization percentage and cumulative dialysis event rate per access type

| Type of access | Total number 2014-2017 | % utilization | Total number of events | Dialysis event rate per 100 patient-months |
|---|---|---|---|---|
| Arteriovenous fistula | 3,020 | 57.73 | 32 | 1.1 |
| Arteriovenous graft | 1,352 | 25.85 | 29 | 2.15 |
| Central venous catheter | 859 | 16.42 | 102 | 11.9 |
| Total | 5,231 | | 163 | 3.2 |

**Table 2**
Rate of each dialysis event stratified by access type and benchmark against NHSN corresponding rates

| Dialysis event | Type of access | Total number of accesses Jun 2014 to Sep 2017 | Total number of dialysis events reported Jun 2014 to Sep 2017 | Dialysis event rate per 100 patient-months Jun 2014 to Sep 2017 | NHSN pooled mean 2011 | 50th percentile | 75th percentile | 90th percentile |
|---|---|---|---|---|---|---|---|---|
| Antimicrobial starts stratified by vascular access | Arteriovenous fistula | 3,020 | 19 | 0.63 | 1.84 | 1.4 | 2.8 | 3.9 |
| | Arteriovenous graft | 1,352 | 16 | 1.18 | 2.46 | 1.8 | 3.7 | 5.5 |
| | Central venous catheter | 859 | 48 | 5.59 | 6.29 | 4.8 | 10.5 | 12.8 |
| Bloodstream infection stratified by vascular access | Arteriovenous fistula | 3,020 | 6 | 0.20 | 0.48 | 0.3 | 0.7 | 1.1 |
| | Arteriovenous graft | 1,352 | 5 | 0.37 | 0.88 | 0.6 | 1.6 | 2.2 |
| | Central venous catheter | 859 | 28 | 3.26 | 3.24 | 3.4 | 6 | 9.4 |
| Local access infection stratified by vascular access | Arteriovenous fistula | 3,020 | 7 | 0.23 | 0.28 | 0.3 | 0.7 | 1.3 |
| | Arteriovenous graft | 1,352 | 8 | 0.59 | 0.54 | 0.7 | 1.3 | 2.1 |
| | Central venous catheter | 859 | 26 | 3.03 | 1.63 | 3.6 | 6 | 10.7 |

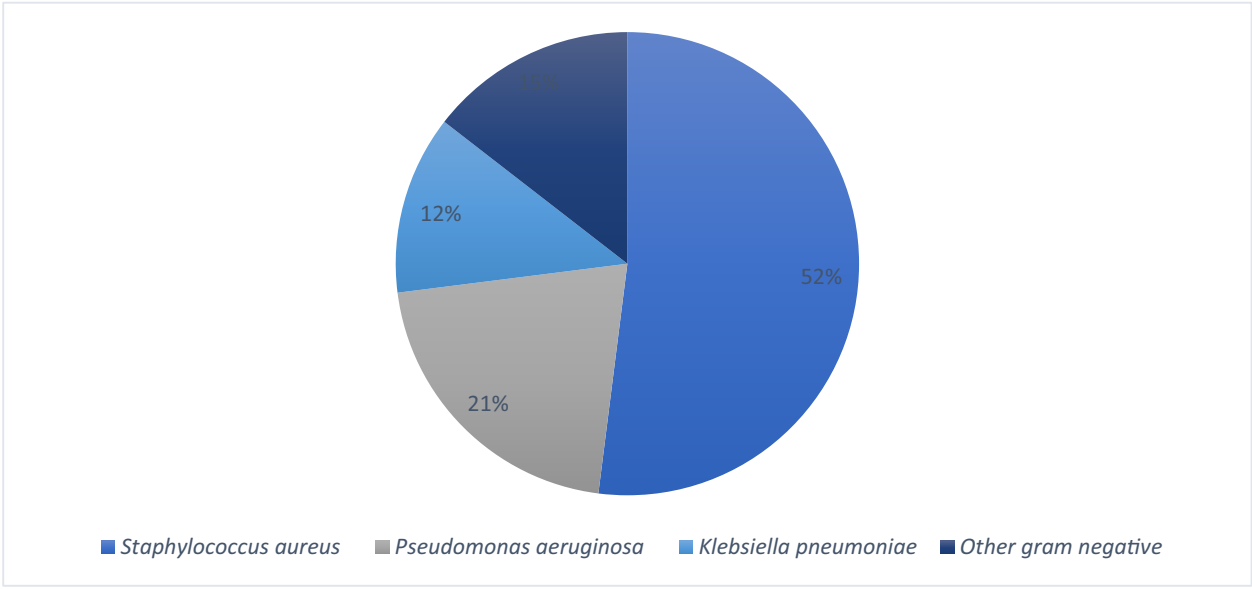


**Fig 1.** Percentage of organisms isolated from positive blood cultures.

respectively. When stratified by vascular access type, the dialysis event rate associated with CVCs was 11.9, whereas the event rate related to AV fistulas and AV grafts was 1.1 and 2.15, respectively (Table 2).

We identified the BSI rate as 0.75 per 100 patient-months (0.2, 0.37, and 3.26 BSIs per 100 patient-months for patients with AV fistulas, AV grafts, and CVCs, respectively). *Staphylococcus aureus* was the most common microorganism isolated from blood cultures, accounting for 52% of all recovered isolates, followed by *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*, accounting for 21% and 13%, respectively (Fig 1). Among *S aureus* isolates, 35% were methicillin-resistant.

IV antimicrobial initiation was the most common type of dialysis event and accounted for 51% of all events. The majority (87%) of those undergoing IV antimicrobial initiation used a single agent. Vancomycin, cephalosporins, and fluoroquinolones were the most commonly used agents, being used by 64%, 23%, and 13%, respectively, of those undergoing IV antimicrobial initiation.

In comparison with NHSN, the pooled mean BSI rate associated with CVCs and local site infections for AV grafts and CVCs was 3.26, 0.59, and 3.03, respectively, which is higher than the corresponding NHSN benchmarks of 3.24, 0.54, and 1.63, respectively (Fig. 2 and 3).

Continuous monitoring and reporting of dialysis events were the main drivers of quality improvement at our dialysis center. Presenting quarterly data and discussing the key findings with the nephrology team guided implementation of multiple interventions. Implemented changes included (1) increasing the number of adult patients dialyzing through a permanent vascular access, (2) applying antibiotic ointment to catheter exit sites during dressing, (3) regular reporting of dialysis staff hand hygiene compliance, and (4) use of chlorhexidine gluconate for skin antisepsis.

## DISCUSSION

The risk of bacteremia in hemodialysis patients is 26-fold higher than in the general population.[12] Monitoring and regular reporting of dialysis events help implement sound infection control practices and guide antimicrobial stewardship. Ongoing infection surveillance in hemodialysis facilities can identify specific device-related outbreaks of

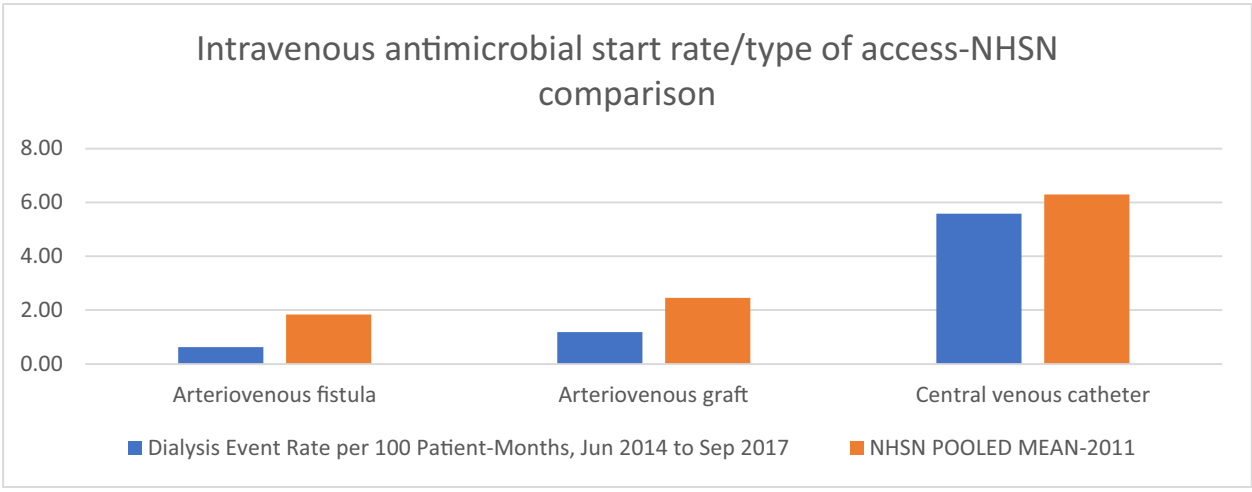


**Fig 2.** Intravenous antimicrobial initiation rate per access type and benchmark against NHSN corresponding rate. *Jun*, June; *NHSN*, National Healthcare Safety Network; *Sep*, September.

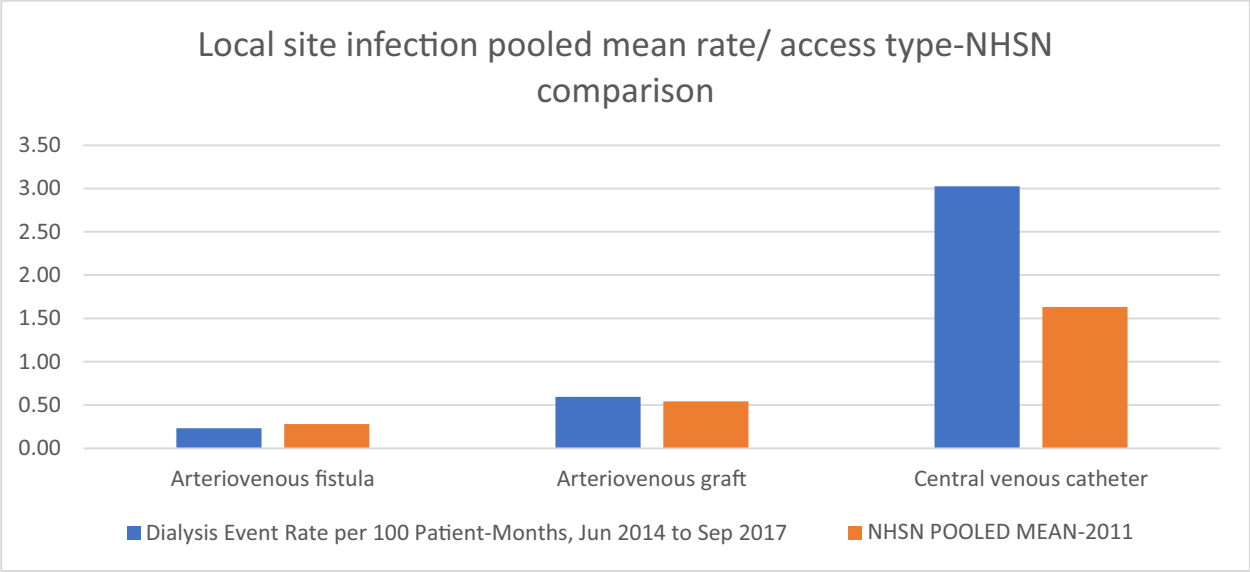


**Fig 3.** Bloodstream infection rate per access type and benchmark against NHSN corresponding rate. *Jun*, June; *NHSN*, National Healthcare Safety Network; *Sep*, September.

infections and promote interventions to reduce infectious complications and promote patient safety.[13] Surveillance for vascular access site infections is recommended as a routine activity in hemodialysis facilities.

To the best of our knowledge, this is the first surveillance report concerning dialysis events in Saudi Arabia. In our study, we identified *S aureus* as the cause of 52% of all BSIs. In a cohort study in Denmark, the incidence rate of *Staphylococcus*-related bacteremia was 35.7 per 1,000 person-years in the end-stage renal disease patient population compared with 0.50 in the general population, yielding a relative risk of 28.6 after adjustments for age, sex, and comorbidities.[11] In another Danish study, *S aureus* was found to have caused 43.8% of the BSIs in hemodialysis patients. Similarly, a Canadian study found that *S aureus* caused 44% of total septicemia episodes.[12]

In an American study of Medicare beneficiaries initiating in-center hemodialysis, it was found that 43% had at least 1 hospitalization for infection during follow-up, highlighting the burden of infection in this population. Of the patients who survived the initial hospitalization, 30% were readmitted within 30 days.[13]

The NHSN surveillance for dialysis events in 2014 reported the rate of BSIs per 100 patient-months was 0.64 (0.26, 0.39, and 2.16 for AV fistulas, AV grafts, and CVCs, respectively).[13] In contrast, we identified a higher rate for BSIs of 0.75 per 100 patient-months (0.2, 0.37, and 3.26 for AV fistulas, AV grafts, and CVCs, respectively). Similar to other studies and previous NHSN reports, our findings showed that the rates of BSIs and other related events were higher in patients on hemodialysis who had CVCs compared with other vascular access types. It has been reported that the use of fistulas is associated with less incidence of complications, including infections, compared with the use of central lines.[14,15]

We found that the overall incidence rate of dialysis events was 3.1 per 100 patient-months. In a large Chinese study conducted in 33 outpatient hemodialysis centers and published in 2017, the incidence of dialysis events was 1.47 per 100 patient-months.[16]

In a retrospective study conducted in a large dialysis practice in the United States, it was concluded that elderly patients (≥75 years) on hemodialysis using tunneled CVCs were at lower risk of catheter-related BSIs than their younger counterparts. Thus, for some elderly patients, tunneled CVCs may represent a suitable dialysis access option in the setting of nonmaturing AV fistulas or poorly functioning synthetic grafts.[17]

Our study showed that regardless of vascular access type, IV antimicrobial initiation was the most common dialysis event reported, and vancomycin was prescribed in 64% of cases. An Australian study identified that vancomycin was administered in 50% of antimicrobial initations.[18] In a study conducted in Tennessee, it was recommended that efforts focus on limiting vancomycin administration for infections caused by $\beta$-lactam-sensitive pathogens in chronic hemodialysis patients.[19] Another study concluded that substantial inappropriate antimicrobial prescribing likely exists in outpatient hemodialysis centers. Future antimicrobial stewardship interventions may benefit from targeted antimicrobial use among patients with catheter access, and health care staff should be informed of a patient's history of health care exposure, including colonization or infection with multidrug-resistant organisms, and unit-specific practices.[20]

Our study has several limitations: (1) it is retrospective in nature, (2) we could not calculate the rate of hospital admission and mortality among patients identified with dialysis events, (3) we did not investigate the risk factors for developing dialysis events, and (4) we were unable to determine the impact of implemented interventions.

## CONCLUSIONS

Dialysis events at our center were significantly more common among patients with central venous lines, and IV antimicrobial initiation was the most common event reported. We identified *S aureus* as the cause of 52% of all BSIs, and vancomycin was prescribed in 64% of these cases. Our study describes the establishment of baseline dialysis event surveillance at a large dialysis center. Our surveillance data generated useful guidance for infection prevention in dialysis practice. Next steps could include measures to educate physicians regarding wise antibiotic prescribing, auditing staff competency on a regular basis and increasing patient engagement. Monitoring and regular reporting of dialysis events help implement sound infection control practices and guide antimicrobial stewardship. Ongoing infection surveillance in hemodialysis facilities can identify specific areas of improvement, promote interventions to reduce infectious complications, and boost patient safety.

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