

CONCISE COMMUNICATION

Surveillance System of Hemodialysis-Associated Infections in a Pediatric Unit

Carolina Sucupira, MD, MSc;¹

Marcelo Luiz Abramczyk, MD, PhD;¹

João Tomas de Abreu Carvalhaes, MD, PhD;²

Maria Isabel de Moraes-Pinto, MD, PhD¹

The bloodstream infection surveillance system proposed by the Centers for Disease Control and Prevention (CDC) was prospectively conducted in a pediatric hemodialysis unit. Thirty patients were included; 73% had a catheter for vascular access at enrollment. Vascular access infection rate was 21.1 per 100 patient-months, well above those observed in adult patient surveys. *Staphylococcus aureus* was most frequently isolated (23%).

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Catheter-related infections are a common problem in all hemodialysis centers. Differently from adult population on hemodialysis, the majority of the pediatric population starts and maintains renal replacement therapy using a catheter for vascular access instead of arteriovenous fistulas (AVFs) or grafts.¹⁻⁴ Although a permanent access is preferred, nearly 70% of the children use central venous catheter mostly because of the difficulties in creating AVFs in small patients.^{1,4} Catheters are a major risk factor for bacteremia, responsible for up to 73% of all infections in hemodialysis patients.⁵ Few published studies have described infection of vascular access in children on hemodialysis; these infections are usually caused by staphylococcal organisms and are associated with higher rates of mortality and antibiotic resistance.²⁻⁴

In 1999, the Centers for Disease Control and Prevention (CDC) initiated the Dialysis Surveillance Network, a data-monitoring system for outpatients undergoing hemodialysis, aiming to standardize methods to study infection in this population.⁶ There are some published papers evaluating this system in adult or mixed populations; however, data in children are lacking.⁵⁻⁸

The objective of this study was to conduct a surveillance of bloodstream infection and vascular access infection in a unit of hemodialysis that comprises only pediatric patients, using the system proposed by the CDC.

METHODS

A prospective cohort was conducted from October 2006 to April 2009 at the pediatric hemodialysis unit of the Universidade Federal de São Paulo, Brazil. Only outpatients who received hemodialysis for at least 1 month were studied. Data were collected using the CDC Dialysis Surveillance Network Program, Atlanta, Georgia.⁶ Census (denominator) and in-

cident (numerator) forms were used. The denominator was provided by a census form of type of vascular access (fistulas, grafts, permanent or temporary catheters) for all patients dialyzed in the first week of each surveillance month.⁶

An incident form was filled in for each overnight hospitalization of any cause or initiation of outpatient intravenous (IV) antibiotics.⁶ It recorded the type of vascular access and whether it was removed, the presence or absence of criteria for infections (clinical evidence for local vascular access infection, wound infection, pneumonia, urinary tract infection, or noninfectious causes), whether the antibiotic administered was vancomycin or any other, and blood culture results.⁶

Definitions. We used the following definitions for hemodialysis-associated infections.⁶

- Local access infection: pus, redness, or swelling of the vascular access site and absence of access-related bacteremia.
- Access-related bacteremia: blood culture positive with source the vascular access site or unknown.
- Vascular access infection: either local access infection or access-related bacteremia.
- Secondary bacteremia: positive blood culture with a source designated as a site other than the vascular access.
- Bloodstream infection: report of a positive blood culture, regardless of the source of the infection, including access-associated bloodstream infections.
- Infection-related mortality: patient death within 7 days of an infection episode.

Data analysis. The analyzed events were hospitalization, in-unit antibiotic starts, in-unit vancomycin starts, vascular access infection, local access infection, and access-related bacteremia. Rates of events were expressed per 100 patient-months, calculated by dividing the total number of events by the total number of patient-months and multiplying the result by 100. Rates expressed in patient-months can be interpreted as the average percentage of patients having the event each month.⁶

All data were collected by the same pediatric infectious diseases physician (C.S.). Before enrollment, a consent form was signed by parents/guardians of all patients, and the study was approved by the ethics committee.

RESULTS

During the 31-month period of study, 30 pediatric patients received hemodialysis for at least 1 month. Characteristics of the study group are shown in Table 1.

The main reason for catheter removal was mechanical problems (70%), followed by vascular access infection (16% [12 of 76 patients]), and elective replacement of a temporary catheter for a permanent one (10% [8 of 76 patients]).

During the study period, 33.3% of the patients underwent

TABLE 1. Characteristics of Pediatric Patients at Study Entry

Characteristic	Data
Median age in years (Q1–Q3)	9.8 (5.4–13.3)
Median age in years at start of HD (Q1–Q3)	9.2 (4.7–12.9)
Male sex	19 (63.0)
Median duration of HD in months (Q1–Q3)	4.9 (0–44)
Renal disease	
Glomerular disease	12 (40.0)
Urinary tract malformation	8 (26.6)
Tubular disease	6 (20.0)
Undiagnosed genetic syndrome	2 (6.7)
Undetermined	2 (6.7)
Vascular access	
Permanent catheter	14 (46.6)
Temporary catheter	8 (26.6)
Arteriovenous fistula	8 (26.6)

NOTE. Data are no. (%) of patients unless otherwise indicated. HD, hemodialysis; Q1–Q3, first through third quartile.

kidney transplantation. The mortality rate was 20% (6 of 30); 4 of the 6 deceased had infection-related deaths, all of them in use of catheters. Dialysis was discontinued in 2 patients due to renal function improvement; 1 patient was transferred to an adult hemodialysis unit after reaching 18 years of age. At the end of the study period, 36.7% (11 of 30) patients were still on hemodialysis.

Only 2 patients were not hospitalized during the period of follow-up. The main reasons for hospitalization were vascular access complications.

Event rates. In the study period, 450 patient-months were analyzed: 290 patients (64.4%) with permanent catheter, 112 (24.9%) with fistula, and 48 (10.7%) with temporary catheter.

The total number of incidents was 181, with 132 hospitalizations (73%). Among the 102 outpatient IV antibiotic treatments (with or without subsequent hospitalization), vancomycin was empirically chosen in 66 cases (73.5%), and the proportion that had blood culture obtained was 98% (100 of 102 patients). There was no vascular access infection among the patients with fistula. The overall and catheter categorized rates are shown in Table 2.

Vascular access infections with loss of the vascular access were observed in 22.1% (22 of 95) of the cases. The rate of vascular access infection did not vary significantly during the months of the study.

Among the 93 positive blood cultures, 97 microorganisms were reported, all from patients with central lines: 48.4% (47 of 97) gram-positive bacteria, 49.5% (48 of 97) gram-negative bacteria, and only 2 fungi (*Candida guilliermondii* and *Candida parapsilosis*). The most frequent one was *Staphylococcus aureus* (34% isolates), of which 21% were resistant to methicillin, followed by 8.5% coagulase-negative *Staphylococcus*. Among the gram-negative bacteria, *Acinetobacter* species and *Enterobacter* species were the most common.

DISCUSSION

The surveillance system proposed by the CDC was easy to implement and maintain; the activities required an estimated 2-hour staff time per month, as suggested by CDC.⁶ On average, each month 30% of the patients were hospitalized for any cause, 11% received IV antimicrobial in the unit, and 21% had a vascular access infection.

Our rate of catheter-associated infection was 10.1 per 1,000 catheter-days. However, our aim was to test the CDC surveillance system specific for outpatient hemodialysis units, using exclusively the pediatric population.

The use of this surveillance system to detect vascular access infections in pediatric dialysis patients has not, to our knowledge, been reported. The rates of hospitalization, initiation of IV antibiotics, and vascular access infection registered in our study are much higher than those from similar studies performed in adult or mixed-age populations, the only available data for comparison.^{5–8} These differences are probably due to characteristics associated to hemodialysis in childhood. In our study, the most common form of vascular access at initiation of hemodialysis was a central line access (73.2% of patients), similar to data found in other pediatric studies.¹

Catheter-related bacteremia is the major cause of morbidity and the second cause of mortality among children on hemodialysis, but the true incidence of vascular access infection in the pediatric population is not known.^{3,9} Few studies are available in the literature, and the contrasting results reported are frequently due to the lack of uniformity in diagnosis criteria and methods of data collection of catheter-related infections.^{2,3,9,10}

Studies in an adult population using the same surveillance system as the one used in this study showed rates of vascular access infection from 2 to 3.2 per 100 patient-months, lower

TABLE 2. Rates of Event Distribution per Vascular Access Type

Event per vascular access	All	Fistula	Grafts	Permanent catheter	Temporary catheter
Hospitalization	29.3 (132)	8.0 (9)	0.0 (0)	8.6 (95)	58.3 (28)
In-unit antibiotic starts	10.8 (49)	0.9 (1)	0.0 (0)	14.8 (43)	10.4 (5)
In-unit vancomycin starts	8.0 (36)	NA	NA	NA	NA
Vascular access infection	21.1 (95)	0.0 (0)	0.0 (0)	30.0 (87)	16.7 (8)
Local access infection	1.1 (5)	0.0 (0)	0.0 (0)	1.7 (5)	0.0 (0)
Access-related bacteremia	20.0 (90)	0.0 (0)	0.0 (0)	28.3 (82)	16.7 (8)

NOTE. Data are event per 100 patient-months unless otherwise indicated. NA, not available.

than our rate, probably because of the higher rates of catheter use in the pediatric population.⁵⁻⁸

These higher rates compared with adults can also be explained by the more extended duration of the catheter life in children. Due to the difficulties of access sites in the pediatric population, catheter salvage measures are frequently used, and it has been reported that the rate of catheter-related bacteremia corresponds closely with duration of time and the insertion sites of the catheters.¹⁰

Successful use of AVFs in children weighing <20 kg and the prevalent use of this type of access in patients from 0 to 19 years of age (80%–90%) was reported in European countries.⁴ That contrasts with the low use of AVFs in children in the United States (21%) and in our study (26.6%).¹ This project resulted in a multidisciplinary team that explained to the staff of the participating centers the current guidelines, surgical approach and use of microsurgery techniques, and how to monitor vascular access in children.⁴

S. aureus was the most prevalent bacterial agent, isolated in 34% of all vascular access infections, similar to 30%–32% rates previously reported.⁵⁻⁸ Methicillin-resistant *S. aureus* strains were 21%, lower than the 38%–42% of adult hemodialysis patients' surveillances.^{6,8}

In summary, by applying the CDC surveillance system in pediatric patients, our study showed very different results than what is usually noted for adult patients. Although our sample size is limited and may not be representative of the entire pediatric hemodialysis population, that initiative will help identify and monitor local rates of vascular access infection and implement and evaluate strategies for preventing these infections, such as to increase the use of fistulas and to improve the practices of infection control and catheter care. These data could be used to establish a benchmark that would be useful to compare data among other pediatric hemodialysis units where this system of surveillance is applied.

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Affiliations: 1. Division of Pediatric Infectious Diseases, Department of Pediatrics, Universidade Federal de São Paulo, São Paulo-SP, Brazil; 2. Division of Pediatric Nephrology, Department of Pediatrics, Universidade Federal de São Paulo, São Paulo-SP, Brazil.

Address correspondence to Carolina Sucupira, Rua Apinajés, 1949 apartamento 62, 01258-001 São Paulo, Brazil (carusucupira@gmail.com).

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