New national surveillance system for hemodialysis-associated infections: Initial results

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Background: Hemodialysis patients have frequent infections, especially of the vascular access site, and often harbor antimicrobial-resistant pathogens. Therefore a voluntary national system was created to monitor and prevent infections in these patients.

Methods: From October 1999 to May 2001, participating centers recorded the number of chronic hemodialysis outpatients that were treated (denominator). Several outcome events, including infections of the vascular access site, were monitored. Data were reported on paper forms or via an Internet-based data entry and analysis system.

Results: Among 109 participating centers, the vascular access infection rate per 100 patient-months was 3.2 overall and varied markedly by type of vascular access: 0.56 for native arteriovenous fistulas, 1.36 for synthetic arteriovenous grafts, 8.42 for cuffed catheters, and 11.98 for noncuffed catheters. Among 76 dialysis centers reporting at least 200 patient-months of data, 11 had a significantly low and 14 a significantly high rate of vascular access infection.

Conclusion: Initial results from the first national project to monitor infections in patients undergoing hemodialysis indicate that vascular access infections were common and that risk varied substantially among different vascular access types and different dialysis centers. These results can be used for quality improvement at individual centers and to help evaluate the efficacy of specific infection control measures. (Am J Infect Control 2002;30:288-95.)

At the end of 2000, more than 240,000 patients were being treated with chronic hemodialysis at > 3600 dialysis centers in the United States. These patients are at high risk for infection because of impaired immune defenses, a high severity of illness, and the need for routine puncture of a vascular access site to remove blood for hemodialysis.[1] Vascular access sites may consist of fistulas (created from the patient's native vessels), grafts (created with synthetic materials), and cuffed (permanent) or noncuffed (temporary) catheters. Of these, the risk of infection is highest for catheters, intermediate for grafts, and lowest for fistulas.[2]

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The Dialysis Surveillance Network currently consists of 109 outpatient dialysis centers that voluntarily report data to this system.

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Infections in patients undergoing hemodialysis have adverse consequences for the individual patient, including increased morbidity and mortality, and for society, including increased costs, hospitalization rates, and need for antimicrobials. As a result of their frequent receipt of antimicrobials, particularly vancomycin, antimicrobial resistance has been common in patients undergoing dialysis. One of the first reports of vancomycin-resistant enterococci was from a renal unit in London, England.[3] In the United States, patients undergoing dialysis have comprised a significant percentage of vancomycin-resistant enterococci cases in hospital-based studies.[4] Also, of 6 US patients from whom strains of *Staphylococcus aureus* with reduced susceptibility to vancomycin have been isolated, 5 had received dialysis.[5]

Although systems for monitoring infections in patients who are hospitalized have been in place for many years,[6] uniform methods to study infections in outpatient groups have not been available. In 1999, the Centers for Disease Control and Prevention (CDC) initiated the Dialysis Surveillance

Network, a data monitoring system for outpatients undergoing hemodialysis.[7] This is the first report presenting data collected in this system.

METHODS

Dialysis centers treating outpatients undergoing hemodialysis were invited to participate in this project on a voluntary basis. Participating centers agreed to collect data according to the study protocol and participate in a conference call to review the procedures and data collection process. The study protocol was approved by the Institutional Review Board at the CDC, and by institutional review boards at participating dialysis centers, where applicable. From August 1999 to August 2000, project data were recorded on paper forms by personnel at participating centers and forwarded to the CDC for data entry. In September 2000, an Internet-based data entry and analysis system was made available, and thereafter data could be either reported to the CDC on paper forms or entered into a computer at the participating centers. Data tables and analyses were mailed to all participating centers every 3 months. Centers using the Internet-based system could generate and print out analysis tables and graphs whenever desired.

Data collection

Only outpatients receiving chronic hemodialysis were studied. Data were collected on census (denominator) and incident (numerator) forms. Copies of these forms are available at http://www.cdc.gov/ncidod/hip/Dialysis/procedure.htm. The census form was used to record the number of patients undergoing chronic hemodialysis who received hemodialysis at the dialysis center at least once during the first week of the month. The patients were categorized into 1 of 4 vascular access types (fistulas, grafts, cuffed catheters, or noncuffed catheters). If a patient had both an implanted access (fistula or graft) and a catheter, the patient was categorized as having a catheter.

An incident form was completed for each overnight hospitalization of any cause or outpatient start of an intravenous (IV) antimicrobial of any cause in a patient undergoing chronic hemodialysis. If a patient was given an antimicrobial and hospitalized on the same day, only one incident form was completed. A form was completed for each hospitalization, regardless of how soon after a previous hospitalization it occurred; however, if a patient was receiving an antimicrobial when he or she returned from the hospital to the outpatient unit, a new incident form was not completed. If a patient was receiving an antimicrobial and the agent was stopped for < 21 days and then restarted, a new incident form was not completed; however, if antimicrobials were stopped for ≥ 21 days and then restarted, a new incident form was completed.

Data collected on the incident form included the date of the hospitalization or the date when the IV antimicrobial was first given; treated with an IV antimicrobial, researchers noted whether IV vancomycin was used; type of vascular access and if it was removed as a result of the incident; whether clinical evidence for local access infection, wound infection, pneumonia, or urinary tract infection was present (see below); whether a blood culture was obtained, and, if so, the result; and if the blood culture was positive, the source (see below), genus, and species identities of up to 2 organisms and results of susceptibility testing of these organisms to oxacillin and vancomycin.

Clinical evidence for infections was as follows:

- Local access infection: pus, redness, or swelling of the vascular access site
- Wound infection: pus or redness at a wound not related to the vascular access
- Pneumonia: a new infiltrate or pneumonia seen on chest radiograph
- Urinary tract infection: a urine culture with $> 100{,}000$ organisms/mL with no more than 2 species isolated

The source of a positive blood culture was designated as:

- The vascular access if there was access drainage, pus, redness, swelling, pain, an open area, or a positive culture from the access showing the same organism found in the blood
- A site other than the vascular access (ie, secondary bacteremia) if (1) a culture from another site (eg, leg wound or urine) showed the same organism found in the blood or (2) clinical evidence of infection at another site, but a culture was not taken from it
- A contaminant if the organism was judged to be a contaminant by a physician
- Uncertain if there was insufficient evidence to decide among the 3 previous categories.

Definitions

Data on the incident forms were evaluated with a computer algorithm to determine whether each incident met the definitions of one or more of the

Table 1. Characteristics of participating vs nonparticipating dialysis centers, December 1999*

Category	Participating centers (N = 96)†	Nonparticipating centers (N = 3222)†
Ownership (% of centers)		
Profit	30.6	78.0
Nonprofit	58.3	18.3
Government	11.1	3.8
Location (% of centers)		
Hospital	67.6	17.1
Freestanding	32.4	82.9
No. of patients treated‡	54	56
Percent of patients receiving vancomycin (median)‡	4.9	4.3
Vascular access types (% of patients)‡		
Fistula	28.8	25.9
Graft	46.3	52.1
Permanent catheter	22.5	18.9
Temporary catheter	2.4	3.3

*Data for this table are taken from the National Surveillance of Dialysis-Associated Diseases in the United States, 1999.
†As a result of missing data, the number of centers included in each category is different; the value shown is the minimum number of centers among the categories.
‡Values are for a 1-month period (December 1999).

following events. Note that all definitions included either hospital admission or initiation of an IV antimicrobial in addition to the criteria listed below.

- Local access infection: pus, redness, or swelling of the vascular access site and access-related bacteremia was not present
- Positive blood culture: isolation of any microorganism from a blood culture
- 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
- Wound infection: pus or redness at a wound not related to the vascular access
- Pneumonia: a new infiltrate or pneumonia seen on chest radiograph
- Urinary tract infection: a urine culture with > 100,000 organisms/mL with no more than 2 species isolated
- Secondary bacteremia: positive blood culture with a source designated as a site other than the vascular access.

Comparison of participating vs nonparticipating centers

Data from the National Surveillance of Dialysis-Associated Diseases in the United States, 1999,[8] were used to assess the representativeness of centers participating in the project. This is a yearly mail survey of all US centers providing outpatient hemodialysis.

Data analysis

Data were entered into SQL Server (Microsoft, Redmond, CA) and analyzed with SAS for personal computers (SAS Institute, Cary, NC).* For a given center, the total number of patient-months was calculated by summing the census during the first week of each month of data collection; for example, a center treating 57, 54, and 59 patients during the first week of 3 successive months would have a total of 170 patient-months for the 3-month period. Rates per 100 patient-months for various outcome events were calculated by dividing the total number of events by the total number of patient-months and multiplying the result by 100; this rate can be interpreted as the average percent of patients having the stated event each month. Rate ratios were computed by dividing the rate in one group by the rate in a second (baseline) group; 95% confidence intervals (CI) for rate ratios were computed with the exact binomial method,[9] and exact *P* values were computed with the binomial or Poisson distribution.[10] Rate ratios standardized for mix of vascular access types were calculated with the method of indirect standardization.[10] All *P* values are two-tailed.

RESULTS

From October 1999 to May 2001, 109 dialysis centers located in 30 states reported data for at least 1 month. The median number of months participated per center was 9 (range, 1-20). The median number of patients treated each month per center was 56 (range, 7-284). A total of 75,535 patient-months were reported; the median number of patient-months reported per center was 469 (range, 17-3378). Fistulas were used in 30.9% of the patients, grafts in 40.9%, cuffed catheters in 25.1%, and noncuffed catheters in 3.1%. The percent of patients treated with catheters (either cuffed or noncuffed) was 28.2% overall and varied from 3.5% to 72.2% among the centers.

Comparison of participating vs nonparticipating centers

Data reported in a yearly mail survey of all US dialysis centers performed in December 1999 showed

*Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the US Department of Health and Human Services.

Table 2. Census data for a representative dialysis center, Dialysis Surveillance Network, October 1999–May 2001

	No. of patients, by vascular access type				All patients	
Month*	Fistula	Graft	Cuffed catheter	Noncuffed catheter	Total census	Percent difference from mean census
1	15	24	18	0	57	–7.9
2	13	25	14	2	54	–12.8
3	13	26	17	3	59	–4.7
4	13	24	15	4	56	–9.5
5	13	24	22	0	59	–4.7
6	15	26	21	2	64	+3.4
7	15	26	24	2	67	+8.2
8	15	26	23	5	69	+11.5
9	15	24	22	4	65	+5.0
10	18	24	22	2	66	+6.6
11	17	25	17	6	65	+5.0
Mean	14.7	24.9	19.5	2.7	61.9	7.2†

*This example center had submitted data for 11 months as of the time of article preparation.
†The mean of the absolute value.

that, compared with US dialysis centers not participating in the project, participating centers were more likely to be nonprofit (58.3% vs 18.3%) and hospital-affiliated (67.6% vs 17.1%) (Table 1). Participating centers were similar to nonparticipating centers in the number of patients treated (54 vs 56, respectively) but treated a higher percentage of patients with vancomycin during a 1-month period (4.9% vs 4.3%, respectively). In addition, the distribution of vascular access types was similar for participating vs nonparticipating centers (note that data in Table 1 were taken from the December 1999 mail survey and, therefore, differ from data collected in the data monitoring system and reported elsewhere in this article).

Census

The typical variation in numbers of patients treated each month is illustrated by census data from a representative dialysis center (Table 2). The first month census (57 patients) was 7.9% lower than the center's mean census (61.9 patients). The average variation in census at this center was 7.2% per month, higher than the average per month variation for all participating centers (5.8%).

Incidents and event rates

Of 13,705 incidents reported, 10,102 (74%) were for hospitalization only, 2885 (21%) incidents were for the administration of IV antimicrobial only, and 718 (5%) were for both a hospital admission and administering IV antimicrobial. Among 3603 incidents of IV antimicrobial administration, the proportion with a blood culture obtained was 60% overall and ranged from 17% to 97% among 51 centers having at least 20 incidents of IV antimicrobial administration.

A total of 2429 vascular access infections were reported; 1292 (53%) of these infections resulted in loss of the access, including the loss of 21 fistulas, 109 grafts, 873 cuffed catheters, and 289 noncuffed catheters. The 2429 vascular access infections included 1082 (45%) local access infections and 1347 (55%) access-related bacteremias. Among local access infections, 293 (27%) were treated with hospitalization and 789 (73%) with outpatient IV antimicrobials. In contrast, among access-related bacteremias, 827 (61%) were treated with hospitalization and 520 (39%) with outpatient IV antimicrobials.

Most event rates varied substantially by vascular access type. The hospitalization rate per 100 patient-months was 14.3 overall, 9.4 for grafts, 12.9 for fistulas, 20.5 for cuffed catheters, and 32.0 for noncuffed catheters (Table 3). The rate of access-related bacteremia was 1.78 per 100 patient-months overall, 0.25 for fistulas, 0.53 for grafts, 4.84 for cuffed catheters, and 8.73 for noncuffed catheters. With grafts used as the reference category, the rate ratios for access-related bacteremia were 0.48 (95% CI, 0.35-0.65) for fistulas, 1.0 (reference category) for grafts, 9.2 (95% CI, 7.7-10.8) for cuffed catheters, and 16.5 (95% CI, 13.3-20.3) for noncuffed catheters.

Among infections not related to the vascular access, rates per 100 patient-months were 1.29 for wound

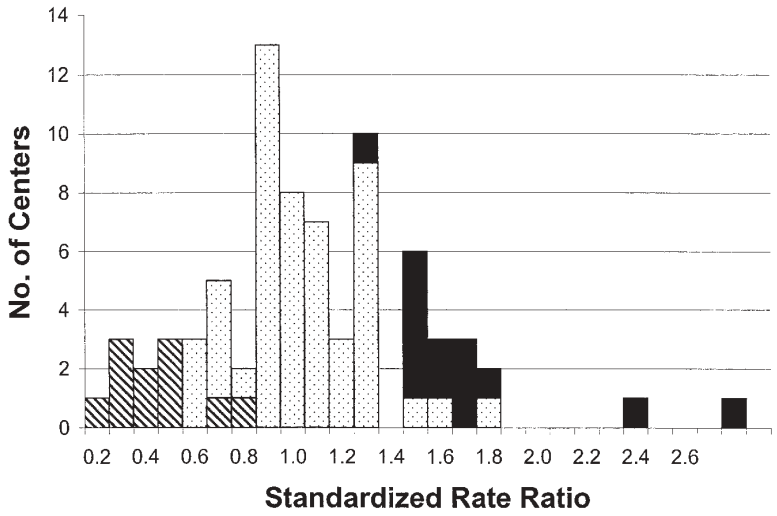

Fig 1. Distribution of vascular access infection standardized rate ratios, Dialysis Surveillance Network, October 1999–May 2001. Includes 76 centers with ≥200 patient-months of data. *Diagonal fill*, rate significantly (P <.05) lower than other centers (n = 11 centers); *dotted fill,* rate not significantly different from others (n = 51 centers); *solid fill,* rate significantly higher than others (n = 14 centers).

Table 3. Event rates by vascular access type, Dialysis Surveillance Network, October 1999–May 2001*

	Fistula	Graft	Cuffed catheter	Noncuffed catheter	All access types
Incidents and related events					
Hospitalization	2185 (9.4)	3991 (12.9)	3886 (20.5)	758 (32.0)	10,820 (14.3)
Outpatient IV antimicrobial treatment courses started	471 (2.02)	740 (2.39)	1489 (7.87)	185 (7.80)	2885 (3.82)
Outpatient IV vancomycin treatment courses started	282 (1.21)	530 (1.72)	1226 (6.48)	185 (7.80)	2223 (2.94)
Positive blood cultures	122 (0.52)	292 (0.94)	1097 (5.80)	236 (9.95)	1747 (2.31)
Infections at the vascular access site					
Vascular access infection	130 (0.56)	421 (1.36)	1594 (8.42)	284 (11.98)	2429 (3.22)
Local access infections	71 (0.30)	257 (0.83)	677 (3.58)	77 (3.25)	1082 (1.43)
Access related bacteremia	59 (0.25)	164 (0.53)	917 (4.84)	207 (8.73)	1347 (1.78)
Infections at other sites					
Wound infection	215 (0.92)	417 (1.35)	315 (1.66)	31 (1.31)	978 (1.29)
Pneumonia	156 (0.67)	247 (0.80)	195 (1.03)	35 (1.48)	633 (0.84)
Urinary tract infection	32 (0.14)	69 (0.22)	101 (0.53)	16 (0.67)	218 (0.29)

*All numbers are expressed as number of events and rate per 100 patient-months. Number of patient-months (denominator for rates) is 23,333 for fistulas, 30,903 for grafts, 18,928 for cuffed catheters, 2371 for noncuffed catheters, and 75,535 for all access types.

infection, 0.84 for pneumonia, and 0.29 for urinary tract infection for all access types (Table 3). Compared with rates for access infections, the rates of these infections varied less markedly among the access types (eg, for wound infections, the rate was 0.92 for fistulas, 1.35 for grafts, 1.66 for cuffed catheters, and 1.31 for noncuffed catheters). Among patients with grafts, wound infections occurred almost as commonly as vascular access infections (rates per 100 patient-months of 1.35 for wound vs 1.36 for vascular access infections).

Vascular–access infection rates in individual dialysis centers

Among 76 dialysis centers reporting at least 200 patient-months of data, rates of vascular access infection per 100 patient-months varied from 0.31 to 3.98 and rate ratios standardized for differences in mix of vascular access types varied from 0.1 to 2.7 (Figure 1). Of the 76 centers, 11 had a standardized rate ratio significantly (P < .05) lower than others, 51 were not significantly different from others,

Table 4. Microorganisms isolated from blood cultures, Dialysis Surveillance Network, October 1999–May 2001*

Category/organism	Access-related bacteremia, catheter (N = 1243)	Access-related bacteremia, fistula, or graft (N = 232)	Secondary bacteremia (N = 363)
Staphylococcus aureus	399 (32.1)	123 (53.0)	97 (26.7)
Other gram-positive	149 (12.0)	23 (9.9)	58 (16.0)
Enterococcus spp	125 (10.1)	11 (4.7)	33 (9.1)
Streptococcus spp	24 (1.9)	12 (5.2)	25 (6.9)
Gram-negative rods	229 (18.4)	23 (9.9)	95 (26.2)
Citrobacter spp	11 (0.9)	0	4 (1.1)
Enterobacter spp	57 (4.6)	4 (1.7)	13 (3.6)
Escherichia coli	36 (2.9)	6 (2.6)	29 (8.0)
Klebsiella spp	48 (3.9)	5 (2.2)	18 (5.0)
Pseudomonas spp	27 (2.2)	5 (2.2)	14 (3.9)
Other	50 (4.0)	3 (1.3)	17 (4.7)
Common skin contaminants	449 (36.1)	57 (24.6)	98 (27.0)
Coagulase-negative staphylococci	401 (32.3)	47 (20.3)	80 (22.0)
Streptococcus spp	6 (0.5)	3 (1.3)	5 (1.4)
Other	42 (3.4)	7 (3.0)	13 (3.6)
Other	17 (1.4)	6 (2.6)	15 (4.1)
Fungi	5 (0.4)	2 (0.9)	3 (0.8)
Other	12 (1.0)	4 (1.7)	12 (3.3)

*Values are numbers (percent) of blood isolates.

and 14 had a standardized rate ratio significantly higher than others.

Microorganisms isolated from blood

Among 1747 positive blood cultures, 1919 isolates were reported. Of the 1919 isolates, 1244 (66%) represented access-related bacteremias in patients with catheters; 232 (12%) access-related bacteremias in patients with fistulas or grafts; 363 (19%) secondary bacteremias; and 80 (4%) contaminants. Among isolates from access-related bacteremia in patients with catheters, 32% were *S. aureus* and 36% were common skin contaminants (predominantly coagulase-negative staphylococci) (Table 4). Among isolates from access-related bacteremias in patients with fistulas or grafts, 53% were *S. aureus*.

Among isolates tested for antimicrobial susceptibility, 38% (225 of 558) of *S. aureus* were resistant to oxacillin, 65% (294 of 449) of coagulase-negative staphylococci were resistant to oxacillin, and 4.6% (7 of 154) of *Enterococcus* spp were resistant to vancomycin.

DISCUSSION

These initial results are from the first national system for monitoring infections and related events in outpatients undergoing hemodialysis. These data represent the largest study ever undertaken of this problem. This project was started as a result of the high rates of infection in these patients, the strong link with antimicrobial resistance, and the lack of uniform methods for data collection. Rates of various events per 100 patient-months are reported, which can be interpreted as the average percentage of patients having the event each month. On average, 14% of patients were admitted to a hospital for any cause each month, 4.7% were started on an outpatient course of an IV antimicrobial, and 3.2% had a vascular access infection, 55% of which had accompanying bacteremia.

As has been reported by others,[2] this study indicates that rates of infections and other events were substantially higher in patients who underwent dialysis with the use of catheters, especially noncuffed catheters. Catheters are a portal of entry for infection and are probably used in patients with higher severity of illness (ie, those who have required dialysis longer and for whom there are no other options for vascular access). The high infection rates associated with catheters are a concern because both the number of patients undergoing hemodialysis and the percentage of patients with dialysis catheters are increasing each year.[8]

In most hospital-based studies of bloodstream infections, the numbers of patients with catheters is counted each day and rates of infection per 1000

catheter-days are calculated.[6] However the census is much more stable in outpatient dialysis centers; therefore, in the Dialysis Surveillance Network the census is determined only during the first week of the month. During the remainder of the month, some patients will be added and others removed from the census, but the first-week census should be a good estimate of the average daily census during the month. This method allows calculation of relatively accurate rates while greatly reducing the burden of collecting denominator data. Additionally, the resulting rates have an intuitive interpretation; a vascular access infection rate of 3.2 per 100 patient-months indicates that, on average, 3.2% of the patients had the infection each month. Rates per 100 patient-months are approximately 3 times higher than rates per 1000 patient- (or catheter-) days; the rate of 3.2 per 100 patient-months is equivalent to a rate of 1.1 per 1000 patient-days.

The rate of vascular access infection (which includes infections both with and without bacteremia) found (3.2 per 100 patient-months) is similar to the rate (3.5 per 100 patient-months) found in a pilot study of the system at 7 dialysis centers,[11] and it is in the range reported in other studies (1.3-7.2 per 100 patient-months).[12-15] However the reported rate of access-related bacteremia (1.8 per 100 patient-months) was higher than previously reported rates (1.2-1.38 per 100 patient-months).[11,15] Differences in infection rates among various studies may be a result of differences in study methods and definitions, mix of vascular access types, intrinsic risk of the patients studied, or use of infection control measures at study centers.

Blood cultures were performed before only 32% of IV antimicrobial courses in a study of 7 outpatient dialysis units[11] and only 60% in the surveillance system. The higher rate in the system may result from the self-selection process of the participating centers (ie, voluntarily choose to collect and report data in a quality promotion activity), and a majority are nonprofit hospital-based units. Therefore the participating units may be more likely to comply with good patient-care practices. Blood cultures should be obtained before most courses of IV antimicrobials in patients undergoing hemodialysis. The results of such cultures could help optimize antimicrobial use and the duration of treatment so infections could be eradicated while minimizing selection for antimicrobial resistance.

The distribution of bloodstream isolates reported here is similar to that found in previous studies. Among blood isolates from patients with hemodialysis catheters, 32% were *S. aureus* and 32% were coagulase-negative staphylococci; data pooled from other studies showed proportions of 30% and 38%, respectively.[16] Bloodstream isolates from patients with catheters in the intensive care unit showed a similar percentage of coagulase-negative staphylococci (33.5%) but a lower percentage of *S. aureus* (13.4%).[17] Among blood isolates from patients with fistulas or grafts, 55% were *S. aureus* vs 57% for data pooled from other studies.[16]

Compared with data monitoring in the inpatient hospital setting, data monitoring in the outpatient hemodialysis setting is more difficult because fewer diagnostic tests are performed, clinical evaluation and documentation are less detailed, and trained infection control practitioners are usually not available. To cope with these challenges, a system was created with the following unique features: simplified data collection methods; a carefully defined method for finding infections; a record of the presence or absence of criteria for infections, not the infections themselves (ie, the data collector does not have to memorize case definitions); and a computer algorithm to determine whether the infection case definitions are met. These features are intended to increase the accuracy and consistency of data collection at a large number of geographically dispersed facilities.

This data collection system has both strengths and weaknesses. Weaknesses include that the system has not been validated and does not require that data be collected by trained infection control practitioners. In traditional systems, the data collector reports only those events meeting a case definition. In this study's system, a form is completed for each hospitalization or start of IV antimicrobial treatment of any cause, only some of which represent an infection of interest. This increases the workload but provides a defined method for finding infections and allows calculation of rates of hospitalization and IV antimicrobial treatments. Another potential problem with this system is that infections treated with oral antimicrobials alone are not counted; thus, only the more serious infections are included in our system, and some centers that tend to use oral antimicrobials in preference to IV agents, even occasionally for bacteremia, may have falsely low rates. Conversely, some infections may be counted more than once (eg, a patient initially treated with outpatient IV antimicrobial and admitted to a hospital a few days later for the same problem). This "double counting" may lead to a mod-

est overestimate of infection rates, but the overestimate should be similar for all centers, and, thus, the relative ranking of the centers should be correct for benchmarking purposes. To some degree, the factors leading to over-vs-under counting of infections may offset each other. However, these potential disadvantages are compensated for by the simplicity and practicality of the system.

As with any voluntary data collection effort, it is uncertain whether the data collected by participating centers are representative of other US facilities. Compared with nonparticipating centers, our participating centers were much more likely to be located in hospitals and operated on a nonprofit basis. Additionally, they reported slightly higher use of vancomycin in December 1999; because use of vancomycin can be used as a rough estimate of the number of patients with access infections, our participating centers may have had slightly higher rates of access infections than other US centers.

After adjusting for potential differences in vascular access types, marked differences were noted in the risk of vascular access infections among the participating dialysis centers. By feeding this information back to dialysis center personnel on a routine basis, either through quarterly mailed reports or real-time analyses produced by our Internet-based system, we hope to facilitate improvements in the quality of care at individual units. By comparing practices at centers with high vs low infection rates, we hope to develop new infection control strategies. Dialysis centers wishing to enroll in or receive a protocol for this project may do so by visiting http://www.cdc.gov/ncidod/hip/Dialysis/procedure.htm or by calling the CDC at (404) 498-1109.

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