Reviews in Infection RIF

RIF 1(1):1-6 (2010) ISSN:1837-6746

Original Research

Infection related processes during haemodialysis: A study in General Hospital Haemodialysis unit

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Background: Hemodialysis patients are prone to frequent infections, especially of the vascular access site, and often harbor antimicrobial-resistant pathogens. Implementation of a surveillance system to monitor and prevent infections in these patients is therefore of extreme importance.

Methods: From September 2007 to September 2008, all hemodialysis patients attending the hemodialysis unit of Mubarak Al-Kabeer Hospital, Kuwait, were monitored by professional infection control staff for pre-defined dialysis associated outcome events. Data were collected and recorded on a standard worksheet according to the method of the Dialysis Surveillance Network, United States Centers for Disease Control and Prevention.

Results: A total of 187 outcome events were reported in 47 patient over 13 months as follows: hospitalization: 4 (2.1%), administration of any IV antibiotic: 50 (26.7%) and vancomycin specifically 41 (21.9%), positive blood culture: 31 (16.57%), vascular access infection: 38 (20.3%) and access related bacteremia: 21 (11.23%). Of all vascular access infections, 15 (39.5%) occurred in temporary catheters, 19 (50%) in permanent catheters and 4 (10.5%) in arteriovenous fistulas (AVF). None of the synthetic A-V grafts (AVG) was infected. The overall vascular access infection rate was 2.3 per 100 patient-months. The rate varied substantially by vascular access type: 15.6 for temporary catheters, 3 for permanent catheters and 0.5 for native AVF.

Conclusion: Event rates were highest among patients with temporary catheter but none were recorded for synthetic grafts. These results can be used for quality improvement and to help evaluate the efficacy of specific infection control measures.

Introduction

Chronic hemodialysis patients are especially vulnerable to infections commonly with antimicrobial-resistant organisms since they are immunosuppressed, require vascular access for prolonged periods, need to puncture their vascular access site routinely, necessitate frequent hospitalization, and often treated with long courses of antimicrobials [1,2]. Interestingly, five of the first seven reports of *Staphylococcus aureus* with intermediate level resistance to vancomycin (VISA), and the first of three patients with *S. aureus* resistant to vancomycin (VRSA) in the United States were dialysis patients [3]. The standard types of vascular access include native arteriovenous fistulae (AVF); synthetic arteriovenous grafts (AVG); permanent tunneled, cuffed central venous catheters (CVCs); and temporary non-tunneled, non-cuffed CVCs [4]. Of these, the risk of infection is highest for catheters, intermediate for AVG, and lowest for AVF [5].

Monitoring infections and antibiotic resistance patterns in dialysis populations is an important component of improving patient safety and quality of health care. Although studies published in the literature can provide useful guidance for preventing infections at the local level, surveillance data collected at the facility level can provide the information to quickly identify problems and target control measures. For comparison of data on infections or complications across outpatient facilities, it is necessary to adjust the number of events for patient risk factors, or the number of dialysis sessions [6]. Therefore, the aim of this study was to determine the infection related processes during haemodialysis among haemodialysis patients in the dialysis unit of a general hospital in Kuwait.

Patients and methods:

From September 2007 to September 2008, all hemodialysis patients attending the hemodialysis unit of Mubarak Al-Kabeer Hospital (A 523 bed governmental teaching hospital) Kuwait, were monitored by

Table 1. Demographic characteristics of the dialysis patients with reported infection related processes.

Variable		
Age in years, range, mean±SD	17 - 84	51±17.5
Gender, male No., (%)	28	(59.6)
Nationality, Kuwaiti No. (%)	23	(48.9)
Dedicated vascular access type		
Permanent catheter No. (%)	29	(61.7)
Temporary catheter No. (%)	14	(29.8)
AVF No. (%)	4	(8.5)

professional infection control staff for infection related processes during haemodialysis according to the method of the National Health Safety Network (NHSN) [7].

Forty-seven chronic hemodialysis outpatients were studied. Data were collected on census (denominator) and incident (numerator) forms. The census form was used to record the number of patients undergoing chronic hemodialysis who received hemodialysis at the dialysis unit at least once during the first week of the month. The patients were categorized into 1 of 4 vascular access types (AVF, AVG, cuffed catheters, or noncuffed catheters). If a patient had both an implanted access and a catheter, the patient was categorized as having a catheter [8].

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. Incident form also included whether a blood culture was obtained, and, if so, the result; and if the blood culture was positive, the source, genus, and species identities of up to 2 organisms. All patients with a positive blood culture were included even if they did not have an associated hospitalization or in-unit IV antimicrobial start; whether clinical evidence for local access infection, wound infection, pneumonia, or urinary tract infection was present.

Denominator data were collected once a month (on the first two working days of the month) and included the number of patients with various types of vascular access (AVF, AVG, cuffed catheter, non-cuffed catheter). These data were used to estimate the number of patient-months. Only chronic hemodialysis outpatients were included [7, 8].

Statistical analysis

Statistical Package for the Social Sciences (SPSS) for Windows (version 16.0; SPSS Inc., Chicago, Ill., USA) was used for analysis of data. Categorical variables were expressed as numbers and percentages. Continuous variables were expressed as mean and standard variation. The rates of these events per 100 patient-months were calculated by dividing the number of events by the number of patient-months and multiplying the result by 100. These rates were stratified by vascular access type.

Results

A total of 182 outcome events were reported in 47 patient (mean age, 51 ±17.5 years) over 13 months (mean, 3.6 vent/patient/year). Twenty-eight (59.6%) patients were males and 23(48.9%) were Kuwaiti nationals. The demographic characteristics of the patients are shown in table 1.The reported infection related processes during haemodialysis were as follows: 4 for hospitalization, 48 for start of IV antibiotics, of which 38 were vancomycin, 31 for positive blood culture, 38 for vascular access infection and 23 for access related bacteremia. Among 48 incidents of IV antimicrobial administration, the proportion with a positive blood culture obtained 64.6% (31/48).

Of the 38 vascular access infections: 15 (39.5%) occurred in temporary catheters, 19 (50%) in permanent catheters and 4 (10.5%) in arteriovenous AVF. None of the synthetic AVG was infected. The overall vascular access infection rate per 100 patient-months was 2.3. Events' rate varied substantially according the vascular access type: 15.6 for temporary catheters, 3 for permanent catheters and 0.5 for native A-V fistulas. The 38 vascular access infections included 15 (39.5%) local access infections and 23 (60.5%) access-related bacteremias (10 related to temporary catheters, 11 related to permanent catheters and 2 related to fistulas). The distribution of the infection related processes during haemodialysis according to the vascular access type is shown in Table 2.

Table 2. Distribution of infection related processes according to the vascular access type

Access type	Temporary catheter		Permanent catheter		AVF		All access	
Event	No.	Rate	No.	Rate	No.	Rate	No.	Rate
Hospitalization	0	0	4	0.7	0	0	4	0.2
Administration of IV antibiotics	15	15.6	29	4.7	4	0.5	48	2.9
Administration of vancomycin	14	14.6	20	3.3	4	0.5	38	2.3
Positive blood culture	13	13.6	16	2.7	2	0.2	31	1.9
Vascular access infection	15	15.6	19	3	4	0.5	38	2.3
Access-related bacteremia	10	10.4	11	1.8	2	0.2	23	1.4

*All numbers are expressed as number of events and rate per 100 patient-months. Number of patient-months (denominator for rates) is 96 for temporary catheters, 603 for permanent catheters, 864 for fistulas, 87 for grafts, and 1650 for all access types.

Episodes of bloodstream infection were mainly due to gram positive organisms (77%). Of the 31 episodes, MRSA was responsible for 8 of them (26%) as shown in table 3.

Discussion

This is the first report from Kuwait, which describes the infection related processes during haemodialysis among outpatients undergoing haemodialysis. Although the advent of central venous catheters is considered to have been a breakthrough in the treatment of patients with end-stage renal failure requiring haemodialysis, the burden of disease (particularly catheter-related infections) associated with their use has become a serious concern for healthcare professionals [9].

Complications related to vascular access account for approximately 25% of all hemodialysis-associated hospitalizations [10].

In one study [8], 3.2% had a vascular access infection, 55% of which had accompanying bacteremia, while our study has shown 31 (16.57%) positive blood culture, 38 (20.3%) vascular access infection and 21 (11.23%) access related bacteremia.

Our results have shown that vascular access infection rate (which included infections both with and without bacteremia) was 2.3 per 100 patient months.

Our reported rate of bloodstream infection was 1.9 per 100 patient-months, 13.6 per 100 patient-months were among patients with temporary catheters, 2.7 were among patients with permanent catheters and 0.2 in patients with AVF.

In one report,the pooled mean rate of bloodstream infection ranged from 0.5 to 27.1
per 100 patient-months. The pooled mean rate of a vascular access infection (either a local access infection or an access-associated bloodstream infection) ranged from 0.4 to 22.9 per 100 patient-months [11].

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). Our results matched those reported by others which indicated that rates of infection related processes during haemodialysis were substantially higher in patients who underwent dialysis with the use of catheters, especially non-cuffed catheters [3].

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.

The vascular access site is the most common site for infection in hemodialysis patients, and access site infections are particularly important because they can cause disseminated bacteremia or loss of the vascular access. The primary risk factor for access infection is access type, with catheters having the highest risk for infection, AVG intermediate, and native AVFs the lowest [2].

Reported national infection rates for local and bacteremic infections are 1% to 4% for native AV fistulae7-9 and 11% to 20% for AV grafts. Reported infection rates for cuffed central catheters depend on the duration of use, with 5% to 8% bacteremia rates for catheters in use <3 months and rates approaching 50% for catheters in use for 12 months [10].

The variability 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 should be obtained before most courses of IV antimicrobials in patients undergoing hemodialysis. The results of such cultures could help in optimizing antimicrobial use and the duration of treatment so infections could be eradicated while minimizing emergence of antimicrobial resistance [12].

The two most common pathogens isolated in cases of catheter- related infection are the skin-derived microorganisms S. epidermis and S. aureus, [12] a finding also confirmed in our study where episodes of bloodstream infection were mainly due gram positive organisms (77%) of the 31 episodes, MRSA was responsible for 8 of them (26%).

In another study, among the 32 confirmed blood stream infections (BSIs), 10 different microorganisms were positively identified. They were as follows: S. aureus was identified in 7 BSIs (21.9%); Staphylococcus epidermis in 7 BSIs (21.9%), Enterococcus faecalis in 6 BSIs (18.8%), Escherichia coli in 3 BSIs (9.4%), Proteus mirabilis in 2 BSIs (6.25%), Klebsiella pneumoniae in 2 BSIs (6.25%), Acinetobacter species in 2 BSIs (6.25%), Pseudomonas aeruginosa in 1 BSI (3.1%), Enterobacter cholaceae in 1 BSI (3.1%), and Candida species in 1 BSI (3.1%). The microbiologic findings did not appear to vary by vascular access type. However, statistical testing for associations could not be undertaken because of the relatively small number of confirmed BSIs [13].

This is also consistent with another study in which eighty-two percent of the bacterial organisms isolated from the bloodstream or vascular-access sites were gram positive cocci (43% Staphylococcus aureus, 23% coagulase negative staphylococci, 8% methicillin-resistant S aureus, 8% enterococci). None of the enterococci were found to be vancomycin-resistant. Ten percent of isolates were aerobic, gram-negative bacilli (Pseudomonas aeruginosa, Enterobacter species, or Salmonella species), and 8% were classified as other bacteria (gram-positive bacilli, not further character-rized) [10].

The above mentioned data raises concern with the increased incidence of infection with methicillin-resistant S. aureus, in particular, and a possible outbreak of nosocomial infection in the hemodialysis population in general [14].

Our results showed that out of the total 187 reported incidents, 4 were for hospitalization (2.1%). This percentage is much lower than that reported in one study [8] where 14% of patients required admission to the hospital for any cause each month. However, the start of any outpatient IV antibiotic in our study was much higher being 26.7% Vs 4.7% in that study.

The pooled mean rate among the 977 reports of antimicrobial starts ranged from 1.8 to 25.4 per 100

Table 3. Microbial etiology of bloodstream infection episodes in the dialysis patients

Organisms	No.
Gram positive (24)	
Methicillin resistant Staphylococcus aureus	8
Staphylococcus aureus	7
Enterococcus fecalis	5
Unspecified Gram positive cocci	2
Staphylococcus epidermidis	1
Staphylococcus hemolyticus	1
Gram negative (7)	
Campylobacter spp.	1
Morganella morganii	1
Enterobacter sakazaki	1
Pseudomonas aeruginosa	1
Pseudomonas lateola	1
Serratia marsescens	1
Unspecified Gram negative bacilli	1
Total	**31**

patient months. In 73% of these events, vancomycin was used; the pooled mean rate of vancomycin starts ranged from 1.2 to 16.1 per 100 patient-months [10].

In order to report bloodstream infection, the numbers of patients with catheters were counted each day and rates of infection per 1000 catheter-days were calculated**.** However, the census used in this study was much more stable in outpatient dialysis ward; in which 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 [15].

Although our surveillance method adopted the (NHSN) [7], it has some limitations as reported by others [8]. In traditional systems, the data collector reports only those events meeting a case definition. However, in this study system, a form is completed for each hospitalization or start of IV antimicrobial treatment of any cause and only some of which represented an infection of interest. This substantially increases the workload though it 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 (e.g, 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 modest 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 [8].

It is important that ongoing surveillance be continued and that strategies be developed to minimize the risk of vascular space access associated infection. Meanwhile, surveillance documentation must be improved so that complete and reliable individual data are recorded to supplement the aggregated data.

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