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Epidemiology of infections and antimicrobial use in Australian haemodialysis outpatients: findings from a Victorian surveillance network, 2008–2015

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SUMMARY

Background: Patients with chronic renal failure who require haemodialysis are at high risk for infections.

Aim: To determine the burden of bloodstream and local access-related infections and the prescribing patterns for intravenous antibiotics in Australian haemodialysis outpatients.

Methods: A surveillance network was established following stakeholder consultation, with voluntary participation by haemodialysis centres and data collation by the Victorian Healthcare Associated Infection Surveillance System Coordinating Centre. Definitions for infection and intravenous antimicrobial starts were based upon methods employed by the Centers for Disease Control and Prevention. Longitudinal mixed-effects Poisson regression was used to model time-trends for the period 2008–2015.

Findings: Forty-eight of 78 Victorian dialysis centres participated in the network, with 3449 events reported over 78,826 patient-months. Rates of bloodstream infection, local infection and intravenous antimicrobial starts were much higher for patients with tunnelled central lines (2.60, 1.41, and 3.37 per 100 patient-months, respectively), compared to those with arteriovenous fistulae (0.27, 0.23, and 0.73 per 100 patient-months, respectively) and arteriovenous grafts (0.76, 1.08, 1.50 per 100 patient-months, respectively). *Staphylococcus aureus* was the most frequent pathogen, with meticillin-resistant isolates (MRSA) responsible for 14.0%. Access-related infections diminished significantly across all vascular-access modalities over time. Vancomycin contributed nearly half of all antimicrobial starts consistently throughout the study period.

Conclusion: Risk for bloodstream and local access-related infections is highest in Australian haemodialysis patients with tunnelled central lines. *S. aureus* is the most frequent cause of infection, with a low incidence of MRSA. Future programmes should evaluate infection prevention practices and appropriateness of antibiotic prescribing in this population.

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Introduction

Patients requiring haemodialysis are at high risk of infection, related to immune compromise due to renal failure and other comorbidities as well as the need for ongoing vascular access. Bloodstream and localized infections of the vascular access site are significant complications associated with poor clinical outcomes and increased healthcare costs [1—4]. In addition, repeated hospitalizations and recurrent use of antimicrobial agents place these patients at risk of infection with antimicrobial-resistant pathogens [1—8].

In 2000, the Centers for Disease Control and Prevention (CDC) developed a national surveillance system for use in outpatient haemodialysis centres in the USA, now co-ordinated by the National Healthcare Safety Network (NHSN) [9]. This programme enables monitoring and benchmarking of infections and antimicrobial use, including reporting of hospitalizations, bloodstream infections, and antimicrobial use [10].

High rates of bloodstream infection have been reported retrospectively in haemodialysis outpatients in Australia [11]. High rates of colonization with multi-resistant organisms with increased risks of infection due to these pathogens are also recognized in this patient group [12]. Given the recognized benefits of monitoring to inform prevention programmes, a standardized surveillance strategy for infections and antimicrobial use was established in the state of Victoria in 2004, based upon methods developed by the CDC/NHSN [13].

The objectives of this study were: (i) to determine the burden of bloodstream infections and local access-related infections and evaluate time-trends for these infections; (ii) to compare risks of infection according to vascular access modality; and (iii) report patterns of intravenous antimicrobial use in Victorian outpatients requiring haemodialysis for the period 2008—2015.

Methods

Development of surveillance strategy

In 2002, the Victorian Healthcare Associated Infection Surveillance System (VICNISS) Coordinating Centre was established to develop and support standardized surveillance of healthcare-associated infections within the state of Victoria [14]. In 2004, a haemodialysis event surveillance module was developed, following consultation with local infection control personnel, renal physicians and renal nurses, and based primarily upon the CDC/NHSN dialysis surveillance tool [15]. Participation by dialysis centres was voluntary and surveillance findings (individual centre compared with pooled data) were reported quarterly. Stakeholder review in 2008 led to refinement of the programme, including removal of the non-specific 'hospitalization' metric, with ongoing monitoring of dialysis access infections, bloodstream infections, and antimicrobial starts.

The target population for surveillance was defined as Victorian patients who were treated in outpatient haemodialysis centres, which may or may not have been affiliated with an acute care hospital. In 2016, there were 78 public haemodialysis units in the state of Victoria [16].

Infection prevention and dialysis staff were responsible for data collection at participating centres. Regular face-to-face education regarding surveillance methods and a central service for enquiry and discussion regarding definitions and standardized classification of cases was supplied by the VICNISS Coordinating Centre.

Definitions

Monitored haemodialysis events were defined as intravenous antimicrobial starts, local access infections, or bloodstream infections. Intravenous antimicrobial starts were defined as all outpatient antimicrobial starts, irrespective of the indication for therapy. If an agent was stopped for less than 21 days and then restarted, the second start was not considered a new event. Bacteraemia was defined as all positive blood cultures collected from outpatients or within one calendar day of hospital admission. To be considered a unique event, 21 days or more must have lapsed between two consecutive positive blood cultures.

Patient demographics, type of vascular access, and complications related to each event were captured using standardized data fields. Where a pathogen was identified, the infecting organism and antimicrobial susceptibility were also recorded. Consistent with CDC/NHSN surveillance methodology, a denominator of 'patient-months' was used for reporting of events, estimated by the number of chronic haemodialysis patients with each access type who underwent dialysis at the centre during the first two working days of each month [15].

Ethics review

No patient-identifying data were captured for the purposes of the study, and all hospital-level data were de-identified. As a quality-assurance audit without direct impact upon patient care, ethics review was not required.

Statistical analysis

Using data for the period 2008—2015, haemodialysis events were reported as rates per 100 patient-months. Categorical variables were summarized using frequency and percentage. Continuous variables were summarized using mean and standard deviation or median and interquartile range (IQR), as appropriate.

A longitudinal mixed-effects Poisson regression was used to model trends in counts of haemodialysis events over time where the aggregate number of haemodialysis patients formed the offset exposure variable. In the absence of explicit data regarding individual hospital characteristics which may systematically differ between contributing sites (e.g. case-mix), the hospital identifier was included in the mixed model as a random effect to adjust for unobserved inter-site heterogeneity. Event counts were tested for over-dispersion. Effect size was quantified as the risk ratio (RR). For all analyses $P < 0.05$ was considered significant. All analyses were conducted in Stata version 14 (StataCorp, College Station, TX, USA).

Results

During the study period, 48 haemodialysis centres participated in surveillance, representing 61.5% of public dialysis units in Victoria. In total, 3449 events were reported during a total of 79,803 patient-months. Median age of patients with a