Nosocomial blood stream infection in Auckland Healthcare hospitals

Tanya M Nicholls, Infection Control Co-ordinator; Adrienne S Morgan, Infection Control Nurse Practitioner, Arthur J Morris, Clinical Microbiologist, Auckland; for the Auckland Healthcare Infection Control Service.

Abstract

Aim. To report the epidemiology of nosocomial bloodstream infections in Auckland Healthcare Hospitals.

Methods. From January 1995 to December 1997 every positive blood culture result was followed up by an infection control nurse who recorded relevant clinical, laboratory and treatment information on a data collection sheet. The clinical significance of each isolate was determined and the most likely source recorded.

Results. During the three year study period, there were 1046 nosocomial blood stream infections yielding 1147 isolates. The most common isolates/groups were: coagulase negative staphylococci 19%, S. aureus 18%, E. coli 12%, streptococci 10%, other Enterobacteriaceae 10%, Enterobacter spp. 7%, Pseudomonas spp. 5%, anaerobes 2%, and yeasts 4%. The most common sources were: intravascular lines 40%, urinary tract 8%, skin/soft tissue 8%, gastrointestinal 7%, and unknown 25%. The overall results were strongly influenced by the neonatal intensive care unit at National Women's Hospital where 58% of blood stream infections had intravascular-lines as the source and 53% of the isolates were coagulase negative staphylococci. The overall blood stream infection rate was approximately 6/1000 admissions. Rates per 1000 inpatient days for haematology, intensive care, oncology, neonatal and all other patients were 13, 11, 3, 3 and 1 respectively.

Conclusions. Surveillance data that are clinically relevant are useful in identifying areas where infection prevention strategies can be implemented. Because of the importance of lines as a source of nosocomial blood stream infections all aspects of line care are being reviewed with the aim of reducing these devices as a source of blood stream infection.

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Blood stream infections (BSI) comprise approximately 20% of nosocomial infections.[1] It is estimated that up to 35% of nosocomial BSI can be prevented if an effective surveillance programme is in place.[2] Surveillance of BSI is recommended because of the associated morbidity and attributable mortality.[3] BSIs prolong patient hospitalisation by 7-10 days [3] and are therefore costly both to the healthcare organisation and the patient.

The Crown Company Monitoring Advisory Unit (CCMAU) monitor, for the New Zealand Government, public hospitals to ensure they provide quality health care. BSIs were chosen by CCMAU as a performance indicator for a number of reasons, one of which was to ensure that some infection control surveillance was being undertaken. Hospital and Health Services (HHS) are now required to report each month the BSI rate per 1000 inpatient admissions to CCMAU. The first two years of

data have recently been published.[4] The average rate of BSI for the six tertiary HHS's was 3.7 per 1000 inpatient admissions.[4] While this gives an indication of how frequent BSI's are, it does not provide information on the local epidemiology of nosocomial BSI, ie. organisms encountered, their sources and the different rates for different clinical services. We, therefore, have collected other relevant information in order to guide initiatives to reduce nosocomial BSI's.

Methods

All positive blood cultures at Auckland Healthcare hospitals between January 1995 and December 1997 were reviewed. Auckland Healthcare is New Zealand's largest HHS. It undertakes almost 40% of tertiary care services in the country and provides hospital services for 40% of the country's population. Three of the four hospitals in the Auckland Healthcare HHS were included in this study. Auckland Hospital with 576 beds is a tertiary teaching hospital affiliated with Auckland University Medical School which provides acute and elective general medical and surgical services, as well as major haematology, oncology, trauma and neurosurgical services. Green Lane Hospital with 219 beds provides tertiary cardiology, cardiothoracic surgery, respiratory medicine and otorhinolaryngology services. National Women's Hospital with 256 beds provides obstetric and gynaecology services including a neonatal intensive care unit with 16 beds. Data were collected and recorded by infection control nurse practitioners for all patients with positive blood cultures during the three year period. The significance and probable source for each isolate were determined after reviewing all relevant clinical and microbiological data with the clinical microbiologist.

A nosocomial BSI was defined as a positive blood culture obtained 48 hours or more after admission to hospital, provided there was no evidence that the BSI was due to an infection present or incubating at the time of admission, unless related to a previous admission. Common skin contaminants (eg. *Corynebacterium* spp., *Bacillus* spp. and coagulase-negative staphylococci [CNS]) were included only if isolated from two independently collected blood culture sets unless, on review, single positive cultures were thought to be clinically relevant.[4] BSI's detected by blood cultures obtained within 48 hours of admission were counted as nosocomial if they were clearly related to a previous admission, for example in a cancer patient with a long-term central line, or *S. aureus* bacteraemia due to a surgical site infection.

Results

From January 1995 to December 1997 there were 1046 episodes of nosocomial BSIs. The most frequent source of infection was intravascular lines (40%), (Table 1). Central venous catheters predominated over peripheral lines. The proportion of BSI with intravascular lines as a source was significantly higher at National Women's Hospital than the other two hospitals (Table 2). The source of 25% of the BSIs could not be determined.

Table 1. Sources of nosocomial blood stream infection, 1995-7.

Source	Number (%)
Intravascular lines	415 (40%)
- central lines	366 (35%)
- peripheral lines	49 (5%)
Urinary tract	81 (8%)
Gastrointestinal tract	74 (7%)
Skin/soft tissue	85 (8%)
Respiratory tract	50 (5%)
Other	83 (8%)
Unknown	258 (25%)
Total	1046 (100%)

The 1046 BSIs yielded 1147 isolates with 95 (9%) being polymicrobial (89 with two isolates, 6 with 3 isolates). The predominant pathogens were CNS (19%), *Staphylococcus aureus* (18%) and *Escherichia coli* (12%) (Table 3). The overall number of CNS infections was strongly influenced by BSIs in the neonatal intensive care unit at National Women's Hospital where 58% had intravascular lines as the source and 53% of the isolates were CNS (Table 4). *S. aureus* caused 22% of intravascular line related BSIs, 79% of peripheral line BSIs, but only 9% of central line BSIs.

Table 2. Proportion of blood stream infections intravascular lines as the source, 1995-7.

	Source		
Hospital	Intravascular lines	Others	Total
1. Auckland	221 (33%)	451	672
2. Green Lane	77 (45%)	95	172
3. National Women's	117 (58%)	85	202
Total	415 (40%)	631	1046 (100%)

1 vs. 2 p = 0.005
1 vs. 3 p = <0.001
2 vs. 3 p = 0.01

Table 3. Organisms causing nosocomial blood stream infections, 1995-7.

Organism/group	n	(%)
Coagulase-negative Staphylococci	210	(19)
Staphylococcus aureus	205	(18)
Escherichia coli	144	(12)
Streptococcus spp.	118	(10)
Other *Enterobacteriaceae*	117	(10)
Enterobacter spp.	80	(7)
Pseudomonas spp.	62	(5)
Enterococcus spp.	51	(4)
Candida spp.	45	(4)
Anaerobes	19	(2)
Other gram-positives	40	(3)
Other gram-negatives	56	(5)
Total	1147	(100)

Table 4. Proportion of blood stream infections due to coagulase-negative staphylococci, 1995-7.

	Causative organism		
Hospital	CNS	Others	Total
1. Auckland	71 (10%)	661	732
2. Green Lane	25 (13%)	174	198
3. National Women's	114 (53%)	103	217
Total	210 (19%)	938	1147

1. vs. 2. p = 0.3,
1. vs. 3. p = <0.001,
2. vs. 3. p = <0.001.
CNS = coagulase negative *Staphylococci*.

Over three years the BSI rate for Auckland Healthcare Services increased from 4 to 7 per 1000 inpatient admissions. The overall rate for the three year period for each hospital was Auckland 8, Green Lane 6 and National Women's 5 per 1000 inpatient admissions. Sixty percent of the BSI's occurred at Auckland Hospital. Higher rates per 1000 inpatient days occurred in haematology 13, and intensive care unit patients 11, compared with 3 in oncology and neonatal and 1 for all other patients. Thirty two percent of the BSI's at Auckland Hospital occurred in haematology patients although they occupied only 4% of the bed days. BSI's in neonates made up 80% of all episodes at National Women's Hospital.

Discussion

This study provides clinically useful and epidemiologically relevant information beyond simply knowing the overall BSI rate. Varying definitions and populations studied make direct comparisons with other studies difficult. Intravascular lines are the most frequent source of BSI in, for example, Spanish ICU's (37%)[5] and in the USA (19%).[6] Studies in both the USA and Europe show that the risk of BSI is increased significantly (odds ratio approximately 5) in patients with central venous lines.[7,8]

Our surveillance results have been used to educate staff on the importance of intravascular line management. They were also instrumental in the establishment of a HHS wide group to review and develop a multidiscipline intravascular line policy.

The recently published Centres for Disease Control and Prevention (CDC) guidelines for the prevention of intravascular device- related infections provides a framework for the prevention of these infections.[9] The CDC emphasise the importance of device associated rates when comparing infection rates between units or hospitals.[10] Although we have identified intravascular lines as the most common source of BSI we have only recently begun to record central intravascular line days as a measure of patient exposure to these devices. A prospective central line associated BSI study for high risk patients has commenced. This will permit comparisons with other studies, including those from New Zealand. [11]

The predominant pathogens encountered in our hospitals are similar to those reported in other studies. In Spain BSI isolates in ICU's were CNS (24%) and S. aureus (19%). [5] In the USA the most common isolates are S. aureus (18%), CNS (12%), E. coli (11%), Pseudomonas (6%), and Candida spp. (10%). [6] The National Nosocomial Infections Surveillance system (NNIS) in the USA which studies isolates from ICU's found CNS (34%), S. aureus (13%), enterococci (13%), and Candida (6%) to be common organisms.[12] The NNIS system data also show that gram-positive organisms are the predominant, and increasing, cause of nosocomial BSI. [13] The increasing use of central venous lines has influenced the prevalence of different pathogens dramatically[7] especially the predominance of CNS intravascular line related BSI in neonates.

The BSI rate increased early in this three year observational period, but since mid-1996 has remained steady at approximately 6/1000 admissions. Auckland Hospital (~8/1000) and the HHS as a whole (~6/1000) have BSI rates higher than the Australian Council on Healthcare Standards threshold level of ~3/1000 used by Jones[4] as a baseline. The NNIS system in the USA has shown that BSI rates increase with the size of the hospital and are highest in the largest teaching institutions. [8]

Increasingly, healthcare providers are being asked to benchmark and compare rates of key events. This is a complex and difficult undertaking when comparing nosocomial infections between institutions because they are affected by a variety of factors, some of which, such as underlying health status of the population served by the hospital, are outside the hospital's control. [14] CDC emphasise the importance of surveillance data that adjust for specific infection risks in order to provide better interhospital comparison. [9] As Jones identified,[4] progress should continue with the development of strategies for national hospital infection surveillance and control. Appropriate data need to be collected before comparisons between tertiary services can be made.

Correspondence. Tanya Nicholls, Greenlane Hospital, Auckland. Fax: (09) 631 0727; Email: tanyan@ahsl.co.nz

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