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Enhanced surveillance of *Staphylococcus aureus* bacteraemia to identify targets for infection prevention

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SUMMARY

Background: Surveillance of *Staphylococcus aureus* bacteraemia (SAB) in Scotland is limited to the number of infections per 100,000 acute occupied bed-days and susceptibility to meticillin.

Aim: To demonstrate the value of enhanced SAB surveillance to identify targets for infection prevention.

Methods: Prospective cohort study of all patients identified with SAB over a five-year period in a single health board in Scotland. All patients were reviewed at the bedside by a clinical microbiologist.

Findings: In all, 556 SAB episodes were identified: 261 (46.6%) were hospital-acquired; 209 (37.9%) were healthcare-associated; 80 (14.4%) were community-acquired; and in six (1.1%) the origin of infection was not hospital-acquired, but could not be separated into healthcare-associated or community-acquired. These were classified as non-hospital-acquired. Meticillin-resistant *S. aureus* (MRSA) bacteraemia was associated with hospital-acquired and healthcare-associated infections. In addition, there was a significantly higher 30-day mortality associated with hospital-acquired (31.4%) and healthcare-associated (16.3%) infections compared to community-acquired SAB (8.7%). Vascular access devices were associated with hospital-acquired SAB and peripheral venous cannulas were the source for most of these (43.9%). Community-acquired infections were associated with intravenous drug misuse, respiratory tract infections and skeletal and joint infections. Skin and soft tissue infections were more widely seen in healthcare-associated infections.

Conclusion: The data indicate that enhanced surveillance of SAB by origin of infection and source of bacteraemia has implications for infection prevention, empirical antibiotic therapy, and health improvement interventions.

Introduction

Staphylococcus aureus bacteraemia (SAB) is a widespread and complex infectious disease. Spread of bacteria from the primary focus of infection, through the bloodstream, may

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result in serious metastatic sequelae such as infective endocarditis, prosthetic joint infection, osteomyelitis (especially vertebral), and septic arthritis. *Staphylococcus aureus* is the bacterial species associated with the highest mortality in bacteraemic infection.[1] In a large cohort study of 216,644 episodes of SAB in the UK, the overall 30-day mortality was found to be 29%.[2] Overall SAB-associated mortality varies between studies, but has been reported to be as high as 83%.[3] Bedside consultation by an infection specialist has been associated with improved quality of management and lower mortality in SAB.[4,5]

In Scotland and other parts of the UK there is mandatory reporting of *S. aureus* bacteraemia as a care quality indicator. In Scotland reporting is limited to the number of infections per 100,000 acute occupied bed-days and susceptibility of isolates to meticillin. Health Boards in Scotland have been set targets to achieve a reduction in *S. aureus* bacteraemia. In NHS Fife we had been monitoring the number of *S. aureus* bacteraemia episodes. Despite introducing measures to reduce hospital-acquired infections such as hand hygiene, MRSA screening and adopting the Scottish Patient Safety Programme, there had been no significant reduction in the number of *S. aureus* bacteraemia episodes.[6]

An enhanced surveillance protocol was written to collect extra data on each episode of *S. aureus* bacteraemia. Information on patient demographic, the origin (i.e. hospital, community, or healthcare), and source of bacteraemia was collected to understand the epidemiology of *S. aureus* bacteraemia. We hypothesized that NHS Fife had a high number of *S. aureus* bacteraemia episodes due to a large proportion of patients being admitted to hospital with their infection. In these infections, there would be limited opportunity to prevent occurrence. However, hospital-acquired SAB could be prevented, but we lacked sufficient information on the source of the infection to target resources.

The aim of this study was to understand the epidemiology of SAB in NHS Fife and to identify targets for infection prevention.

Methods

Setting

This was a prospective cohort study of patients with SAB managed in a single health region in Scotland. Fife is a mainland region of Scotland covered by a single health board. The health board covers a population of ~330,000 set in a rural environment with mixed settlements of villages and towns. One acute hospital with a single diagnostic laboratory processes all the bacterial specimens for the region. The acute hospital has ~550 beds. It is classified as a district general hospital and has all the major medical and surgical specialties except neurosurgery, cardiothoracic surgery, and transplant surgery. There is a mixed haematology/oncology ward, renal ward, and outpatient dialysis unit. Critical care provision is through a ten-bedded intensive care unit plus an eight-bedded medical high-dependency unit and an eight-bedded surgical high-dependency unit.

Data collection

Data were collected between October 1st, 2009 and September 30th, 2014. Positive blood culture reports in the diagnostic microbiology laboratory were reviewed daily for growth of *S. aureus*. A clinical microbiologist reviewed each patient at the bedside to confirm the origin of infection, source of infection, collect demographic data, and provide a management plan. The date of admission was obtained from the hospital patient administration system. The date on which the blood culture was taken was obtained from the clinical request form.

Definitions

An episode of SAB was defined in the Health Protection Scotland SAB surveillance protocol as a positive blood culture for *S. aureus* with no positive *S. aureus* blood cultures in the previous 14 days.[7] The patient was considered to have a true bacteraemia if one or more blood culture bottles flagged positive and the patient had clinical evidence of infection.

The origin of infection was categorized into four groups to indicate where the patient had acquired the SAB: hospital-acquired infection (HAI); healthcare-associated infection (HCAI); community-acquired infection (CAI); or non-hospital-acquired infection (NHAI). The definitions, as follows, were modified from Freidman *et al.*[8]

- HAI: Positive blood culture obtained from a patient who (i) had been hospitalized for ≥48 h and who had no evidence of infection prior to admission (if the patient was transferred from another hospital, the duration of inpatient stay was calculated from the date of the first hospital admission), or (ii) a patient who receives regular haemodialysis via a fistula or central venous catheter as an outpatient.
- HCAI: Positive blood culture obtained from a patient within 48 h of admission to hospital and who fulfils one of the following criteria: (i) received any form of medical care in a hospital clinic, general practice clinic or at home within the 30 days prior to the positive blood culture being taken, (ii) was hospitalized overnight in the 90 days prior to the positive blood culture being taken, (iii) resides in a nursing, long-term care facility or residential home, or (iv) patient with an indwelling medical device which is managed in the community, i.e. peritoneal catheter or tunnelled central venous catheter.
- CAI: Positive blood culture obtained from a patient within 48 h of admission to hospital who does not fulfil any of the criteria for healthcare-associated infection.
- NHAI: SAB that was not hospital-acquired but could not be placed in either the HCAI or community infection categories from either the clinical history or the medical record.

The infection that gave rise to the positive blood culture was recorded as the source of SAB. For data analysis the source of SAB was categorized into a body system or external factor. Infections of implanted medical devices were recorded under the body system in which they were placed. Medical devices that penetrated the skin into the vasculature were recorded under 'vascular access device (VAD)'. All other devices that passed through the skin or an orifice into a body cavity were recorded under 'related to medical device other than VAD', i.e. urinary catheters. 'Obstetric/congenital infection' was used to record SAB in the mother or neonate that occurred due to an obstetric infection in the mother. SAB episodes arising at a surgical site or with prosthetic material within 30 days of a

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