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The Scottish enhanced *Staphylococcus aureus* bacteraemia surveillance programme: the first 18 months of data in children

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SUMMARY

Background: National enhanced surveillance of *Staphylococcus aureus* bacteraemia (SAB) commenced on 1st October 2014 to gain a more in-depth understanding of the epidemiology of SAB in Scotland. Children under 16 years of age were analysed separately from adults because previous studies had demonstrated epidemiological differences.

Aim: To identify risk factors and patient populations at greatest risk to enable the development of focused improvement plans.

Methods: All National Health Service (NHS) boards within NHS Scotland take part in the mandatory enhanced surveillance, with data collected by trained data collectors using nationally agreed definitions.

Findings: Analysis of the first 18 months of data showed that hospital-acquired SAB was mostly associated with neonates with device risk factors, whereas community-associated SAB was found in older children who had few, if any, risk factors and most presented with a bone or joint infection.

Conclusion: The enhanced SAB data highlighted the difference in risk factors and entry points for the acquisition of SAB within the paediatric population.

Introduction

Staphylococcus aureus is a major cause of hospital-acquired, healthcare-associated and community-acquired bacteraemia. The incidence, especially for hospital-acquired *S. aureus* bacteraemia (SAB), remains high, partly due to a high number of invasive methods of treatment including vascular access devices. SAB is a major problem in adult patients, with significant morbidity and mortality [1]. Little is known about SAB in the neonatal and paediatric population, especially regarding the main entry points and deep metastatic infections. This knowledge is essential for development of focused improvement plans, both locally and nationally, to reduce the burden of SAB in this patient population.

The analysis of longer-term trends of published mandatory data in Scotland showed no significant increase or decrease in the total incidence of SAB in the last five years [2]. However,

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there was a decrease in the number of patients with meticillin-resistant *Staphylococcus aureus* (MRSA) bacteraemia and an increase in the number of patients with meticillin-sensitive *S. aureus* (MSSA) bacteraemia in Scotland. Data from other countries suggest that, in some centres, MRSA is increasing in frequency as a cause of SAB in children [3]. In a study in Illinois, USA, Mongkolrattanothai *et al.* found that MRSA is increasing as a cause of skin and soft tissue infection in the community, but MSSA remains a common cause of invasive infections [3].

Historically, more than half of the SAB episodes in adults were hospital acquired [4,5]. Mandatory surveillance data from England and Wales from the last decade of the 20th Century and the beginning of the 21st Century showed an overall increase in SAB rates, including SAB in children, with MRSA bacteraemia rates reported to be as high as 40% of the overall SAB [6,7]. This led to development of numerous initiatives aiming to reduce healthcare-associated infections, and SAB rates became a national performance indicator for hospital-acquired infection, impinging on Commission for Health Improvement scores and hospital trust finances. All National Health Service (NHS) Boards in Scotland have been set a local delivery plan to achieve, and one of these targets is reduction of the number of SAB cases. This target, previously termed 'Health Improvement, Efficiency, Access and Treatment', was established in 2006 for SAB. Mandatory enhanced surveillance for SAB was established in NHS Scotland in October 2014 as a result of collaborative work of infection prevention and control teams (IPCTs) from the Scottish health boards and Health Protection Scotland (HPS).

Previous studies on SAB in children indicated that disease severity differs between children and adult populations [8–10]. Previous studies have also noted that MRSA is increasingly identified as a cause of bloodstream infection in children [7,11–15]. In adults, SAB carries both high morbidity and mortality of up to 30% [16]. Mortality in children with SAB appears to be lower despite the presence of significant underlying diseases, but can be up to 15% [17,18].

This paper will analyse the data collected from the paediatric population in the first 18 months of enhanced SAB surveillance in Scotland to demonstrate the individual patient risk factors that should be considered to prevent SAB in neonates and children.

Methods

Data collection

Data were collected between 1st October 2014 and 31st March 2016 through the mandatory SAB surveillance programme [19–21]. An episode of SAB was defined in the HPS SAB surveillance protocol as a positive blood culture for *S. aureus* with no positive *S. aureus* blood culture in the previous 14 days, excluding postmortem blood cultures [22]. IPCT data collectors were trained using the Enhanced *S. aureus* Bacteraemia Surveillance Protocol [23], and collated information in an Excel (Microsoft Corp., Redmond, WA, USA) spreadsheet that was exported to the surveillance team at HPS at the end of each quarter.

The enhanced data collected included demographic details, origin of infection, source of bacteraemia and risk factors. The origin of infection was divided into hospital-acquired infection (HAI), healthcare-associated infection (HCAI), community-acquired infection and not known using definitions modified from Morris and Russell [23,24]. Positive blood cultures that were considered to be contaminants were excluded from this study.

The source field contained both entry point and sources of deep-seated/metastatic infection, and was mapped to provide the breakdown required for the analysis. Full details of the definitions are provided in HPS Protocol of Enhanced SAB surveillance [23]. Risk factors for invasive *S. aureus* infection were recorded. Data were collected on all devices *in situ* at the time of the first positive blood aspirate or present in the previous 30 days, but did not include devices inserted to treat the current SAB episode. Details were collected about skin integrity plus other risk factors, including previous hospital admission and immunosuppression [23]. More than one risk factor could be selected in any of the risk categories. A number of validation checks are performed by HPS every quarter to cross-check the definitions and risk factors selected.

Outcomes of interest were 30-day all-cause mortality, and 30-day and 90-day re-admission after a positive SAB result. Outcome measures were calculated through linkage of the enhanced SAB data to National Records Scotland death records and SMR01 (Scottish Morbidity Recording) acute hospital episodes. Data were linked using the Community Health Index number.

Data analysis

Chi-squared tests were used to test differences in the distributions of sex, age groups, presence of device, skin or other risk factors, and entry point between the origin types. Logistic regression was used to estimate crude and adjusted odds ratios together with 95% confidence intervals for sex, age group, origin of infection, presence of device, skin or other risk factors, and entry point using SPSS Statistics Version 21.0 (IBM Corp., Armonk, NY, USA).

Results

Between 1st October 2014 and 31st March 2016, there were 137 episodes of SAB recorded in 135 neonates and children across 18 hospitals, three of which are specialist children's hospitals. In 13 episodes, the positive blood culture was deemed to be a contaminant so these samples were excluded from the study; 124 episodes were analysed. Of these, only four were MRSA (3.2%). No difference was found between males and females ($P=0.889$), and the median age was one year.

The entry point was known in 58.9% ($N=73$) of cases, and 1.6% ($N=2$) of these had a metastatic deep focus. In 41.1% ($N=51$) of cases, the entry point was not identified but a deep focus was present in 58.8% ($N=30$) of cases. The most common known entry point recorded was vascular access device (VAD) (Table I). All device-related sources (VAD and device other than VAD) were responsible for 33.8% ($N=42$) of SAB cases in this patient population within NHS Scotland. VAD entry points included central venous catheter (CVC) (16.9%, $N=21$), peripherally inserted central catheter/midline (4.9%, $N=6$) and peripheral venous catheter (4.0%, $N=5$) (Figure 1). The most common (20.2%, $N=25$) metastatic deep focus was bone and joint infection (Table II).