Sources of healthcare-associated *Staphylococcus aureus* bacteraemia in New Zealand acute hospitals

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ABSTRACT

AIM: The primary aim of this study was to identify the source of healthcare-associated *Staphylococcus aureus* bacteraemia (HA-SAB) in acute district health board (DHB) hospitals to inform future national quality improvement activities.

METHOD: De-identified HA-SAB event source information was submitted to the Commission from all DHBs for the period 1 January 2017 to 30 June 2021. Data was categorised and analysed to identify trends and significant sources of infection.

results: There were 1,867 HA-SAB events. Of the events where *S. aureus* susceptibility results were reported, 159 (10%) isolates were methicillin-resistant *S. aureus.* The principal sources of HA-SAB were medical devices (65%), surgical site infection (10%), and organ site (8%). Ninety-five percent of medical devices were for vascular access, primarily central venous catheters (50%) and peripheral intravenous catheters (45%).

CONCLUSION: This study has identified intravascular devices as significant sources of HA-SAB. Ongoing surveillance for HA-SAB source is required to identify the major risk factors and to support quality improvement activities targeting infection prevention measures and best practice related to intravascular and other medical devices.

Staphylococcus aureus is a common human commensal of the skin and upper respiratory tract, and is an important opportunistic pathogen.[1,2] It is a major cause of both community-acquired and healthcare-associated bacteraemia worldwide. It is associated with significant morbidity and mortality.[3–5] Key sources for healthcare-associated *S. aureus* bacteraemia (HA-SAB) infections include vascular access devices, medical procedures and surgical site infections (SSI).[6,7]

In Aotearoa New Zealand, the Health Quality and Safety Commission (the Commission) infection prevention and control (IPC) programme regards HA-SAB as an important measure of infection prevention practice. The Commission currently reports HA-SAB incidence data as an outcome measure for the Hand Hygiene New Zealand (HHNZ) programme and includes the HA-SAB incidence in quarterly Quality and Safety Marker (QSM) reporting. This provides important national data about this serious and potentially preventable infection and includes both hospital- and community-onset HA-SAB.[8]

Despite improvement in hand hygiene performance, there has not been an associated significant decrease in HA-SAB rate. Instead, the HA-SAB rate has increased steadily; the median quarterly HA-SAB rate rose from 0.11 to 0.13 HA-SAB events per 1,000 bed-days in late 2016 and increased again to 0.15 events per 1,000 bed-days in 2019. This increase prompted the Commission to investigate the source of HA-SAB events nationally, to identify any trends or other information that may inform future quality improvement activity to reduce the rate of HA-SAB in District Health Board (DHB) hospitals.

Method

All 20 DHBs were asked to submit de-identified details of all HA-SAB events for the period 1 January 2017 to 30 June 2021. The definition of a HA-SAB event is as previously defined.[9]

Data was reported on a supplied Excel template or local spreadsheet. DHBs were asked to supply numbers of HA-SAB infections per month, and for each HA-SAB event, the clinical service providing clinical care, *S. aureus* susceptibility results, source and type of relevant medical device or medical/surgical procedure, if appropriate.

No standard definitions for the source data were provided, to allow DHBs to submit already collected data. For DHBs who omitted data for more than eight quarters, counts of HA-SAB infec-

tions for the omitted period were obtained from the HHNZ QSM data set.

HA-SAB sources were categorised into eight groups for analysis: medical device, neutropenic sepsis, organ site infection (not SSI), pneumonia, medical procedure, SSI, "other source" and "no source identified". The category "no source identified" included those HA-SAB events where the DHB reported the source as "unknown" or where the source category was left blank by the DHB. We interpreted the absence of data in the latter to mean that the source was not identified by the DHB team. Medical devices were further categorised by type.

The Commission collated and analysed the data. This study was approved by the Auckland Health Research Ethics Committee (Ref AH24626).

Results

DHBs provided monthly data sets for the source of HA-SAB events between 1 January 2017 and 30 June 2021 (54 months, 18 quarters). Three DHBs omitted data for more than eight quarters (292 events, 16%). In total, there were 1,867 HA-SAB events from all 20 DHBs.

The three DHBs with incomplete data sets were excluded from detailed source analysis. The remaining 17 DHBs provided HA-SAB data for 1,575 events (84% of total events).

The majority of DHBs returned their data using local data collection spreadsheets which had differences in the description of the source and amount of source detail provided. Notably, the type of surgery for which the HA-SAB infection was attributed to was often not reported, and clinical specialities were categorised differently. Consequently, these two variables were excluded from our analysis. Although descriptions varied for other data fields, the intended category was clear. Conversely, DHBs consistently provided HA-SAB source details attributed to intravascular devices.

S. aureus susceptibility

S. aureus susceptibility was available for all 1,575 of reported events from the 17 DHBs. There were 159 methicillin-resistant *S. aureus* (MRSA) HA-SAB (10%) events of which 114 (74%) were reported from Northern Region DHBs (Northland, Waitematā, Auckland and Counties Manukau DHBs). There was no significant increase in the MRSA percentage over time.

Sources of HA-SAB

Of the 17 DHBs which provided HA-SAB data, the source was recorded for 1,369 (73%) HA-SAB events (Table 1). The remaining 206 (13%) of these HA-SAB events did not have a source recorded.

Medical devices accounted for the majority of HA-SAB sources (65%) followed by SSI (10%) and organ site (8%). Other sources of HA-SAB included medical procedure (7%); neutropenic sepsis (4%); and pneumonia (2%). Variation in SSI data provided by individual DHB teams limited reporting by type of surgery or class of SSI.

HA-SAB sources were analysed as a percentage of reported HA-SAB events, where source was identified (Figure 1).

Table 1: Number of HA-SAB sources reported by DHBs, 2017–2021.

Year	Medical device	SSIa	Organ siteb	Medical procedurec	Neutropenic sepsis	Pneumonia	Other sourced	No source recorded	Total
2017	158	41	16	26	10	10	2	27	290
2018	165	45	18	20	3	10	5	26	292
2019	214	27	22	20	20	8	1	47	359
2020	235	34	33	17	10	5	0	64	398
2021e	124	23	20	16	6	5	0	42	236
All	896 (65%)	170 (12%)	109 (8%)	99 (7%)	49 (4%)	38 (2%)	8 (0.6%)	206(13%)	1,575

[a] Surgical site infection.[b] Non-surgical organ sites, e.g., liver, gastrointestinal tract, heart, skin and soft tissue, ear, nose and throat, reproductive system.[c] Includes insertion of pacing wires, interventional radiology, endoscopy, intracavity ultrasound.[d] "Other source" as reported by DHB but not specified.[e] First two quarters only reported for 2021.Source: DHB surveillance data.

Figure 1: HA-SAB sources as a percentage of total HA-SAB events by quarter, 2017–2021.

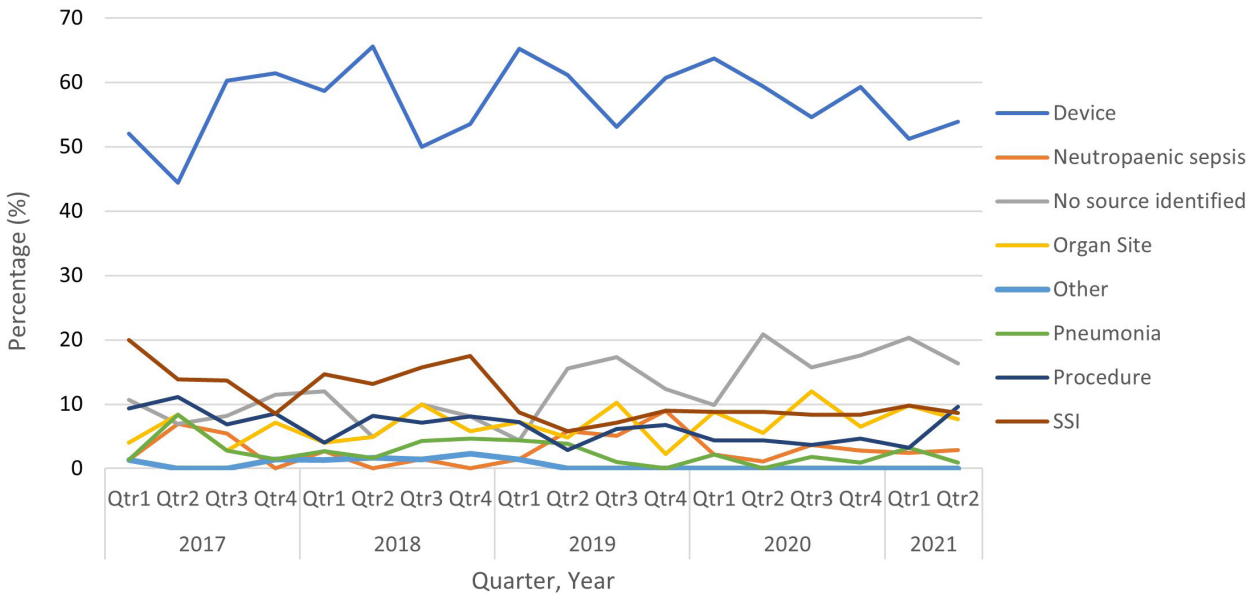
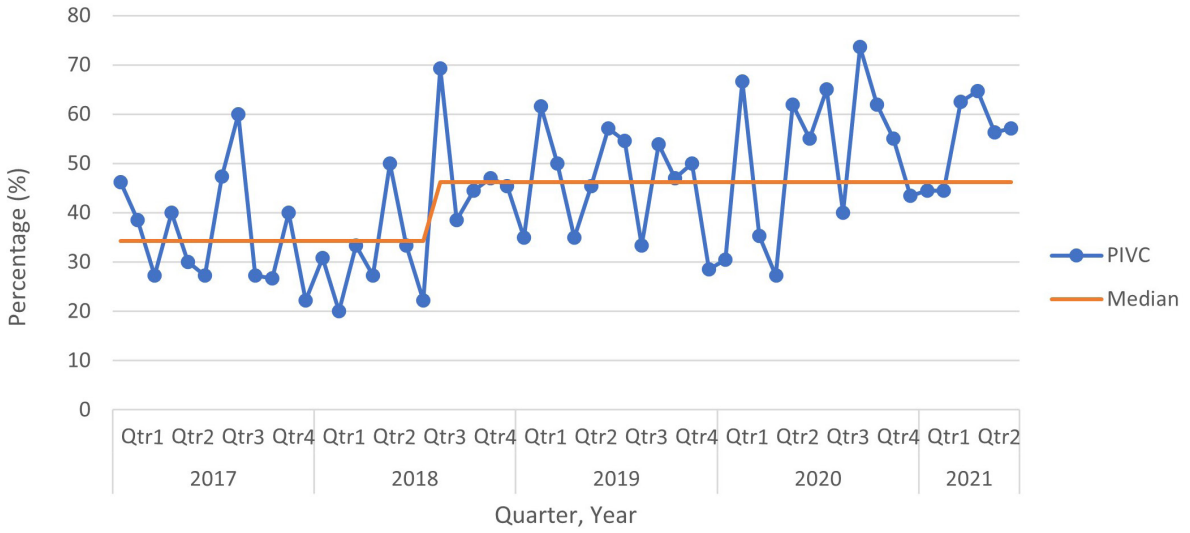


Table 2: Number of devices by type reported as HA-SAB sources by DHBs, 2017–2021.

Year	Type of device						
	CVC	PIVC	IDC	Arterial catheter	ETT	SPC	Total
2017	97	58	3				158
2018	96	65	4				165
2019	106	97	8	3			214
2020	101	121	7	2	2		233
2021	53	63	5		1	1	123
Total	453(50%)	404(45%)	27 (3%)	5 (0.6%)	3 (0.3%)	1	893

Abbreviations: CVC = central venous catheter; PIVC = peripheral intravenous catheter; IDC = in-dwelling urinary catheter; ETT = endotracheal tube; SPC = suprapubic catheter.
Source: DHB surveillance data.

Figure 2: PIVC-related HA-SAB as a percentage of total HA-SAB events by quarter, 2017–2021.



Abbreviation: PIVC = peripheral intravenous catheter.
Source: DHB surveillance data.

Medical device-related HA-SAB source

Medical devices were the most common source of HA-SAB events (Table 2).

The proportion of medical devices reported as a source of HA-SAB infection increased from 60% in 2017 to 70% in 2020 (p<0.02). Vascular access devices accounted for 95% of all medical devices, comprised of central venous catheters (CVC) for 50% and peripheral intravenous catheters (PIVC) for 45%.

Run chart analysis indicates a significant increase in HA-SAB events between 2017 to mid-2021 (34% to 46%, p<0.01) where a PIVC was identified as the source (Figure 2).

Discussion

This national descriptive study of the source for HA-SAB events has identified medical devices as the major contributor, accounting for 65% of all events. In general, international HA-SAB surveillance programmes do not report HA-SAB source data; however, our percentages of medical device-related HA-SAB is high compared to Scotland's at 23.1%.[10]

The source for 65% of all HA-SAB events was a medical device, of which 95% were vascular access devices. In New Zealand and Australia, vascular access devices have previously been identified as an important source of SAB. A one-year prospective observational study in 2009 reported 1994 SAB events from 27 independent or hospital pathology laboratories in Australia (24) and New Zealand (3), with 60.8% having onset in the community. 34% were due to medical devices with vascular access devices, accounting for 96% of the medical devices.[11]

A recent review of HA-SAB events across participating healthcare facilities in Victoria, Australia, identified CVCs as the source for 28% of all cases and 40% in a cohort of cancer patients. The proportion of intravascular device-related HA-SAB events was approximately twofold higher in the cancer cohort than the state-wide comparator.[12]

Fifty percent of all HA-SAB events in this study were associated with a CVC. CVCs are widely recognised as a significant source of bloodstream infection.[13,14] Quality improvement programmes and infection prevention interventions incorporating CVC bundles of care have been used successfully in high-risk settings to reduce CVC-related infections.[13–16] Similarly the Commission's Target CLAB Zero programme has been successful in reducing central line blood stream infections (CLABSI) in ICU.[17] However, in this present study, many of the CLABSI events reported by DHBs appeared to have occurred in patients outside of the ICU setting (results not reported), such as renal dialysis, haematology and oncology patients. CLABSI are an important source of morbidity and mortality in vulnerable populations, and are associated with high hospital costs.[18,19] Targeted surveillance for CLABSI in high-risk populations would be useful to monitor adherence to infection

prevention strategies but can be challenging due to the difficulty in capturing catheter days to support reporting as a rate per catheter days.

There was a significant increase in the number of HA-SAB events associated with PIVC use over the time period; 34% to 46%, ($p<0.01$). Although prevention of CLABSI events has received attention with the introduction of bundles of care, PIVC infection rates are less well documented.[20] A systematic review of blood stream infections associated with PIVCs in the hospital setting revealed that PIVCs account for a mean of 38% (range 12%–64%) of intravascular device related HA-SAB.[21] A prospective observational study in Spain reported an increase in PIVC bacteraemia from 0.06 episodes/1,000 patient days in 1992 to 0.13 episodes/1,000 patient days in 2016.[22]

Recognising phlebitis as an indicator of localised PIVC infection is an important first step in reducing HA-SAB events. An international point prevalence study involving more than 40,000 patients with a PIVC revealed that one in 10 had symptoms of phlebitis.[23] A device point prevalence survey at Auckland DHB in 2018 reviewed 564 adult patients and 49.8% had one or more vascular access devices in situ. Five (1.7%) patients had evidence of phlebitis (personal communication, S. Muttaiyah). Canterbury DHB undertook a point prevalence survey for PIVC complications in 2019 and found that of the 212 patients with a PIVC in situ, 13% (n=27) had signs of phlebitis.[24]

Intervention programmes to reduce PIVC complications commonly use an insertion and maintenance care bundle which includes a PIVC assessment and decision-making tool to facilitate early identification of complications and the timely removal of the catheter.[20,25] In New Zealand, several DHB and private surgical hospitals are in the process of implementing an ACC-funded hospital-based programme called "Know Your IV Lines", which incorporates a care bundle to reduce PIVC complications.[26] Other DHBs use alternative PIVC monitoring tools.[24] The sustainability of these programmes is challenging and non-compliance with the bundles of care has been reported.[24,27]

The surveillance data collected by DHBs for HA-SAB source varies and was not standardised. Notably the source of HA-SAB was not known for 206 (13%) of events during the report period. The Scottish Antimicrobial Resistance and Healthcare-associated Infection (ARHAI) programme failed to identify a point of entry for 22.1% of all HA-SAB reported events.[10] A review of all HA-SAB events in 2019 at Auckland DHB found 15% had no identified source, however, upon further review of the medical records a source was identified for 60% of those events; the majority were due to vascular access devices.[28] In a study that examined the mortality of blood stream infections (BSI) acquired within the ICU, the rate of BSI of unknown source was 33.5% and was associated with a higher risk of death.[29]

A limitation of this study was that complete source data was not provided by all 20 DHBs. The three DHB who provided incomplete data were excluded from the source data analysis, however, the source data were incomplete for 206 (13%) patients from the other 17 DHB. Overall, source data were not known for 498 (27%) of all HA-SAB events; 292 events from three DHBs who provided no source data and 206 events from the remaining 17 DHBs. This may have skewed the data. However, the sample size—1,369—was large and while there was some variation in absolute number per source category over time, HA-SAB events related to medical devices were the most common source. The review at Auckland DHB identified that vascular access devices were the source for 60% of events where the source was not initially identified,[27] so it is unlikely that the absence of this data would have impacted on the overall finding.

To improve the quality of the data, the Commission has developed a standardised data collection tool for HA-SAB, using dropdown lists for source data fields. The tool will facilitate the reporting of HA-SAB data by the DHBs. Standardising the categorisation and details of HA-SAB source data will support the use of performance measures for national quality improvement programmes aimed at reducing these events.

Conclusion

HA-SAB events related to medical devices are not a new issue. Accurate and standardised surveillance is required to identify the major risk factors and to support quality improvement activities targeting infection prevention measures and best practice related to intravascular and other medical devices. There needs to be a concerted effort to reduce these largely preventable events; they can no longer be considered an acceptable consequence of healthcare.

COMPETING INTERESTS
Nil.

ACKNOWLEDGEMENTS
We would like to thank the DHBs and, in particular, those individuals who found time to provide the data requested for this investigation.
Ethical Approval reference: AH24626.

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