Health Protection Scotland

NHS National Services Scotland

Surveillance of Healthcare Associated Infections in Scottish Intensive Care Units

Annual report of data from January - December 2013

August 2014

Scottish Intensive Care Society Audit Group

Health Protection Scotland is a division of NHS National Services Scotland.

Health Protection Scotland website: http://www.hps.scot.nhs.uk

Citation for this document:
Health Protection Scotland. Surveillance of Healthcare Associated Infections in Scottish Intensive Care Units. Annual report of data from January - December 2013. Health Protection Scotland 2014 [Report]

Published by Health Protection Scotland, Meridian Court, 5 Cadogan Street, Glasgow G2 6QE
First published August 2014

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ACKNOWLEDGEMENT

Scottish Critical Care and surveillance staff throughout NHS boards are commended for their efforts in collecting the surveillance data.

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GLOSSARY

APACHE II	Acute Physiology and Chronic Health Evaluation II
BSI	Bloodstream Infection
CDC	Centers for Disease Control and Prevention
CI	Confidence Intervals
CR-BSI	Central Venous Catheter-Related Bloodstream Infection
CRI	Central Venous Catheter-Related Infection
CRI-1	Central Venous Catheter-Related Infection- Local
CRI-2	Central Venous Catheter-Related Infection- General
CVC	Central Venous Catheter
ECDC	European Centre for Disease Prevention and Control
HAI	Healthcare Associated Infection
HDU	High Dependency Unit
HELICS	Hospitals in Europe Link for Infection Control through Surveillance
HPS	Health Protection Scotland
ICU	Intensive Care Unit
IQR	Interquartile Range
LRT	Lower Respiratory Tract
LOS	Length of Stay
MRSA	Meticillin Resistant *Staphylococcus aureus*
MSSA	Meticillin Sensitive *Staphylococcus aureus*
PN	Pneumonia
SD	Standard Deviation
SICSAG	Scottish Intensive Care Society Audit Group
SPSP	Scottish Patient Safety Programme
VAP	Ventilator-Associated Pneumonia
VAE	Ventilator-Associated Events

SUMMARY REPORT

- This is the fourth annual report from the Surveillance of Healthcare Associated Infection (HAI) in Scottish Intensive Care Units (ICUs) Programme.
- Surveillance data related to pneumonia, bloodstream infections and central venous catheter (CVC) related infections were collected in accordance with the European Centre for Disease Control and Prevention (ECDC) methodology.
- Data from 6775 patients admitted to 23 Scottish ICUs between January and December 2013 were collected and 224 infections were reported from 3.0% (206) patients.
- Bloodstream infections accounted for 41.1% of all infections reported, pneumonia for 50% and 8.9% were local and general CVC-related infections.
- Of the 112 pneumonia reported, 71.4% were ventilator-associated pneumonia (VAP) and the incidence density of VAP was 2.5 per 1000 invasive respiratory device days. The most frequently isolated micro-organisms from pneumonia were *Staphylococcus aureus* (20.4%), *Escherichia coli* (12.6%) and *Pseudomonas* spp. (12.6%).
- A total of 92 BSI were reported from 88 (1.3%) patients. The incidence of BSI was 1.7 per 1000 patients days and the most frequently isolated organisms were *S. aureus* (16.9%), *Entercoccus* spp. (15.7%) and coagulase negative staphylococci (14.5%).
- Scottish data from 2010 and 2011 compared with data from Europe for the same time period suggest that pneumonia rates were low. Scottish BSI rates appear broadly similar to those published from the aggregated European dataset.
- Incidence rates in Scotland in 2013 were similar to those reported from 2012, this may represent a plateau in HAI in the intensive care setting, as has been seen in other HAI surveillance programmes since 2012.
- Future work will focus on supporting units to collect and utilise their data more effectively for improvement and to identify possible data linkage opportunities to access micro-organism and antimicrobial resistance data, in order to further utilise the epidemiology for action.

1. INTRODUCTION

1.1 Surveillance of Healthcare Associated Infection in Scottish Intensive Care Units

Patients admitted to intensive care are severely ill and often have chronic underlying illnesses that may in some cases result in immunosuppression or immunodeficiency. Patients in intensive care are subject to invasive procedures as part of their routine care and are therefore vulnerable to infection. The most recent Scottish Point Prevalence Survey reported that a quarter of patients in intensive care had a healthcare associated infection (HAI) at the time of survey.[1] The recently published European Point Prevalence survey of HAI and antimicrobial use for 2010 and 2011 indicates that intensive care units (ICU) remain the specialty in hospitals with the highest HAI prevalence and an at risk group of patients.[2] Therefore, it is important that we continue to work towards reducing HAI and improving outcomes for this patient group.

This is the fourth annual report from the 'Healthcare Associated Infection in Scottish Intensive Care Units surveillance programme' and it is produced collaboratively by the Scottish Intensive Care Society Audit Group (SICSAG) and Health Protection Scotland (HPS). The Scottish Intensive Care Society Audit Group support surveillance and reduction of HAI with a number of quality improvement activities, including a set of Quality Indicators for Critical Care in Scotland that were implemented in 2012.[3] Within this set of quality indicators, two indicators relate to HAI; intensive care and high dependency units are required to have an HAI surveillance system in place and to report on a monthly basis to staff and to the Scottish Patient Safety Programme (SPSP). Units are also required to submit data to SPSP on the delivery of the ventilator associated pneumonia (VAP) prevention bundle and the central venous catheter (CVC) insertion and maintenance bundle.

The surveillance programme includes monitoring of HAI and data relating to pneumonia (including VAP), bloodstream infections (BSI) and CVC related infections are collected.

1.2 Aims and Objectives of HAI surveillance in Scottish ICUs

- To monitor the incidence of HAI in ICU and contribute to a national database of HAI surveillance data for the ICU setting in Scotland. This will allow the epidemiology to be described and the impact of interventions to improve patient safety to be evaluated.
- To provide standardised surveillance definitions and methods to Scottish ICUs in order that data can be benchmarked with Europe.
- To support local feedback of surveillance data for improvement and reduction of HAI.

2. DATA COLLECTION

2.1 Data collection

Demographic, invasive device exposure (CVC and invasive respiratory device use) and HAI data were collected in accordance with the methods and data definitions set out in the European Centre for Disease Prevention and Control (ECDC) HAIICU protocol for the surveillance of HAI in ICUs.[4] This protocol is based on the surveillance protocol developed by the HELICS (Hospitals in Europe Link for Infection Control through Surveillance) network.[5] The HELICS-ICU surveillance protocol was developed by national experts in the surveillance of ICU-acquired infections in collaboration with several members of the Infection Section of the European Society of Intensive Care Medicine. Since only minor changes were applied to the protocol by the national HAI-Net surveillance contact points before its integration in The European Surveillance System, data collected using the HELICS-ICU protocol are fully compatible with the ECDC HAIICU protocol. It should be noted that in Scotland, data collection still permits the reporting of infections that meet the criteria for the 'BSI-B definition', which has been removed from the ECDC protocol. The number of BSI-B reported are however extremely small. This will also be removed from Scottish data collection in 2014.

There are two versions of the ECDC HAIICU protocol (i) Patient-based (or 'standard') protocol: patient-level data are collected for each patient whether there is an infection or not. The data includes risk factors that could allow for risk-adjusted, inter-hospital comparisons and (ii) Unit-based (or 'light') protocol: selected patient-level data are only collected for infected patients. Denominator data (patient-days) are collected each day for the entire ICU. In Scotland, patient based data are collected by all participating units.

All surveillance data were collected either via WardWatcher or HELICSwin data collection software. Data were collected by a wide range of clinical staff and the methods for data collection varied between units and in one unit a dedicated data collector was employed.

2.2 Patient population

Data were collected from adult patients (aged 16 years or over) admitted to participating ICUs between 01/01/2013 and 31/12/2013, with a stay of more than two days in the ICU.[4]

2.3 Infections included in the surveillance programme

Data relating to central venous catheter-related infection (CRI) which includes local CRI (CRI-1), general CRI (CRI-2) and central venous catheter-related bloodstream infection (CR-BSI), pneumonia (PN) and BSI were collected. All infections reported were identified in accordance with the ECDC surveillance methodology.[4]

2.4 Antimicrobial resistance data

Antimicrobial resistance data were collected for:
Staphylococcus aureus isolates as determined by the organism/antibiotic resistance combinations detailed in the HELICS protocol.[5]

2.5 Exclusion criteria and data cleansing

The process followed for exclusion and data cleansing was as follows:

(i) Records with essential data missing, such as discharge dates were removed.

(ii) Duplicate records were identified and removed.

(iii) Duplicate infections were excluded. Criteria for determining possible duplicates were based on infection episodes defined by a minimum of a four day interval between PN episodes and a seven day interval for BSI and CRI.[6]

(iv) Any patients not discharged at the time of data transfer were arbitrarily discharged (censored) on the last day for which the daily device data had been collected for the patient.

2.6 Data analysis methods

Data analyses were carried out using STATA version.[9] The Wilson method was used to calculate 95% confidence intervals (CI)[7] and the Byar method was used to calculate CI for rates.[8]

3. RESULTS

3.1 Participating ICUs

A total of 23 adult ICUs in Scotland contributed HAI surveillance data for the period 1 January to 31 December 2013. Of the units that contributed data, 15 (65.2%) were solely ICUs, seven (30.4%) were combined ICU/High Dependency Units (HDU) and one (4.3%) was a neurological ICU. The size of the contributing units ranged from three to 18 beds. For the purpose of this report all units including the combined ICU/HDUs will be referred to as ICUs.

3.2 Patient population

Data from 6775 patients (aged 16 years or over) admitted to the participating ICUs between 1 January and 31 December 2013 with a stay of more than two days in the ICU were included in the data analysis.

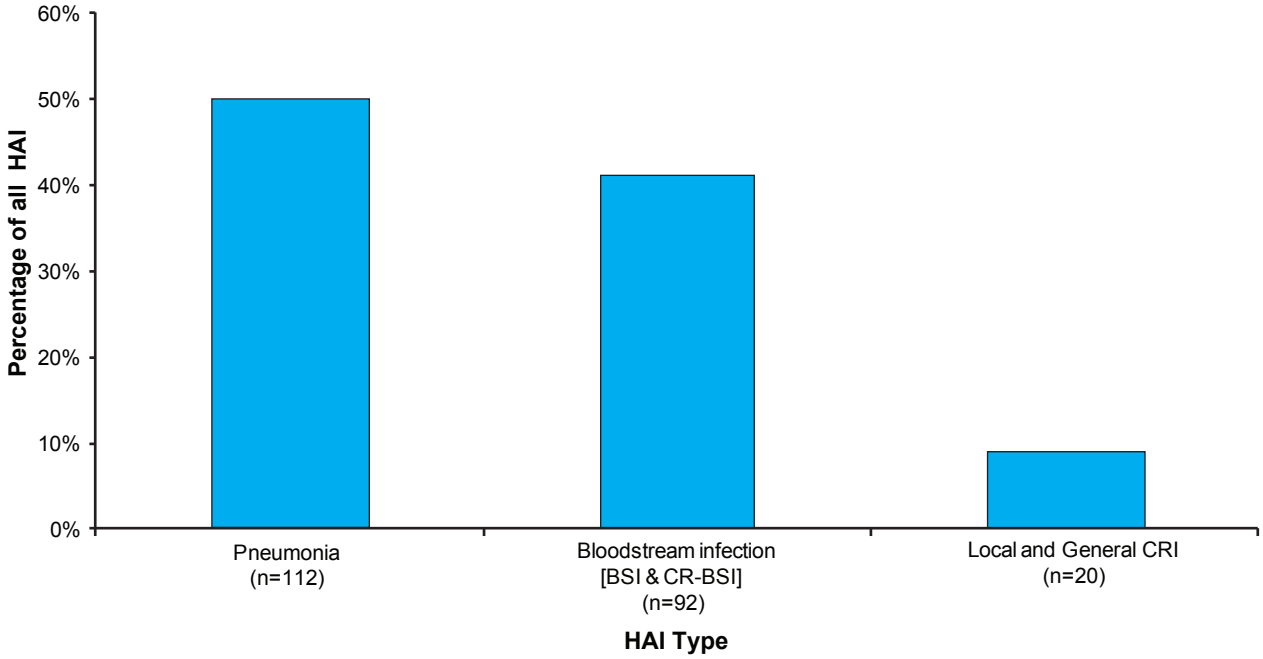
A total of 3.5% of admissions had no HAI surveillance data collected via the WardWatcher system. Data from these admissions contribute to the denominator and these admissions are included in the non-infected group for analysis, however the infection status of this group cannot be accurately defined.

Of the 6775 admissions, 3803 (56.1%) were male and 2971 (43.9%) were female, the gender of one patient was not recorded. The median length of stay (LOS) was five days (interquartile range [IQR] 3, 9), the mean Acute Physiology and Chronic Health Evaluation II (APACHE II)[9] score performed within the first 24 hours of the patient stay was 18.6 (standard deviation [SD], 7.6) and the median age was 62 (IQR: 49, 72). Central venous catheters (CVCs) were present for 61.8% of patient days and invasive respiratory devices were present for 60.4% of patient days.

3.3 HAI epidemiology

In total, 224 HAIs (PN, CRI and BSI) were reported from 206 (3.0%, 95% CI: 2.7-3.5) patients and met the criteria for inclusion in the analysis (four duplicate infections were removed from the database). Of the 224 HAI, 112 (50.0%) were PN, 92 (41.1%) were BSI (including CR-BSI) and 20 (8.9%) were CRI-1 and CRI-2. Figure 1 shows the percentage of each HAI type reported.

FIGURE 1: Percentage of each HAI type (n=224)



3.4 Patient Characteristics

Table 1 shows patient characteristics for admissions to ICU for more than two days.

TABLE 1: Characteristics of patients admitted to ICU

Patient Characteristic		Number	Percentage
Gender	Male	3803	56.1
	Female	2971	43.9
	Not recorded	1	0.0
Patient Origin (Another area of the hospital)	Ward in hospital	4832	71.3
	Other ICU	271	4.0
	Community	1669	24.5
	Long-term care	3	0.0
	Not recorded	0	0.0
Admission Type	Medical	3536	57.4
	Surgical	2629	42.6
	Not recorded	610	9.0
Trauma Admission	No	5332	78.7
	Yes	456	6.7
	Not recorded	987	14.6
Antimicrobials in the 48 hours prior to and/or after admission to ICU	No	1612	23.8
	Yes	4940	72.9
	Not recorded	223	3.3

Comparison of age, APACHE II[9] score (performed within the first 24 hours of the patient stay) and LOS for patients with an HAI and patients without an HAI are shown in Tables 2A and 2B. The median age of patients with an HAI was 60 years and for patients without an HAI, it was 62 years. The median LOS for patients with an HAI (19 days) and patients without an HAI

(five days) was significantly different (p< 0.0001, Mann Whitney U test). The mean APACHE II[9] score for patients with and without an HAI was 20.1 and 18.6 and respectively (20.1 versus 18.6, Student T-test [p=0.006]).

TABLE 2A: Comparison of age and length of stay for patients with HAI (n=206) and without HAI (n=6569)

Variable	No HAI Median	No HAI IQR	HAI Median	HAI IQR	P value (Mann Whitney U test)
Length of stay (days)	5	3,8	19	11.75, 28	p<0.0001
Age (years)	62	49, 72	60	44, 71	p=0.06

TABLE 2B: Comparison of APACHE II[9] score for patients with HAI (n=206) and without HAI (n=6569)

	No HAI Mean	No HAI 95% CI	HAI Mean	HAI 95% CI	P value (Student T-test)
APACHE II[7]	18.6	18.4 - 18.8	20.1	19.1 - 20.1	P=0.006

3.5 Pneumonia

A total of 112 pneumonia infections were reported from 110 (1.6%, 95% C.I: 1.3-2.0) patients. Of these, 80 (71.4%) infections were considered to be ventilator-associated pneumonia (VAP)[§]. Twenty six (23.2%) of the remaining infections were not considered to be VAP and six were unable to be classified due to missing data. Incidence density rates for pneumonia are shown in Table 3.

TABLE 3: Incidence density for pneumonia

Invasive respiratory device present[‡]	Number of Pneumonia	Incidence Rate (95% CI)
Yes (VAP)[§]	80	2.5 per 1000 invasive respiratory device days[¶] (2.0 - 3.1)
No (non-VAP)	26	0.5 per 1000 patient days (0.3 - 0.7)
Not classified	6	-
All	112	2.1 per 1000 patient days (1.7 - 2.5)

§ Infections were considered to be VAP if the patient had an invasive respiratory device present in the 48 hours preceding the onset of infection.

‡ Invasive respiratory device present in the 48 hours preceding the onset of infection.

¶ VAP incidence- Total number of VAP as a proportion of the sum of the invasive respiratory device days (days that a patient required intubation) contributed by each patient in the study population. The proportion is expressed as the number VAP per 1000 invasive respiratory device days.

3.5.1 Diagnostic categories of pneumonia

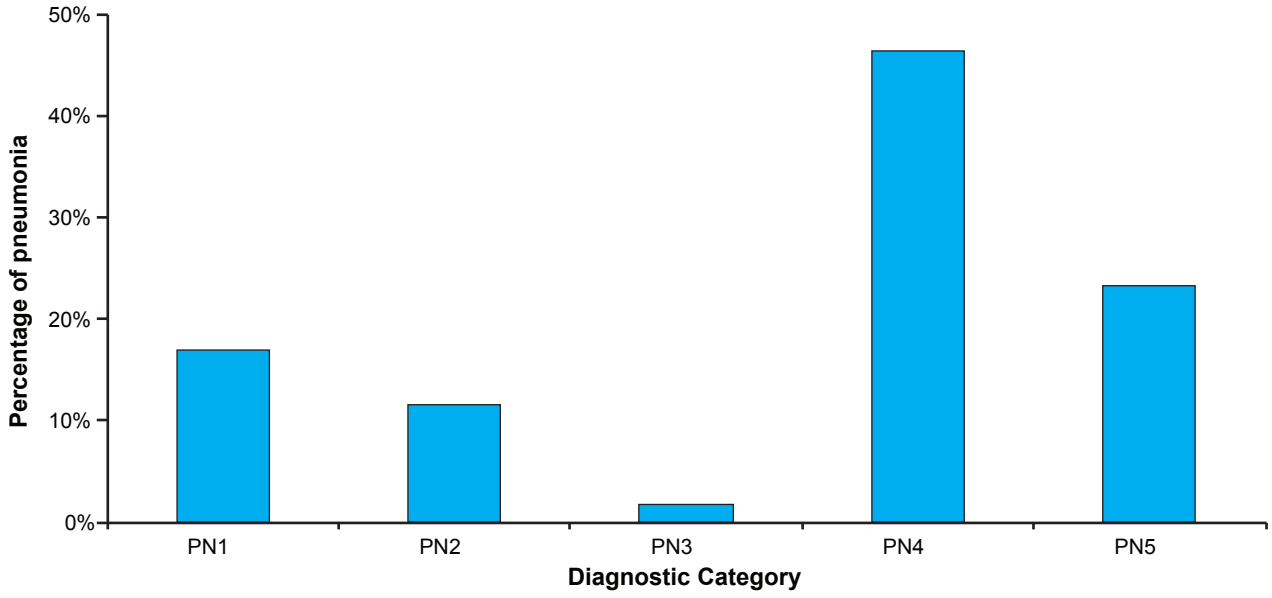
Pneumonia is categorised (for surveillance purposes) according to the microbiology methods (and clinical signs) used to identify the infection,[4] details are given in Table 4. Microbiology methods used across Scotland are not standardised and therefore there is variation across units within Scotland.

TABLE 4: Diagnostic categories and microbiology method for pneumonia

Diagnosis category	Microbiology Method
PN1	Positive quantitative culture from minimally contaminated lower respiratory tract (LRT) specimen e.g. broncho-alveolar lavage.
PN2	Positive quantitative culture from possibly contaminated LRT specimen e.g. endotracheal aspirate.
PN3	Alternative microbiology methods
PN4	Positive sputum culture or non-quantitative LRT specimen culture
PN5	No positive microbiology (Clinical diagnosis only)
UC	Unclassified- This category covers discrepant data where the pneumonia was reported as PN5 however a microbiology result was recorded for that patient.

The distribution of pneumonia reported by diagnostic category is shown in Figure 2.

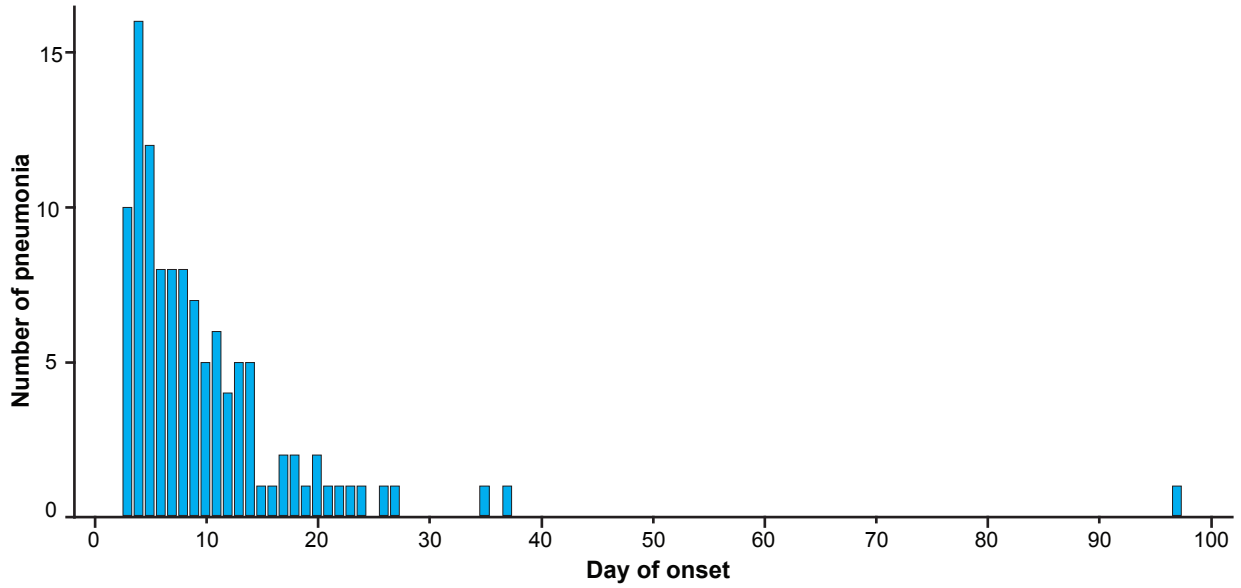
FIGURE 2: The distribution of diagnostic categories of all pneumonia reported



3.5.2 Day of onset of pneumonia

The median day of onset of pneumonia was eight days (IQR, 5, 12.5), the distribution of the day of onset of all pneumonia (from day three of ICU stay onwards) is shown in Figure 3. The median day of onset of VAP was eight days (IQR, 4.5, 13.5).

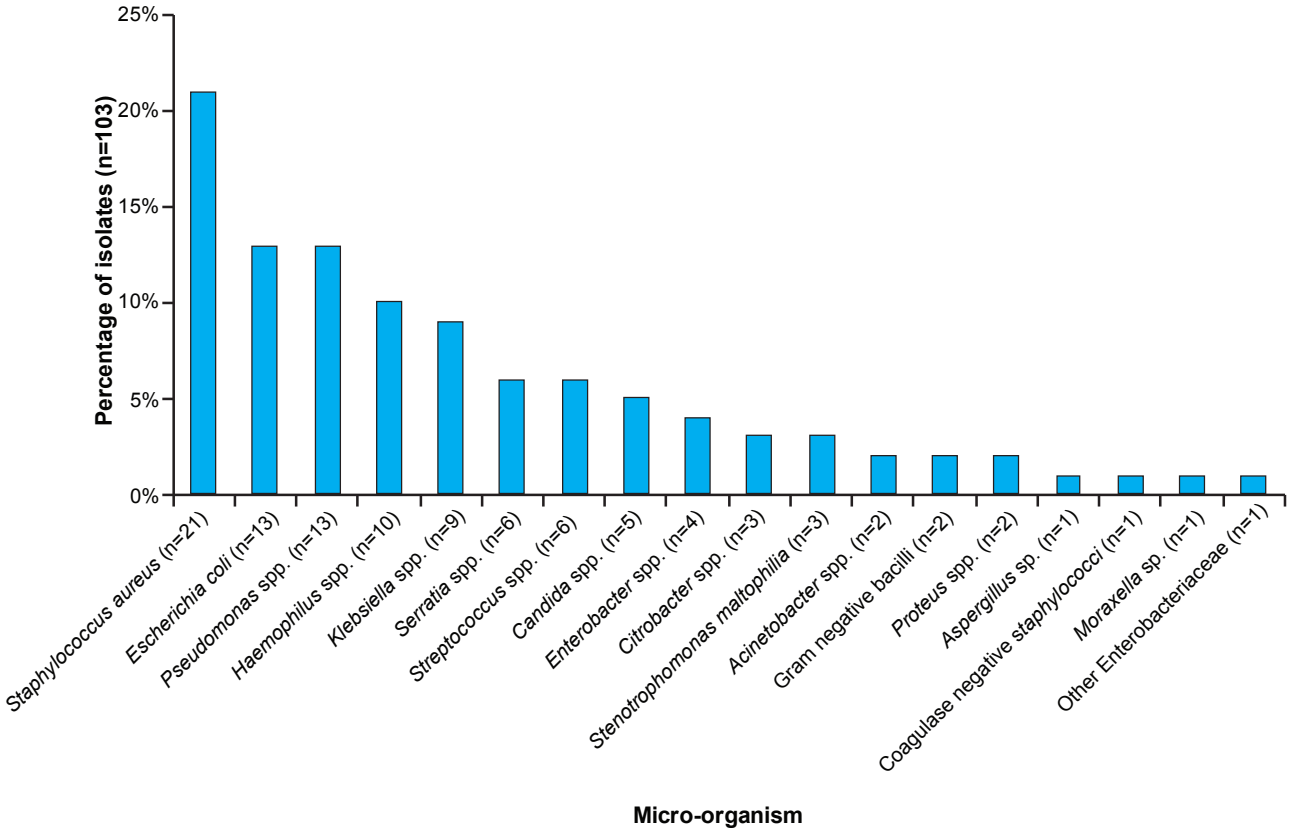
FIGURE 3: Number of pneumonia by the day of onset



3.5.3 Distribution of micro-organisms isolated from pneumonia

A total of 103 micro-organisms were identified from patients with pneumonia. Figure 4 shows the distribution of micro-organisms isolated from pneumonia. The three most frequently isolated micro-organisms were *Staphylococcus aureus* (20.4%), *E. coli* (12.6%) and *Pseudomonas* spp. (12.6%). Of the 21 *S. aureus* isolated, antimicrobial resistance data were available for 16 isolates and two (12.5%) were MRSA.

FIGURE 4: The distribution of micro-organisms from pneumonia



3.5.4 Key Summary Points

- 1.6% of patients developed pneumonia and of these, 71.4% were VAP.
- *S. aureus* (20.4%), *E. coli* (12.6%) and *Pseudomonas* spp. (12.6%) were the organisms most frequently isolated from pneumonia, accounting for 45.6% of all micro-organisms isolated.

3.6 Bloodstream Infections

A total of 92 BSI were reported from 88 (1.3%, 95% C.I: 1.1-1.6) patients and the median day of onset was day 9 (IQR: 6, 14). The incidence of all BSI was 1.7 per 1000 patient days (95% CI: 1.4-2.1). Eleven (12.0%) of the BSI reported were CR-BSI and the incidence density of CR-BSI was 0.3 per 1000 central venous catheter (CVC) days (95% CI: 0.2-0.6). The incidence density of BSI (not including CR-BSI) was 1.5 per 1000 patient days, (95% CI: 1.2-1.9). A summary of BSI incidence rates is shown in Table 5.

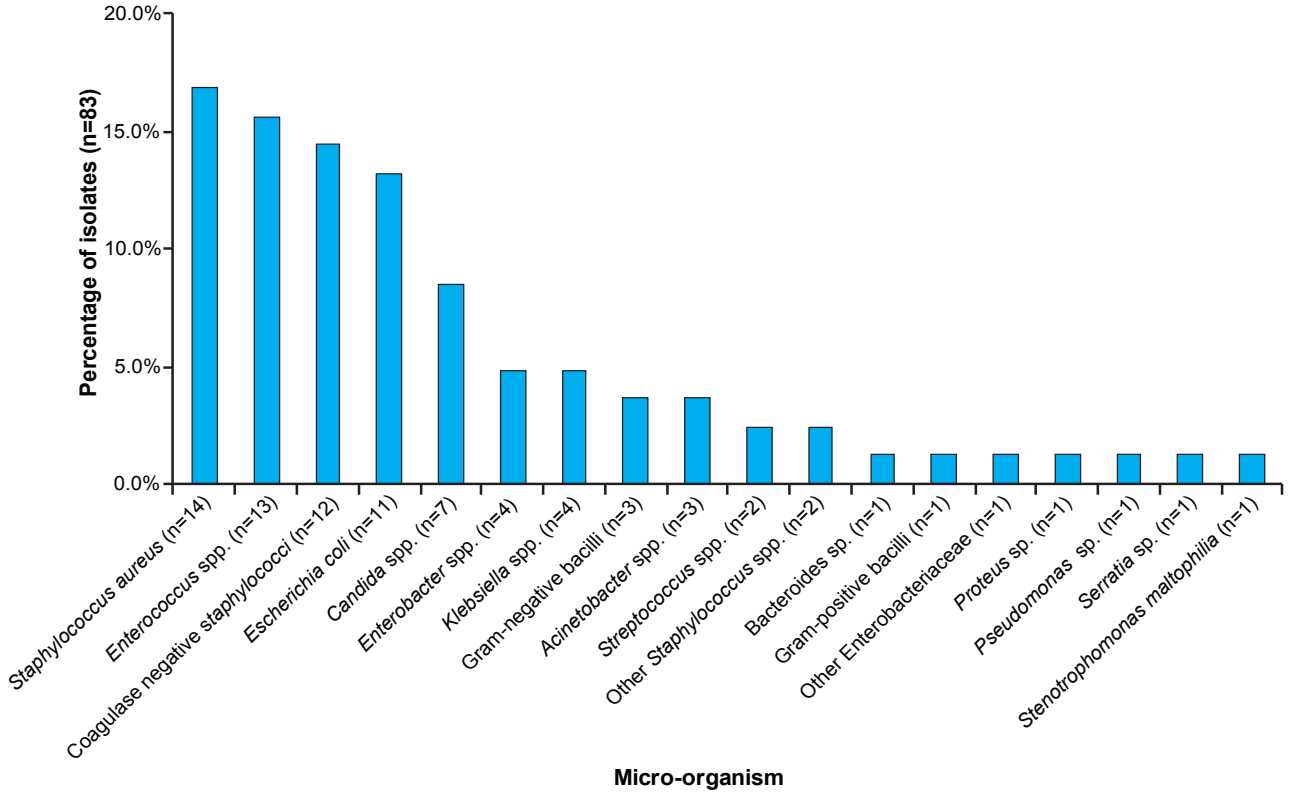
TABLE 5: Summary of BSI incidence rates

Infection type	Number of infections	Incidence rate (95% CI)
BSI (not CRI)	81	1.5 per 1000 patient days (1.2 - 1.9)
CR-BSI	11	0.3 per 1000 CVC days (0.2 - 0.6)
BSI (All)	92	1.7 per 1000 patient days (1.4 - 2.1)

3.6.1 Distribution of micro-organisms isolated from BSI

The distribution of micro-organisms isolated from all BSI (CR-BSI and non CR-BSI) is shown in Figure 5. A total of 83 organisms were reported from 79 (85.9%) infections. A total of 14 *S. aureus* were isolated and one of these isolates (7.1%) was MRSA.

FIGURE 5: The distribution of micro-organisms isolated from bloodstream infections



3.6.2 Presence of a CVC in patients with BSI not defined as CR-BSI

Of the 81 BSI that did not meet the criteria for CR-BSI, 68 (83.9%) were reported to have had a CVC *in situ* on the day of onset or in the 48 hours prior to the date of onset, however microbiological tip culture criteria were not reported.

Summarised in Table 6 are the BSI data relative to those confirmed/reported as CR-BSI, those where a CVC was *in situ* around the time of onset and classified as 'Probable CR-BSI' and where there was no evidence of CVC use around the time of onset. When the 'Probable' and Confirmed CR-BSI data were combined, the 'Probable and Confirmed BSI' incidence rate was 2.4 per 1000 CVC days (95% CI: 1.9-3.0).

TABLE 6: Summary of CVC use in patients with BSI

Infection	Number of Infections	Incidence rate (95% C.I.)
BSI with no evidence CVC	13	0.2 per 1000 patient days (0.1 - 0.4)
BSI with evidence of CVC	68	2.1 per 1000 CVC days (1.6 - 2.6)
CR-BSI (confirmed CR-BSI)	11	0.3 per 1000 CVC days (0.2 - 0.6)
'Probable and confirmed CR-BSI'	79	2.4 per 1000 CVC days (1.9 - 3.0)

3.6.3 Key Summary Points- BSI

- 1.3% of patients developed a BSI and the incidence density for all BSI was 1.7 per 1000 patient days.
- The incidence density of BSI (excluding CR-BSI) was 1.5 BSI per 1000 patient days.
- The incidence density of CR-BSI was 0.3 per 1000 CVC days.
- Of the 81 BSIs reported, a CVC was *in situ* or removed in the 48 hours prior to onset of BSI in 83.9% of cases. The incidence density of 'Probable and Confirmed' CR-BSI was 2.4 per 1000 CVC days.
- The most frequently isolated micro-organisms from BSI were *S. aureus* (16.9%), *Enterococcus* spp (15.7%), coagulase negative staphylococci (14.5%) and *E. coli* (13.3%), accounting for 60% of all isolates.

3.7 CVC related infection (not including CR-BSI)

In total six CRI-1 (local infection) and 14 CRI-2 (general infection) were reported. The incidence density of CRI-1 and CRI-2 was 0.2 per 1000 CVC days (95% CI: 0.4 - 0.9).

Table 7 shows the distribution of micro-organisms isolated from CRI-1 and CRI-2.

TABLE 7: The distribution of micro-organisms isolated from CVC-related infection

Micro-organism	Number
Coagulase negative staphylococci	8
Klebsiella spp.	2
Candida sp.	1
Pseudomonas sp.	1
Gram negative cocci	2
Enterococcus sp.	1
Staphylococcus sp.	1
Streptococcus sp.	1
Total	**17**

3.7.1 Key Summary Points- CRI (not including CR-BSI)

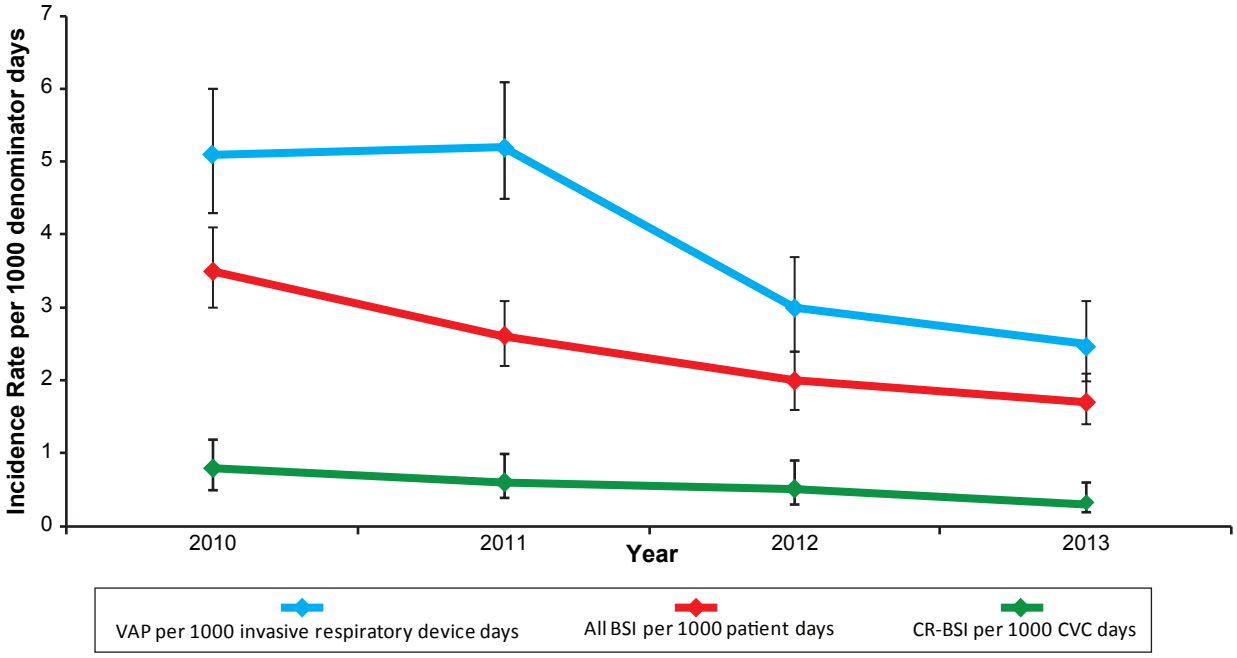
- The incidence density of CRI (CR-1 and CR-2) was 0.2 per 1000 CVC days.

3.8 Year on Year Comparison of Incidence Rates

HAI data collected in 2013 showed that 3.0% (95% C.I:2.7-3.5) of patients admitted to ICU with a stay of more than two days developed one or more HAI. In 2012, 3.4% of patients developed HAI and there has been no significant reduction or increase in the proportion of patients who developed an HAI (Ratio of Rates, p=0.3). Incidence rates for VAP, BSI and CR-BSI for 2010 to 2013 are shown in Figure 6.

Analysis showed that there was no significant difference in the incidence rates between 2012 and 2013 (Ratio of Rates, p>0.05).

FIGURE 6: Incidence rates of BSI, VAP and CR-BSI for 2010 to 2013



3.8.1 Year on year comparison of micro-organisms isolated from HAI

The distribution of the top ten organisms isolated from BSI and pneumonia in 2013 and 2012 are shown in figures 7 and 8.

FIGURE 7: The distribution of the top ten micro-organisms isolated from pneumonia in 2013 and the corresponding distribution of these organisms in 2012

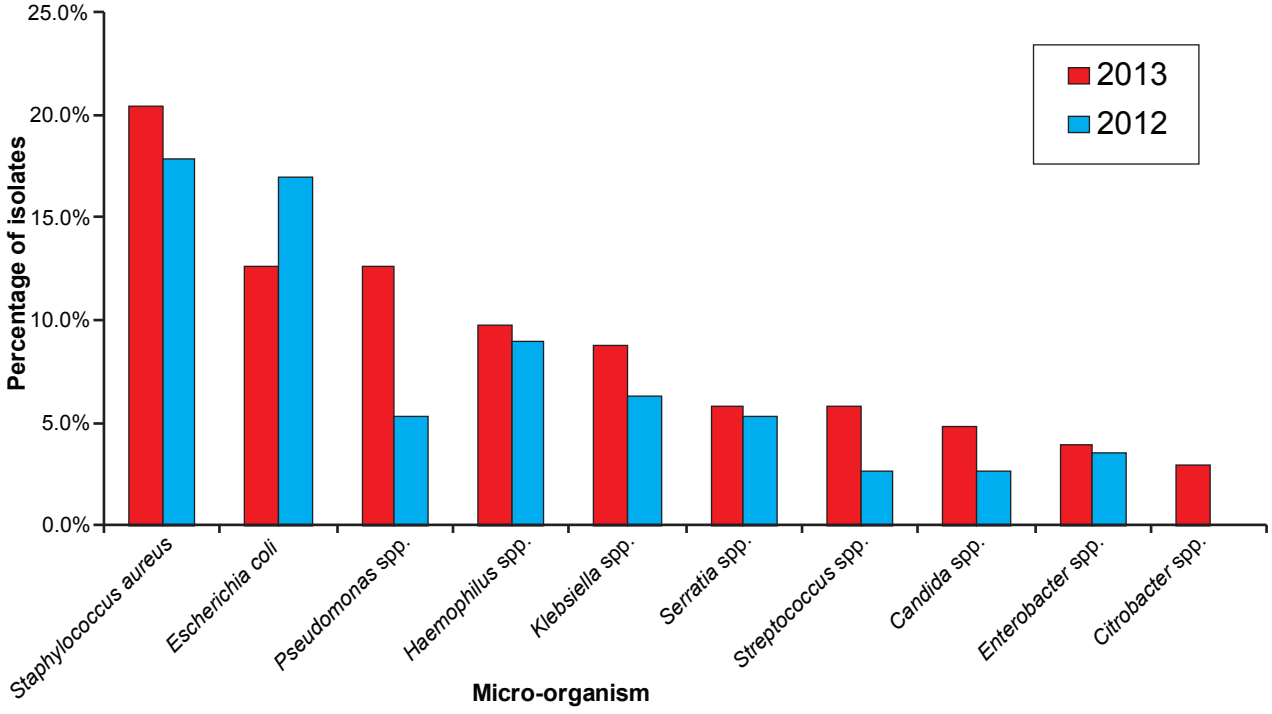
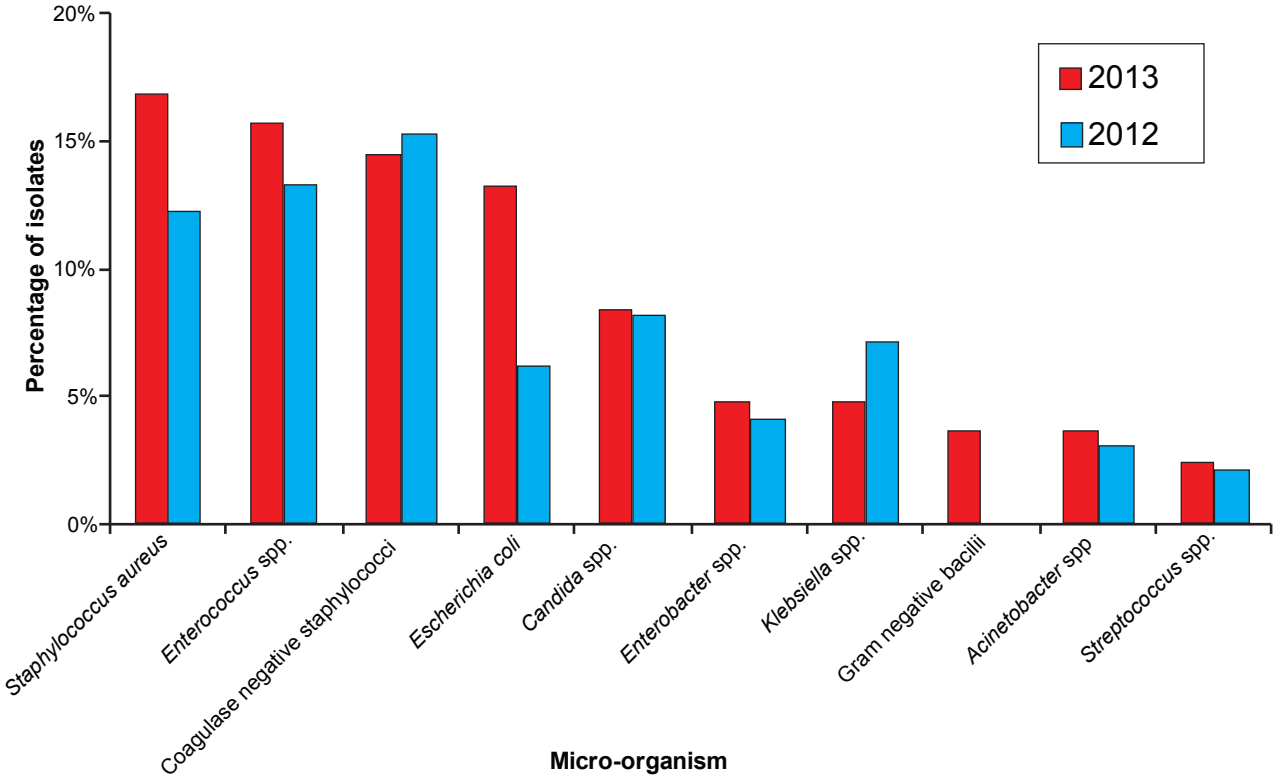


FIGURE 8: The distribution of the top ten micro-organisms isolated from BSI in 2013 and the corresponding distribution of these organisms in 2012



3.9 Benchmarking of incidence rates in Scotland and Europe for 2010 and 2011

Aggregated data from 14 European countries for pneumonia and BSI are shown in table 8 and are compared with equivalent data from Scotland for the same time period. There is no published European data available beyond 2011 for comparison.

TABLE 8: Incidence Rates and percentage of patients with pneumonia and BSI for Scotland and Europe, 2010 and 2011

	Europe (2010)[10]	Scotland (2010)[11]	Europe (2011)[12]	Scotland (2011)[13]
Percentage of patients who developed a pneumonia	5.9	3.1	5.6	2.8
All pneumonia per 1000 patient days	6.9	4.3	6.5	3.9
Ventilator associated pneumonia per 1000 patient days	10.8	5.1	9.9	5.2
Percentage of patients who developed a BSI	3.1	2.6	3.0	2.0
Incidence rate of all bloodstream infection	3.5	3.5	3.5	2.6

4. DISCUSSION

This report presents HAI surveillance data collected from 23 adult ICUs across Scotland during January to December 2013. Intensive care units across Scotland have been contributing data to this surveillance programme on a voluntary basis since 2009. The surveillance programme runs alongside the Scottish Patient Safety Programme (SPSP) and Quality Indicators for Critical Care in Scotland.[3] Units continuously collect HAI surveillance data and these data are reported on a monthly basis, within the context of SPSP to individual units for local improvement purposes. Data from ICUs are collated by SICSAG and HPS to the Scottish national database for HAI surveillance in ICU. The national data are reported on annually and this is the fourth annual report from the programme. Nationally, the database is an expanding resource for analysis and the data are contributed to the European dataset, held by ECDC, every year.

The overall findings presented here indicate that HAI in the intensive care setting in Scotland during 2013 has remained at a similar level to that reported for 2012. There have been no significant changes in the infection rates and this finding reflects what has been reported from other HAI surveillance programmes across Scotland.[14] The HAI Annual Report 2013 published by HPS in May 2014 reports on all national HAI surveillance activity in Scotland and states that infection rates for *S. aureus* bacteraemia, *C. difficile* infection and surgical site infection have continued to plateau in 2013, a trend that emerged in 2012.[14] This plateau in HAI rates across Scotland has led to work being carried out at HPS, across a number of surveillance programmes, to improve understanding around the epidemiology of HAI. The output of this work intends to support the design of new interventions to reduce risk of HAI further and to ensure that patients most at risk are targeted.[14]

A total of three percent of admissions to participating units developed an HAI in 2013, compared to 3.4% in 2012. The data showed that 1.6% of patients developed pneumonia and of the 112 pneumonia reported, 74% were VAP. The incidence density rate for VAP was 2.5 per 1000 invasive respiratory device days, these data are similar to data collected in 2012. Bloodstream infection rates in Scotland also remain unchanged from 2012. The percentage of patients that developed a BSI during their stay in ICU in 2013 was 1.3% and the incidence density rate of BSI was 1.5 per 1000 patient days, in 2012 these figures were 1.5% and 2.0 per 1000 patient days, respectively. The CR-BSI rate was 0.3 per 1000 CVC days, again this was similar to a rate of 0.5 per 1000 CVC days reported in 2013 for data collected in 2012.[15]

Micro-organisms most frequently isolated from pneumonia were *S. aureus*, *E coli* and *Pseudomonas* spp., these accounted for over 45% of micro-organisms. Micro-organisms most frequently isolated from BSI were *S. aureus*, *Enterococcus* spp., coagulase negative staphylococci and *E.coli*. The distribution of organisms was similar to that seen in Scotland in 2012[15] and to the European data published in 2013 for data collected in 2011.[12] It is important that units continue to monitor micro-organisms causing infection for any emerging change and to evaluate any changes in the context of the wider hospital setting. The numbers of micro-organisms reported are relatively small and therefore these comparisons should be interpreted with care.

Lack of antimicrobial resistance data is a limitation of this programme and it is important that we seek to access these data and utilise them effectively. In response to this, a project to investigate the possibility of linking data collected for surveillance and laboratory level data is being developed. A pilot of the linkage is planned for 2015, this would provide more epidemiological data related to causative organisms and their antimicrobial resistance profiles. These data would add considerable value and understanding to the existing dataset and the epidemiology of micro-organisms and antimicrobial resistance in ICU.

Benchmarking with Europe

Scottish data from 2010 and 2011 were compared with the most recently published data from Europe that covered the same time period.[12, 13] These data indicate that incidence rates for VAP and BSI in Scotland are within the lower end of the range seen across the rest of Europe. The incidence of VAP in Scotland in 2010 and 2011 was 5.1 and 5.2 VAP per 1000 ventilator days respectively. The European pooled mean incidence of VAP was 10.8 and 9.9 per 1000 invasive respiratory device days for 2010 and 2011, respectively.[12] While rates appear low, it is important to note that there are many variations across Europe relative to clinical practice, diagnostic methods and surveillance that affect these rates.

Scottish BSI rates appear broadly similar to those published from the aggregated European dataset. In 2010, the incidence of BSI in both Scotland and Europe was 3.5 BSI per 1000 patient days. In 2011, the incidence of BSI in Scotland was 2.6 per 1000 patient days and the European incidence rate was 3.5 per 1000 patient days.[12] European data for 2012 and 2013 have not yet been published and therefore, there are no data to make direct comparisons.

Limitations of the data

The variation in laboratory practice and methodology across Scotland has been noted as a potential limitation, previously.[13] For example, variation in tip culturing and methods used to diagnose pneumonia. There is no evidence that microbiology practice has changed significantly over 2013 and therefore from this perspective, the data remain a reliable national measure of HAI.

Concerns around reporting of CR-BSI in Scotland within the context of the surveillance system have been highlighted in previous reports.[13] Data collected in 2013 showed that only 12% of all BSI reported were CR-BSI, compared to 36.7% reported in the European report of 2011 data. The lack of routine tip culturing across Scotland remains an issue for the surveillance system, making it difficult to fulfil the infection definition for CR-BSI.[13] In order to address this issue pragmatically and determine a means to more accurately measure BSI where a central line may be involved, WardWatcher has been adapted to facilitate the reporting of Central Line Associated BSI (CLABSI) according to the Centers for Disease Prevention and Control (CDC) definition.[14] This definition does not require tip culture data and both CR-BSI and CLABSI will be reported in the future. It is anticipated that this will better quantify BSI where central lines may have played a role in the infection and therefore provide a means to measure the impact of interventions more effectively.

Overall compliance with data collection within WardWatcher and non-completion of the HAI surveillance fields was 3.5%, compared to 2.6% in 2012.[15] All units endeavour to carry

out surveillance continuously, however due to staffing problems and other issues, this is not always possible. It has been acknowledged by SICSAG, HPS and a number of units that surveillance has not always been carried out continuously and this has the potential to result in under-reporting of HAI. In 2013, units that were unable to report continuously were the Western General Hospital in Edinburgh, Inverclyde Royal Hospital, Ayr Hospital and the Western Infirmary in Glasgow. Where units are not collecting data continuously and where issues have been identified, SICSAG and HPS will seek to support them where possible and support units to complete the full dataset for contribution to the national database and for use at hospital level.

Future work

As discussed, there appears to be a plateau in HAI rates across the intensive care setting in Scotland and this is consistent with reports from other HAI surveillance systems in Scotland.[10] The reductions that were seen in previous years are likely to be a combination of the work that has been done over recent years in the ICU setting to reduce HAI and other hospital wide activity to reduce HAI over the same time period. The focus of future work must be to further reduce HAI, where possible.

According to the Quality Indicators for Critical care in Scotland[3], all units are expected to have an HAI surveillance system in place, report HAI monthly to SPSP and local staff and to measure and submit data to SPSP and feedback to unit staff on delivery of VAP prevention and CVC insertion and maintenance bundles.[3] The principles of a bundle approach and HAI data collection system are in place across Scotland. However, it has been recognised by SICSAG and HPS that whilst all units have implemented care bundles and HAI surveillance, there is a lack of consistency across Scotland in the way that surveillance data are collected and fed back to staff locally. It is to be expected that some level of inconsistency will always occur[17] but the way in which data are collected and used for improvement appears to be highly variable across Scotland.

Some units have well defined multi-disciplinary teams with strong ownership of the data and mechanisms for regular feedback to staff. These units are fully engaged with the surveillance process, they are actively seeking to identify HAI and they are using the data to monitor HAI for improvement and to evaluate changes in clinical practice. Other units appear to be less well engaged, data are not being utilised to maximise improvement and the approach to surveillance is passive.

It has been well demonstrated in the literature that the surveillance and bundle approach to improve the process of patient care is very effective in reducing both VAP and CR-BSI.[18, 19, 20] The effectiveness does however rely on regular feedback to staff. Therefore, it would seem logical that to further reduce HAI in ICUs across Scotland that SICSAG and HPS work towards utilising the existing systems to full benefit. This should focus on supporting units to develop a strong sense of ownership of the surveillance data and development of an interdisciplinary approach with regular feedback of data to staff.

It is also important that the tools to measure HAI and the effects of any interventions to reduce HAI are being measured effectively. Identifying VAP remains a challenge and it is well accepted that current definitions are subjective. The Centers for Disease Control and

Prevention (CDC) developed new definitions to identify Ventilator-Associated Events (VAE) in 2012,[21] these definitions are complex but they do go some way to reducing subjectivity. A proposal to compare the ECDC definitions for VAP and CDC definitions for VAE has been developed. It is planned to compare the two sets of definitions and determine the applicability of the VAE definitions in Scotland in collaboration with a volunteer health board. If this work is funded, it would be reported on in 2016.

As the threat of antimicrobial resistance becomes an increasing concern for all, HPS and SICSAG will focus on record linkage, as previously discussed, to explore the epidemiology of antimicrobial resistance in Scotland's ICU setting. SICSAG and HPS will also endeavour to utilise the national dataset in order to identify patients most at risk of developing an HAI in ICU, in order that they can be targeted in efforts to reduce HAI.

Collaborations

HPS and SICSAG will maintain their collaboration to provide support for surveillance and to develop the surveillance programme in line with changing priorities and public health goals.

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6. READER'S NOTES

Confidence Intervals
A range of values within which we are fairly confident the true population value lies. A 95% CI means that we can be 95% confident that the population value lies within the lower and higher confidence limits.

Incidence Density for BSI and PN
Total number of BSI/PN as a proportion of the sum of the ICU in-patient days contributed by each patient in the study population. The proportion is expressed as the number of BSI/PN per 1000 patient days.

Incidence Density for CRI and CR-BSI
Total number of CRI/CR-BSI as a proportion of the sum of the CVC days (days that a patient had a CVC *in situ*) contributed by each patient in the study population. The proportion is expressed as the number CRI/CR-BSI per 1000 CVC days

Incidence density for VAP
Total number of VAP as a proportion of the sum of the invasive respiratory device days (days that a patient required intubation) contributed by each patient in the study population. The proportion is expressed as the number VAP per 1000 invasive respiratory device days.

Interquartile range
The interquartile range for a distribution is the distance between the first and third quartiles.

The quartiles split the distribution into four equal parts with the median being the second quartile. Consequently the interquartile range is the range containing the middle 50% of the data.

Mean
The mean value is obtained by adding all the values in a population or sample and dividing the total by the number of samples that are added.

Median
The median of a finite set of values is that value which divides the set into two equal parts such that the number of values equal to or greater than the median is equal to the number of values equal to or less then the median. If the number of observations is odd, the median will be the middle value when all values have been arranged in order of magnitude, when the number of observations is even, the median is the mean of the two middle observations.

Standard Deviation
A measure of how close the sample mean is to the population mean.
A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data are spread out over a large range of values.

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