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Surveillance of Healthcare Associated Infections in Scottish Intensive Care Units

Annual report of data from January - December 2012

August 2013

Scottish Intensive Care Society Audit Group

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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
IVAC	Infection-Related Ventilator-Associated Condition
LRT	Lower Respiratory Tract
LOS	Length of Stay
MRSA	Meticillin Resistant *Staphylococcus aureus*
PN	Pneumonia
SD	Standard Deviation
SICSAG	Scottish Intensive Care Society Audit Group
SSHAIP	Scottish Surveillance of Healthcare Associated Infection Programme
SPSP	Scottish Patient Safety Programme
VAC	Ventilator-Associated Condition
VAP	Ventilator-Associated Pneumonia

SUMMARY REPORT

- This is the third annual report from the Surveillance of Healthcare Associated Infection (HAI) in Scottish Intensive Care Units (ICUs) programme.
- Surveillance data relating to pneumonia, bloodstream infections (BSI) and central venous catheter (CVC)-related infections were collected in accordance with the Hospitals in Europe Link for Infection Control through Surveillance (HELICS) methodology.
- Data from 5854 patients admitted to 22 Scottish ICUs between January and December 2012 were collected and 217 infections were reported from 197 patients.
- Bloodstream infections (BSI) accounted for 42.9% of infections, pneumonia for 53.5% and 3.7% were local and general CVC-related infections.
- Of the 116 pneumonia reported, 80% were ventilator-associated pneumonia (VAP) and the incidence density of VAP was 3.0 per 1000 invasive respiratory device days.
- The most frequently isolated micro-organisms from pneumonia were *Staphylococcus aureus* (17.9%) and *Escherichia coli* (17.0%).
- A total of 93 BSI were reported from 87 patients (1.5%). The incidence of BSI was 2.0 per 1000 patient days and the most frequently isolated organisms were coagulase negative staphylococci (15.3%) and *Enterococcus* spp. (12.2%).
- The findings of this report demonstrate significant reductions in HAI in the ICU setting. There has been a significant reduction in the percentage of patients who developed an HAI from 4.7% in 2011 to 3.4% in 2012.
- Significant reductions in incidence rates have been seen for VAP and BSI. The incidence of VAP has reduced from 5.1 per 1000 invasive respiratory device days in 2010 to 3.0 per 1000 invasive respiratory device days in 2012. The incidence of BSI has reduced from 3.5 per 1000 patient days in 2010 to 2.0 per 1000 patient days in 2012. Trend analysis indicates that significant reductions occurred between 2010 and 2012.
- These reductions are extremely encouraging and indicate that measures to reduce infection are having an impact. It is essential that good clinical practice and measures aimed at prevention of HAI are maintained and improved upon where possible.
- Future work should focus on identifying groups of patients most at risk of developing HAI in order that further prevention measures can be developed accordingly.

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. Patients in intensive care are subject to invasive procedures as part of their routine care and are therefore vulnerable to infection. In 2011, the Scottish Point Prevalence Survey reported that a quarter of patients in intensive care units (ICUs) 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 ICU remains the specialty in hospitals with the highest HAI prevalence and therefore are an at risk group of patients.[2] It is therefore important that we continue to work towards reducing HAI and improving outcomes for these patients.

This is the third annual report from the 'Healthcare Associated Infection in Scottish Intensive Care Units surveillance programme' developed by the Scottish Intensive Care Society Audit Group (SICSAG) and Health Protection Scotland (HPS). This collaborative programme is supported by a number of quality improvement activities, including a set of Quality Indicators for Critical Care in Scotland that were developed for implementation in 2012.[3] Within this set of quality indicators, there are two indicators relating to HAI; intensive care and high dependency units (HDU) 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 data for pneumonia (including VAP), bloodstream infections (BSI) and CVC-related infections.

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 and HAI data were collected in accordance with the methods and data definitions set out in the Hospitals in Europe Link for Infection Control through Surveillance (HELICS) protocol for surveillance of HAI in the intensive care setting.[4] 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 units between 01/01/2012 and 31/12/2012, with a stay of more than two days in the ICU.[4]

2.3 Infections included in the surveillance programme

Data relating to CVC-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 bloodstream infections (BSI) were collected. All infections reported were identified in accordance with the HELICS 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.[4]

2.5 Exclusion criteria and data cleansing

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

(i) Records with essential data missing e.g. admission date, discharge date.

(ii) Duplicate records were identified and removed.

(iii) Duplicate infections were excluded. Criteria for determining possible duplicates were based on those specified by HELICS. Infection episodes were defined by a minimum of a four day interval between PN episodes and a seven day interval for BSI and CRI.[5]

(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. Wilson's method[6] was used to calculate confidence intervals (CI) for proportions and the Byar method was used to calculate CI for rates.[7] A Poisson regression model was used to test for year on year trends.

3. RESULTS

3.1 Participating Intensive Care Units

A total of 22 adult ICUs in Scotland contributed HAI surveillance data for the period January to December 2012. Of the units contributing data, 15 (68.2%) were solely ICU, six (27.3%) were combined ICU/HDU and one (4.5%) 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/HDU will be referred to as ICU.

3.2 Patient population

Data from 5854 patients (aged 16 years or over) admitted to the participating units between 01/01/2012 and 31/12/2012 with a stay of more than two days in the ICU were included in the surveillance programme and data analyses.

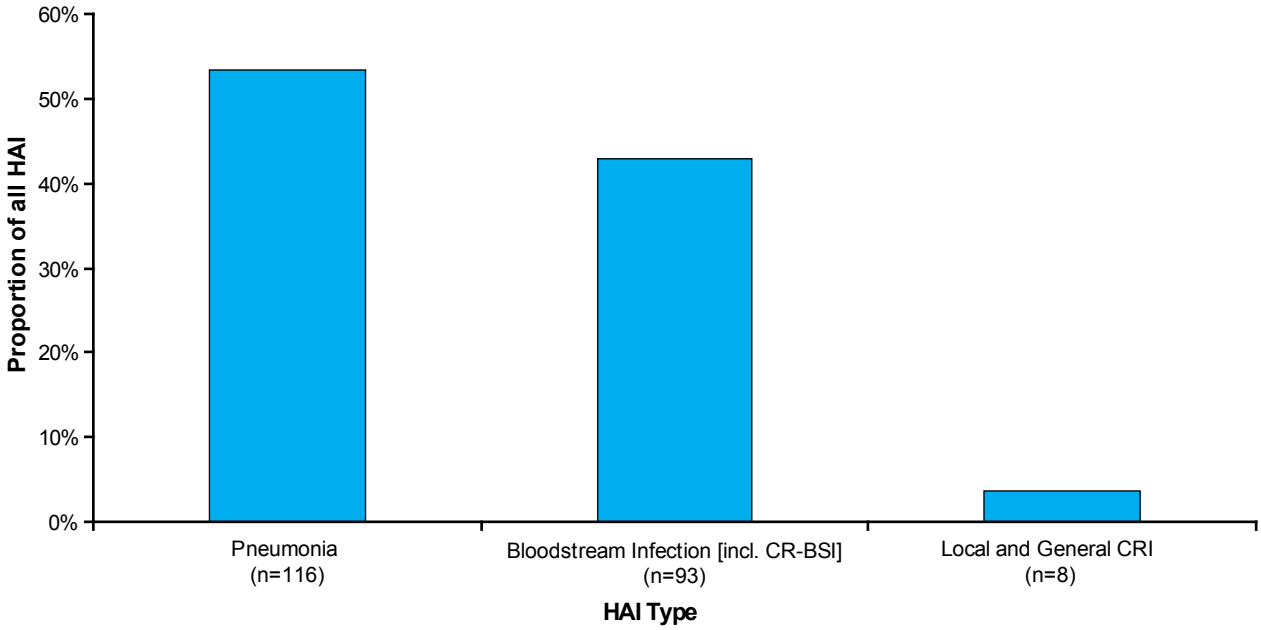
HAI surveillance data fields were not completed for 2.6% of records collected via the WardWatcher system. Data from these admissions contribute to the denominator and these admissions are included in the non-infected group for analysis, however the infection status of this group of patients cannot be accurately defined.

Of the 5854 admissions, 3284 (56.1%) were male and 2570 (43.9%) were female. 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)[8] score performed within the first 24 hours of the patient stay was 18.1 (Standard deviation [SD], 7.0) and the median age was 62 (IQR:49, 72). Central venous catheters (CVCs) were present for 62.9% of patient days and invasive respiratory devices were present for 65.0% of patient days.

3.3 HAI epidemiology

In total 217 HAI (PN, CRI and BSI) were reported from 197 (3.4%, 95% CI: 2.9, 3.9) patients. Of the 217 HAI, 116 (53.5%) were PN, 93 (42.9%) were BSI (including CR-BSI) and eight (3.7%) were CRI-1 and CRI-2. Figure 1 shows the percentage of each HAI type reported.

FIGURE 1: Percentage of each HAI type (n=217)



3.4 Patient characteristics

Table 1 shows a number of characteristics of patients admitted to ICU for more than two days.

TABLE 1: Characteristics of patients admitted to ICU

Characteristic		Number*	Percentage
Gender	Male	3284	(56.1%)
	Female	2570	(43.9%)
Patient Origin (Another area of the hospital)	Ward in hospital	4234	(72.4%)
	Other ICU	223	(3.8%)
	Community	1393	(23.8%)
Admission Type	Medical	3062	(58.2%)
	Surgical	2202	(41.8%)
Trauma Admission	No	4545	(91.8%)
	Yes	404	(8.2%)
Antimicrobials in the 48 hours prior to and/or after admission to ICU	No	1406	(24.7%)
	Yes	4279	(75.3%)

* N.B. Numbers may not total 5854 as data for some variables may be missing.

Comparison of age, APACHE II[8] score and LOS for patients who developed an HAI and those who did not is shown in Table 2(a) and (b). The median age of patients with and without an HAI was 62 years. The mean APACHE II[8] score for patients who developed an HAI was significantly higher than for those who did not (20.0 versus 18.0, Student T-test [$p<0.05$]). The median LOS for patients who developed an HAI was 18 days, compared to five days for those patients who did not develop an HAI ($p<0.05$, Mann Whitney U test).

TABLE 2a: Comparison of age and length of stay for patients with and without HAI

	No HAI (n=5657)		HAI (n=197)		P value (Mann Whitney U test)
Variable	**Median**	**IQR**	**Median**	**IQR**	
Length of stay (days)	5	3, 9	18	12, 27	p<0.0001
Age (years)*	62	49, 72	62	47, 72	p=0.4

* NB. 4 records were missing

TABLE 2b: Comparison of APACHE II[8] score for patients with and without HAI*

	No HAI (n=5277)		HAI (n=177)		P Value (Student T-test)
	MEAN	**95% CI (Lower CI, Upper CI)**	**MEAN**	**95% CI (Lower CI, Upper CI)**	
APACHE II[8]	18.0	17.8, 18.2	20.0	19.0, 21.1	P<0.001

* NB. 400 records were missing

3.5 Pneumonia

A total of 116 pneumonia infections were reported from 115 (2.0%, 95% CI: 1.6, 2.4) patients. Of these patients, 64.1% were medical admissions and 35.9% were surgical admissions. Of the 116 pneumonia, 80.2% infections were considered to be ventilator-associated pneumonia (VAP). Of the 23 remaining pneumonia, 15 were not considered to be VAP (non-VAP) and eight were unable to be classified due to missing data. Incidence density rates for pneumonia are shown in Table 3.

TABLE 3: Incidence density of pneumonia

Invasive respiratory device present‡	Number of Pneumonia	Incidence rate for Pneumonia	95% CI (Lower CI, Upper CI)
Yes (VAP)§	93	3.0 per 1000 invasive respiratory device days	2.4, 3.7
No (non-VAP)	15	0.3 per 1000 patient days	0.2, 0.5
Non-classified¶	8	-	-
All	116	2.4 per 1000 patient days	2.0, 2.9

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

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

¶ A number of pneumonia were unable to be classified as incomplete data relating to invasive respiratory device data were provided for these patients.

3.5.1 Diagnostic categories of pneumonia

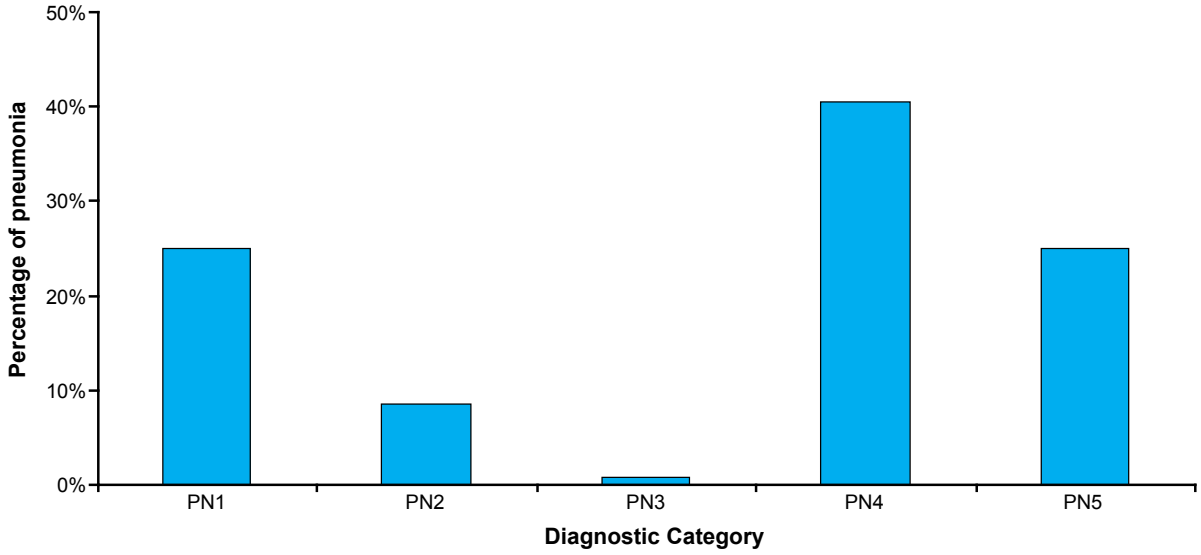
For surveillance purposes pneumonia was categorised according to the microbiology methods and clinical signs used to identify the infection.[1] Details are given in Table 4 below.

TABLE 4: Diagnostic categories 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

The distribution of pneumonia reported by diagnostic category is shown in Figure 2. It is important to note that microbiology methods used across Scotland are not standardised and therefore, there is variation across units within Scotland.

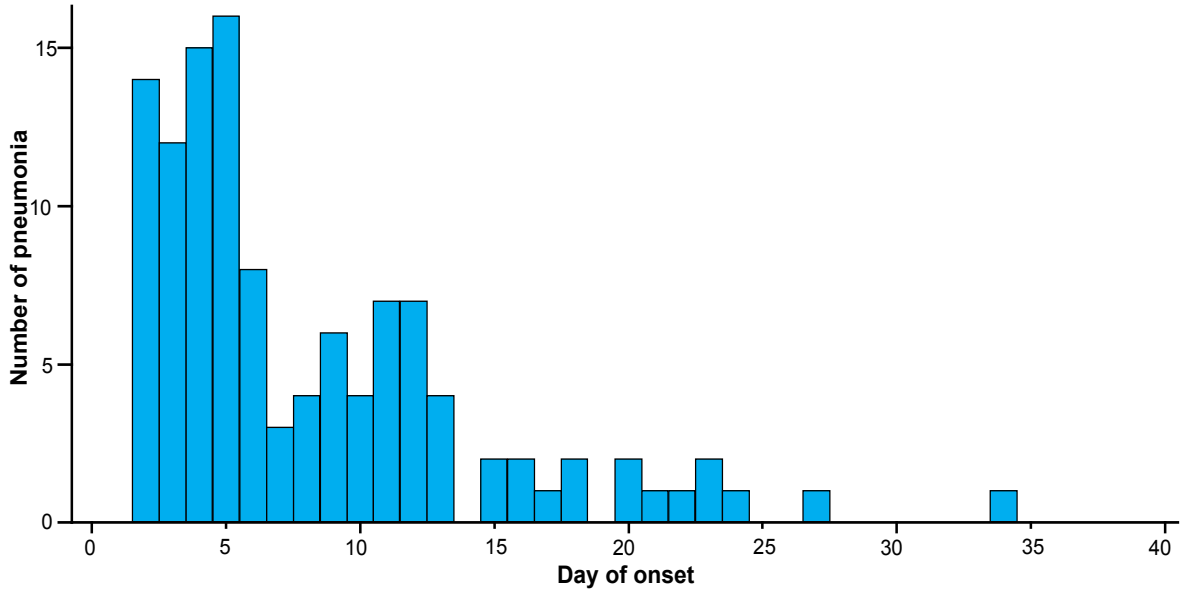
FIGURE 2: The distribution of diagnostic categories of all pneumonia reported



3.5.2 Day of onset of pneumonia

The median day of onset of pneumonia was seven days (IQR: 5, 12) and the distribution of the day of onset of pneumonia (from day three of ICU stay onwards) is shown in Figure 3. The median day of onset of VAP was seven days (IQR: 5, 13).

FIGURE 3: Frequency of all pneumonia by the day of onset

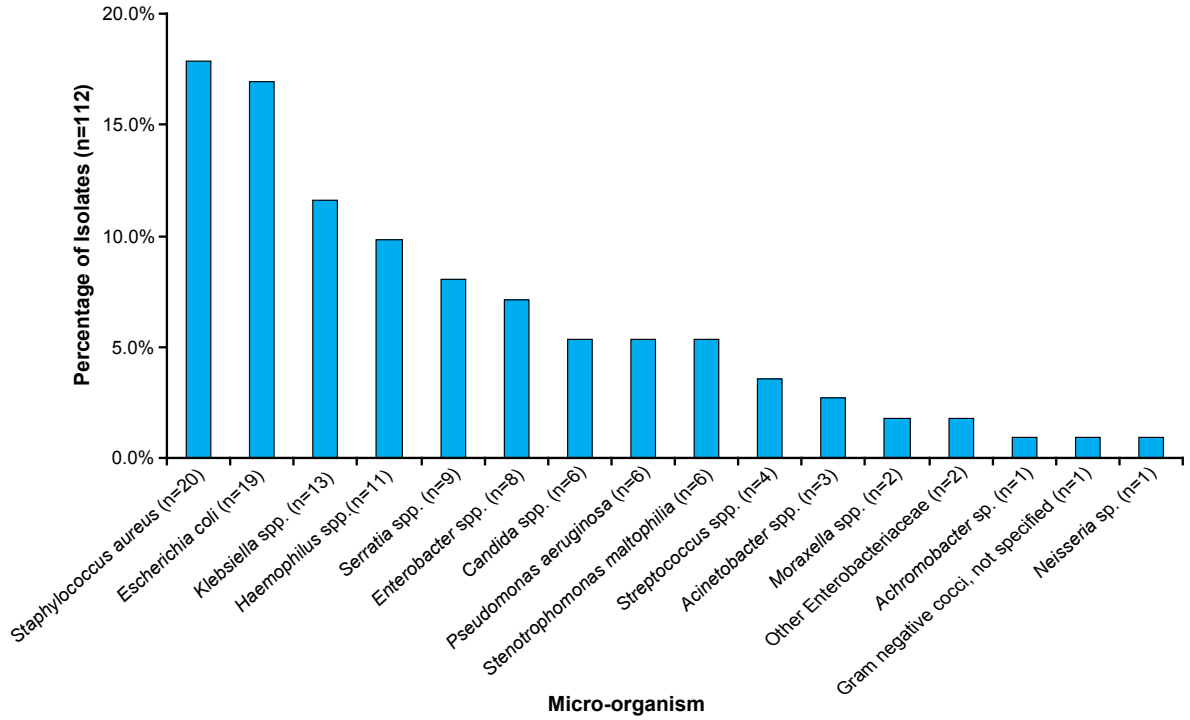


3.5.3 Distribution of micro-organisms isolated from pneumonia

Data for a total of 112 micro-organisms isolated from patients with pneumonia were reported, micro-organism data were available from 64% of reported pneumonia. Figure 4 shows the distribution of micro-organisms isolated from pneumonia and a more complete breakdown of micro-organisms is given in Appendix I.

Of the 20 *Staphylococcus aureus* isolated, antimicrobial resistance data were available for 12 isolates and of the 12 isolates one was a Meticillin Resistant *S. aureus* (MRSA).

FIGURE 4: The distribution of micro-organisms from pneumonia (n=112)



3.5.4 Key Summary Points

- Two percent of patients developed pneumonia during their stay in ICU and 80% of pneumonia were VAP.
- Diagnosis of pneumonia for surveillance using semi-quantitative microbiological methods (PN4) was the most frequent diagnostic method reported.
- *S. aureus* (17.9%), *E. coli* (17.0%) and *Klebsiella* spp. (11.6%) were the organisms most frequently isolated from pneumonia accounting for 46.5% of all micro-organisms isolated.

3.6 Bloodstream Infections

A total of 93 BSI were reported from 87 (1.5%, 95% CI:1.2, 1.8) patients and the median day of onset was day 9 (IQR: 6, 16). Seventy one percent of patients were medical admissions and 28.8% were surgical admissions. The incidence density of all BSI was 2.0 per 1000 patient days (95% CI: 1.6, 2.4). Sixteen of the 93 BSI reported were CR-BSI and the incidence density of CR-BSI was 0.5 per 1000 CVC days (95% CI: 0.3, 0.9).

Seventy seven (82.8%) BSI were reported to be non-CR-BSI and the incidence density of BSI (not including CR-BSI) was 1.6 per 1000 patient days (95% CI: 1.3, 2.0). These incidence rates are summarised in Table 5.

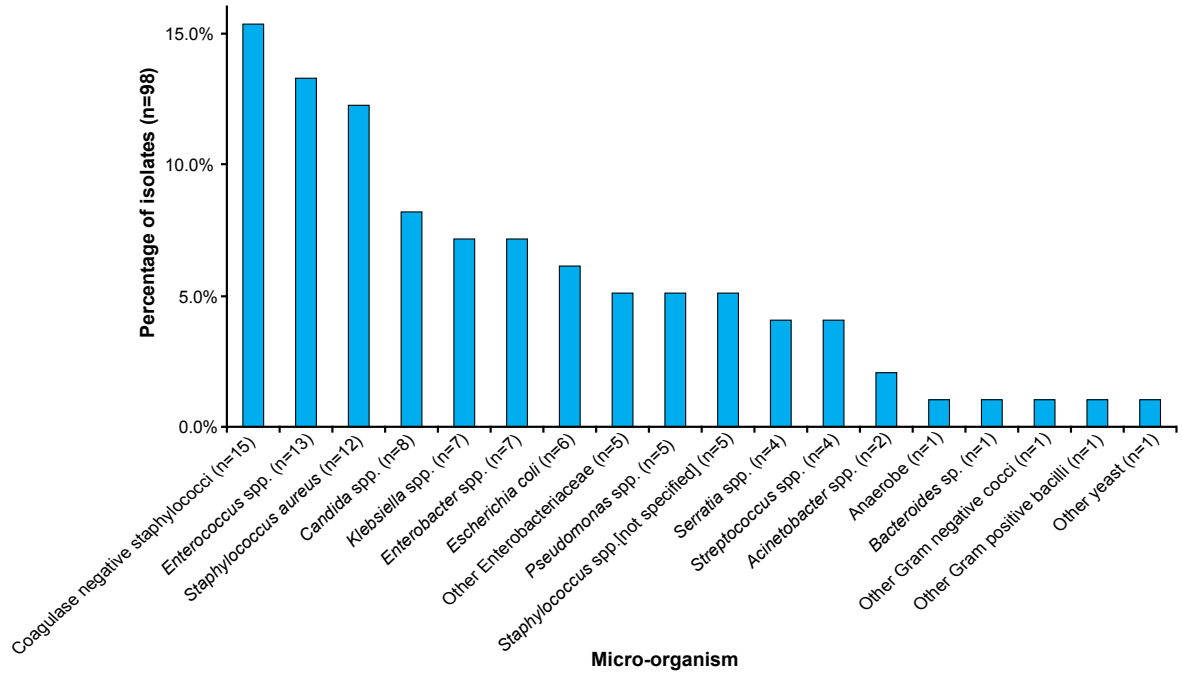
TABLE 5: Summary of BSI incidence rates

BSI type	Number of infections	Incidence rate (95% CI)
BSI (not CR-BSI)	77	1.6 per 1000 patient days (95% CI: 1.3, 2.0)
CR-BSI	16	0.5 per 1000 CVC days (95% CI: 0.3, 0.9)
BSI (All)	93	2.0 per 1000 patient days (95% CI: 1.6, 2.4)

3.6.1 Distribution of micro-organisms isolated from BSI

The distribution of micro-organisms from all BSI (CR-BSI and non CR-BSI) is shown in Figure 5 and a more complete breakdown of micro-organisms is given in Appendix I. Of the 12 *S. aureus* isolates, two were MRSA.

FIGURE 5: The distribution of micro-organisms isolated from bloodstream infections (n=98)



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

Of the 77 BSI that did not meet the criteria for CR-BSI, 60 (77.9%) cases 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.

A summary of the data are shown in Table 6. Summarised 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 those 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 + Confirmed BSI' incidence rate was 2.5 per 1000 CVC days (95% CI: 2.0, 3.2).

TABLE 6: Summary of CVC use in patients with BSI

Infection type	Number of infections	Incidence rate (95% CI)
BSI-no evidence of a CVC	17	0.4 per 1000 patient days (95% CI: 0.2, 0.6)
BSI-with evidence of a CVC (Probable CR-BSI)	60	2.0 per 1000 CVC days (95% CI: 1.5, 2.6)
CR-BSI (Confirmed CR-BSI)	16	0.5 per 1000 CVC days (95% CI: 0.3, 0.9)
'Probable + Confirmed CR-BSI'	76	2.5 per 1000 CVC days (95% CI: 2.0-3.2)

3.6.3 Key Summary Points-BSI

- 1.5% of patients developed a BSI, and the incidence density for all BSI was 2.0 per 1000 patient days.
- The incidence density of BSI (excl. CR-BSI) was 1.6 per 1000 patient days.
- The incidence density of CR-BSI was 0.5 per 1000 CVC days.
- Of the 77 BSI reported, where the criteria for a CR-BSI were not met, a CVC was *in situ* or removed in the 48 hours prior to onset of BSI in 60 (77.9%) cases.
- The incidence density of 'Probable + Confirmed' CR-BSI was 2.5 per 1000 CVC days.
- The most frequently isolated micro-organisms from BSI were coagulase negative staphylococci (15.3%) and *Enterococcus* spp. (13.3%). These organisms accounted for over a quarter of isolates from BSI.

3.7 CVC-related infection (not including CR-BSI)

In total four CRI-1 (local infection) and four CRI-2 (general infection) were reported, the incidence density of CRI-1 and CRI-2 was 0.3 per 1000 CVC days, (95% CI: 0.1, 0.5). Table 7 shows the distribution of micro-organisms isolated from CRI-1 and CRI-2 and a complete breakdown of micro-organisms is given in Appendix I.

TABLE 7: The distribution of micro-organisms isolated from CVC-related infection (n=9)

Micro-organism	Number (%)
Coagulase negative staphylococci	2 (22.2%)
Staphylococcus spp.	2 (22.2%)
Candida sp.	1 (11.1%)
Enterobacter sp.	1 (11.1%)
Enterococcus sp.	1 (11.1%)
Klebsiella sp.	1 (11.1%)
Pseudomonas aeruginosa	1 (11.1%)

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

- The incidence density of CRI (CR-1 and CR-2) was 0.3 per 1000 CVC days.
- The numbers are very small and therefore the data must be interpreted with extreme caution.

3.8 Year on year comparison of incidence rates and micro-organisms isolated

3.8.1 Incidence rates

Data from 2012 showed that 3.4% (95% CI: 2.9, 3.9) of patients admitted to ICU with a stay of more than two days developed an HAI, this is a statistically significant reduction from 4.7% (95% CI: 4.2, 5.2) reported in 2011 (Test of Two Proportions, $p<0.001$).

Incidence rates for HAI from 2010-2012 are shown in Table 8. There have been significant decreasing year on year trends in the rates for VAP (21.3% $p<0.01$) and BSI (25.2% $p<0.01$) since 2010, with the reduction in VAP occurring between 2011 and 2012. The year on year trend for CR-BSI rates was not significant (19.2%, $p=0.19$).

TABLE 8: Incidence rates for VAP, BSI AND CR-BSI for 2010 to 2012

Infection type	Incidence rate (95% CI)		
	2010	2011	2012
VAP per 1000 invasive respiratory device days	5.1 (4.3, 6.0)	5.2 (4.5, 6.1)	3.0 (2.4, 3.7)
All BSI per 1000 patient days	3.5 (3.0, 4.1)	2.6 (2.2, 3.1)	2.0 (1.6, 2.4)
CR-BSI per 1000 CVC days	0.8 (0.5, 1.2)	0.6 (0.4, 1.0)	0.5 (0.3, 0.9)
BSI (not including CR-BSI) per 1000 patient days	2.9 (2.5, 3.5)	2.3 (1.9, 2.7)	1.6 (1.3, 2.0)

3.8.2 Micro-organisms isolated

The distribution of the top ten micro-organisms isolated from pneumonia and BSI in 2011-2012 are shown in Figures 6 and 7. Detailed micro-organism data are shown in Appendix II.

Figure 6: The distribution of the top ten micro-organisms isolated from pneumonia in 2012 and the corresponding distribution of these organisms in 2011

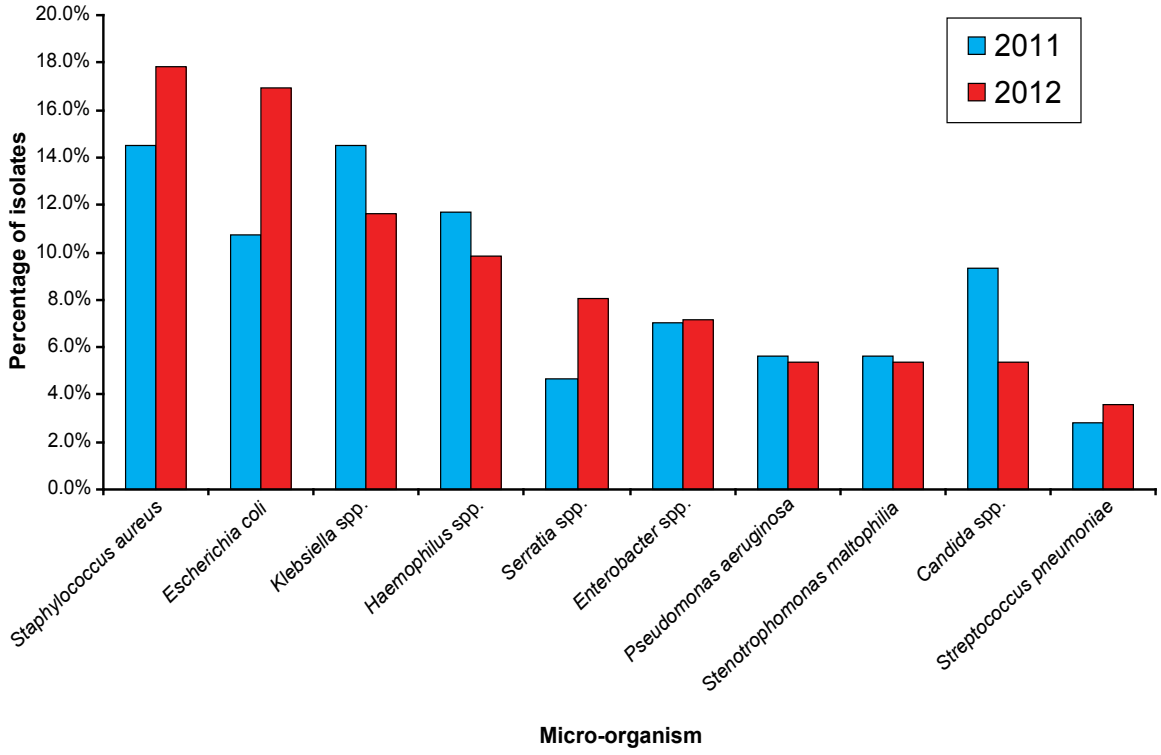
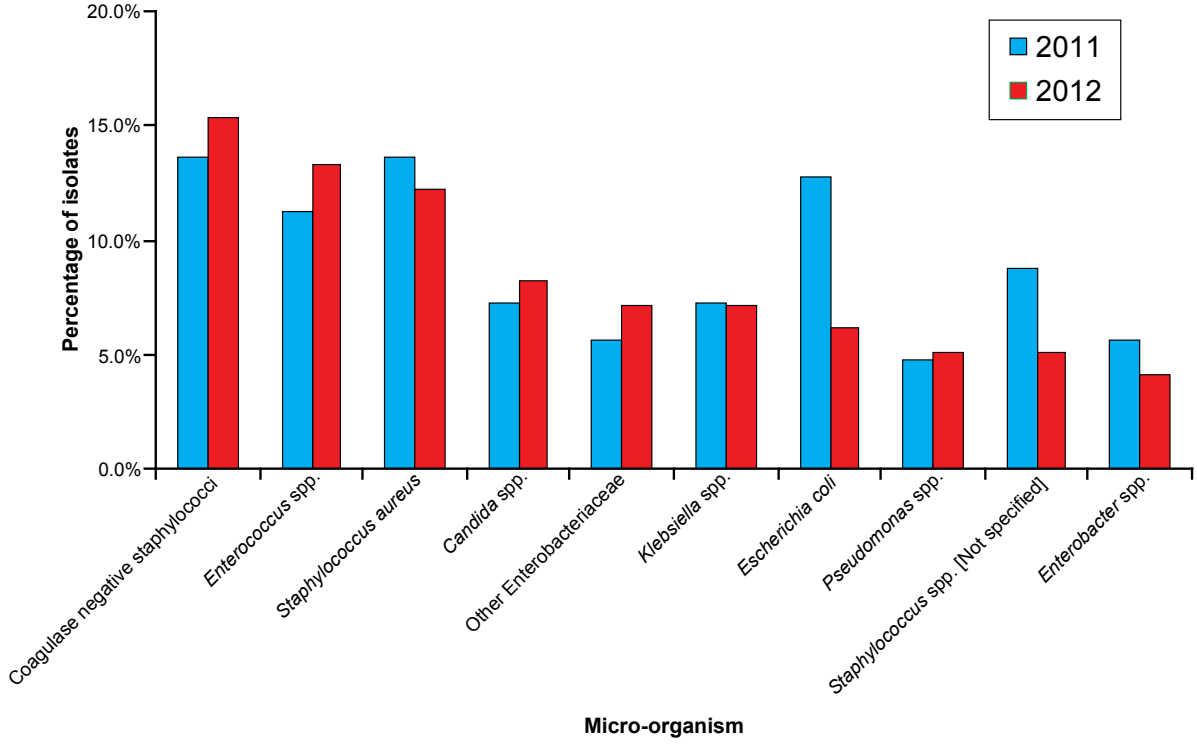


Figure 7: The distribution of the top ten micro-organisms isolated from BSI in 2012 and the corresponding distribution of these organisms in 2011



4. DISCUSSION

This report presents HAI surveillance data collected from 22 adult ICUs across Scotland over the 12 month period, January to December 2012. This surveillance programme demonstrates a commitment across Scotland to monitor and reduce HAI and to improve patient safety in the intensive care setting. Regular data collection for surveillance, SPSP and compliance Quality Indicators[3] ensure that staff awareness of HAI and interventions to prevent HAI is maintained and it provides a useful measure of quality of care for use locally. Local data are used to improve patient care and can be used by infection control teams to allocate and prioritise resources. The database that this programme has contributed to since 2009 provides a useful and expanding resource for analysis, and for the annual contribution to the corresponding European dataset held by the European Centre for Disease Prevention and Control (ECDC).

The overall findings presented in this report indicate that there have been significant reductions in the number of HAI in ICU patients during 2012. The percentage of patients developing an HAI has reduced from 4.7% in 2011[9] to 3.4% in 2012, this follows a reduction from 5.6% in 2010[11] to 4.7% in 2011. This suggests that real progress is being made in reducing HAI and improving patient safety in the intensive care setting.

The data show that two percent of patients developed pneumonia and 80% of these were VAP. The incidence density rate for VAP was 3.0 per 1000 invasive respiratory device days, this was a reduction from 5.2 per 1000 invasive respiratory device days in 2011.[9] The most recently published data from Europe which represents aggregated data from 14 European countries reported 2010 surveillance data this year and this report indicates that 5.9% of patients developed pneumonia and 91% of these were VAP. The European mean device-adjusted rate was 10.8 VAP per 1000 invasive respiratory device days with an inter-country range of 3.9 to 23 per 1000 invasive respiratory device days.[10] Therefore, the Scottish rate is well within the lower end of the range published for Europe. This is the first year of national reporting in Scotland where a significant reduction in pneumonia has been seen.

The most frequently isolated micro-organisms from pneumonia were *S. aureus*, *E. coli* and *Klebsiella* spp. accounting for almost 50% of all micro-organisms isolated from pneumonia. There have been some changes in the distribution of organisms isolated between 2011 and 2012, in particular an increase in *S. aureus* and *E. coli*, these are notable but are not statistically significant increases. It is important to monitor these variations in the distribution of organisms isolated, as it may indicate emerging changes and often mirrors changes seen across the wider hospital setting.

Concerns around variation in reporting pneumonia due to varying microbiology practice across Scotland have been discussed in previous reports.[9] It has been recognised that some units may utilise more sensitive microbiology techniques than others and that the resulting variations in the incidence of pneumonia between units would make inter-unit comparisons invalid. The data are however, reliable as a national measure for monitoring and measuring improvement on a year to year basis. The data presented here demonstrate that categorisation of pneumonia by diagnostic category at a national level is very similar to 2011. PN4 remains the most frequent classification of pneumonia and the overall distribution

of classification (PN1-5) looks very similar to previous years.[9, 11] Therefore, we can infer that reporting of pneumonia has been consistent and there have been no notable changes in microbiology practice with respect to pneumonia diagnosis in intensive care across Scotland.

The data show that 1.5% of patients developed a BSI during their ICU stay and that the BSI incidence rate was 2.0 per 1000 patient days. This is a significant reduction from 2.6 per 1000 patient days in 2011.[9] This is the second year that we have seen a significant reduction in BSI in the ICU setting. Of the BSI, 17% were reported as CR-BSI and the remainder were reported as BSI not related to CVC use, these proportions are similar to those reported previously.[9] Concerns around classification of CR-BSI and the practice of not routinely culturing tips across Scotland remain an issue.[9] Changes currently being made to WardWatcher should allow the data to be reported according to both HELICS and Centers for Disease Control and Prevention (CDC) definitions for CVC-related/associated infections.[12] This should provide both a more meaningful interpretation of the source of BSI and a more accurate measure of BSI where a central line maybe a contributing factor to infection.

The organisms most frequently isolated from BSI were coagulase negative staphylococci and *Enterococcus* spp. The most notable change is an apparent reduction in *E. coli*, however this is not significant. The distribution of organisms isolated from BSI in Scotland shows a very similar pattern to the European data presented in the most recently published report for 2010 data.[10]

The data presented in this report indicate that the rates of HAI in Scottish ICUs have reduced significantly since the implementation of the HAI surveillance programme in 2009, with the greatest reductions seen in 2011 and 2012. Trend analysis of incidence rates in 2010-2012 indicate that there have been significant reductions in VAP and BSI over these three years.

In 2012, SICSAG introduced a set of Quality Indicators which included the requirement for an HAI surveillance system.[3] The reporting of, and feedback to staff of the delivery of the VAP prevention and CVC insertion and maintenance bundles that were introduced in 2008 were also included within the set of quality indicators. It may be that the introduction of the quality indicators has had a positive and reinforcing effect on clinical practice and consequently HAI rates during 2012. At this stage we cannot support and/or evidence this with process data relating to clinical practice and compliance with the 'care bundles'. These are extremely positive findings and it is essential that good clinical practice and measures aimed at prevention of HAI are maintained and improved upon where possible.

In regard to the reduction in VAP, there is anecdotal evidence of an increase in the use of subglottic drainage endo-tracheal tubes in some ICU patients across Scotland. Anecdotal evidence from NHS Tayside has shown a significant reduction in VAP following this measure. There is a body of evidence to support the use of subglotttic drainage to reduce VAP and a recently published meta-analysis of published randomised controlled trials of subglottic drainage has estimated that the intervention may reduce VAP by about 50%.[13] At present, specific data around the extent to which subglottic drainage endo-tracheal tubes are being used in ICU patients across Scotland is not available and the reduction in VAP cannot be attributed to this change in clinical practice at this time.

Limitations of data

All participating units collected data for the full 12 month period reported. One unit that reported data previously was unable to provide data for inclusion in this report due to data collection issues locally. Units vary in size, patient characteristics and compliance with data collection, they may therefore be over or under-represented in the data. Overall compliance with data collection within WardWatcher has improved and non-completion of the HAI surveillance data fields have reduced from 6.0% to 2.6%. These limitations should be recognised but the data remain consistent as a national benchmark for Scotland that can be used to measure improvement.

Future work

As proposed previously, we should look towards a more detailed risk factor analysis of the patient population in ICU in order to characterise the patients most at risk. By defining the risks and identifying those patients most likely to develop an HAI, reduction programmes can focus on those most at risk and aim to reduce HAI in the ICU setting to an irreducible minimum. Risk factor analysis is currently in progress for the Scottish dataset and the output from this will be published in due course.

We will continue to work with our UK counterparts in sharing knowledge and developing the Scottish surveillance system. Other UK countries are investigating the possibility of utilising new CDC definitions for Ventilator Associated Events.[14] These definitions focus on changes to a patient's ventilation requirements, in addition to fever, supporting microbiology, and allow for clinical diagnoses to be more readily reported. They allow for reporting of 'ventilator associated events' at three different levels: (i) Ventilator-Associated Condition (VAC), (ii) Infection-Related Ventilator-Associated Condition (IVAC) and (iii) Possible or Probable VAP.[14] These new definitions have been developed to address the issues around the subjectivity of the current VAP definitions and provide a measure suitable for public reporting and comparison. The VAP definition remains a measure that is best used for internal improvement. These definitions are perhaps worthy of consideration for the future development of Scotland's surveillance programme.

Collaborations

HPS and SICSAG will continue to collaborate to improve surveillance data and to provide support to those participating in data collection. The possibility of linking surveillance data to process data related to 'care bundle' compliance is being examined. Linkage of surveillance data to antimicrobial resistance data held within another National database is also being explored with a view to expanding the antimicrobial resistance data available.

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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.

APPENDIX I

Micro-organisms isolated from each HAI type

a) Micro-organisms isolated from pneumonia (n=112)

Genus	Micro-organism	Number of isolates	Percentage of isolates
Enterobacteriaceae	*Enterobacter cloacae*	4	3.6%
	Enterobacter spp.	4	3.6%
	Escherichia coli	19	17.0%
	Hafnia sp.	1	0.9%
	Klebsiella oxytoca	2	1.8%
	Klebsiella pneumoniae	4	3.6%
	Klebsiella spp.	7	6.3%
	Proteus sp.	1	0.9%
	Serratia marcescens	6	5.4%
	Serratia sp.	3	2.7%
Fungi	*Candida albicans*	3	2.7%
	Candida glabrata	1	0.9%
	Candida spp.	2	1.8%
Gram negative bacilli	*Achromobacter* sp.	1	0.9%
	Acinetobacter baumannii	2	1.8%
	Acinetobacter sp.	1	0.9%
	Haemophilus influenzae	10	8.9%
	Haemophilus sp.	1	0.9%
	Pseudomonas aeruginosa	6	5.4%
	Stenotrophomonas maltophilia	6	5.4%
Gram negative cocci	*Gram negative cocci* (not specified)	1	0.9%
	Moraxella catharralis	1	0.9%
	Moraxella sp.	1	0.9%
	Neisseria sp.	1	0.9%
Gram positive cocci	*Staphylococcus aureus*	20	17.9%
	Streptococcus pneumoniae	3	2.7%
	Streptococcus sp.	1	0.9%

b) Micro-organisms isolated from BSI (n=98)

Genus	Micro-organism	Number of isolates	Percentage of isolates
Anaerobic bacilli	Anaerobe	1	1.0%
	Bacteroides sp.	1	1.0%
Enterobacteriaceae	*Escherichia coli*	6	6.1%
	Enterobacter cloacae	3	3.1%
	Enterobacter spp.	4	4.1%
	Hafnia sp.	1	1.0%
	Klebsiella oxytoca	2	2.0%
	Klebsiella pneumoniae	1	1.0%
	Klebsiella spp.	4	4.1%
	Other enterobacteriaceae	3	3.1%
	Proteus mirabilis	1	1.0%
	Serratia marcescens	3	3.1%
	Serratia sp.	1	1.0%
Fungi	*Candida albicans*	3	3.1%
	Candida glabrata	1	1.0%
	Candida spp.	4	4.1%
	Yeasts	1	1.0%
Gram negative bacilli	*Acinetobacter* spp.	2	2.0%
	Pseudomonas spp.	2	2.0%
	Pseudomonas aeruginosa	3	3.1%
Gram negative cocci	Gram negative cocci	1	1.0%
Gram-positive bacilli	Gram-positive bacilli	1	1.0%
Gram positive cocci	Coagulase negative staphylococci	3	3.1%
	Enterococcus faecalis	8	8.2%
	Enterococcus spp.	5	5.1%
	Staphylococcus aureus	12	12.2%
	Staphylococcus epidermidis	11	11.2%
	Staphylococcus haemolyticus	1	1.0%
	Staphylococcus spp.	5	5.1%
	Streptococcus spp.	4	4.1%

c) Micro-organisms isolated from CRI-1 and CRI-2 (n=9)

Genus	Micro-organism	Number of isolates	Percentage of isolates
Fungi	*Candida albicans*	1	11.1%
Enterobacteriacae	*Enterobacter aerogenes*	1	11.1%
	Klebsiella pneumoniae	1	11.1%
Gram negative bacilli	*Pseudomonas aeruginosa*	1	11.1%
Gram Positive cocci	*Staphylococcus aureus*	1	11.1%
	Staphylococcus sp.	1	11.1%
	Coagulase negative staphylococci	2	22.2%
	Enterococcus faecalis	1	11.1%

APPENDIX II

(a) Top ten micro-organisms isolated from pneumonia in 2012 and corresponding frequencies in 2011

Organism	Year Number (percentage) of total isolates	
	2012 (n=112)	**2011 (n=214)**
Staphylococcus aureus	20 (17.9%)	31(14.5%)
Escherichia coli	19 (17.0%)	23(10.7%)
Klebsiella spp.	13 (11.6%)	31(14.5%)
Haemophilus spp.	11 (9.8%)	25(11.7%)
Serratia spp	9 (8.0%)	10 (4.7%)
Enterobacter spp.	8 (7.1%)	15 (7.0%)
Pseudomonas aeruginosa	6 (5.4%)	12 (5.6%)
Stenotrophomonas maltophilia	6 (5.4%)	12 (5.6%)
Candida spp.	6 (5.4%)	20 (9.3%)
Streptococcus pneumoniae	4 (3.6%)	10 (4.7%)

(b) Top ten micro-organisms isolated from BSI in 2012 and corresponding frequencies for 2011

Organism	Year Number (percentage) of total isolates	
	2012 (n=98)	**2011 (n=125)**
Coagulase negative staphylococci	15 (15.3%)	17 (13.6%)
Enterococcus spp.	13 (13.3%)	14 (11.2%)
Staphylococcus aureus	12 (12.2%)	17 (13.6%)
Candida spp.	8 (8.2%)	9 (7.2%)
Other Enterobacteriaceae	7 (7.1%)	7 (5.6%)
Klebsiella spp.	7 (7.1%)	9 (7.2%)
Escherichia coli	6 (6.1%)	16 (12.8%)
Pseudomonas spp.	5 (5.1%)	6 (4.8%)
Staphylococcus spp. (not specified)	5 (5.1%)	11 (8.8%)
Enterobacter spp.	4 (4.1%)	7 (5.6%)

NOTES

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