Health Protection Scotland

NHS National Services Scotland

# Surveillance of Healthcare Associated Infections in Scottish Intensive Care Units

**Annual report of data from January 2011 to December 2011**


**August 2012**

Scottish Intensive Care Society Audit Group

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## Glossary

| | |
|---|---|
| AMR | Antimicrobial Resistance |
| APACHE II | Acute Physiology and Chronic Health Evaluation II |
| BSI | Blood Stream Infection |
| CI | Confidence Intervals |
| CR-BSI | Central Venous Catheter-Related Blood Stream Infection |
| CRI | Central Venous Catheter-Related Infection |
| CVC | Central Venous Catheter |
| ECDC | European Centre for Disease Prevention and Control |
| GCS | Glasgow Coma Scale |
| 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 |
| MSSA | Meticillin Sensitive *Staphylococcus aureus* |
| MRSA | Meticillin Resistant *Staphylococcus aureus* |
| NHS | National Health Service |
| PN | Pneumonia |
| SICSAG | Scottish Intensive Care Society Audit Group |
| VAP | Ventilator-Associated Pneumonia |

## Summary Report

- This is the second annual report from the Surveillance of Healthcare Associated Infection in Scottish Intensive Care Units programme. All general adult intensive care units and one neurological intensive care unit currently contribute data to this programme on a voluntary basis.
- Surveillance data relating to central venous catheter-related infection, pneumonia and blood stream infection were collected in accordance with the Hospitals in Europe Link for Infection Control through Surveillance methodology.
- Data from 6362 patients admitted to 23 Scottish Intensive Care Units between 1 January 2011 and 31 December 2011 were collected and 356 infections were reported from 301 (4.7%) patients, this was a significant reduction from the 5.6% of patients reported to have an infection in 2011.
- Pneumonia accounted for 198 (55.6%) of infections, 136 (38.2%) were blood stream infections and 22 (6.2%) were Local and General central venous catheter-related infections.
- Of the 198 pneumonia episodes reported, 88.4% (175) were ventilator-associated pneumonia. The incidence density of ventilator-associated pneumonia was 5.2 per 1000 invasive respiratory device days.
- The most frequently isolated micro-organisms from pneumonia were *Klebsiella* spp. (14.5%) and *Staphylococcus aureus* (14.5%), followed by *Haemophilus* spp. (11.7%) and *Escherichia coli* (10.7%), these organisms accounted for 50% of all isolates.
- A total of 136 blood stream infections were reported from 130 (2.0%) patients, the incidence of blood stream infection (not including central venous catheter-related blood stream infection) was 2.3 per 1000 patient days. The most frequently isolated micro-organisms from blood stream infections were coagulase negative staphylococci (13.2%), *Staphylococcus aureus* (13.2%) and *Escherichia coli* (12.4%).
- The number of blood stream infections reported as having coagulase negative staphylococci as the causative organism is of some concern. This high level (13.2%) of coagulase negative staphylococci isolates reported from some units suggests that contamination of blood cultures may be an issue that needs to be addressed.
- There has been a reduction in all blood stream infections during 2011 from 3.5 to 2.6 blood stream infections per 1000 patient days. This reduction is encouraging and reflects the reductions that have been seen via other surveillance systems in Scotland, including the Scottish National Point Prevalence Survey of Healthcare Associated Infections and the *S. aureus* bacteraemia surveillance system for Scotland.
- Future work will concentrate on addressing the issues around blood stream infection reporting and steps will be taken to achieve a more complete microbiology and antimicrobial resistance dataset.

# 1. INTRODUCTION

## 1.1 Surveillance of Healthcare Associated Infection in Scottish Intensive Care Units

This is the second annual report from the Healthcare Associated Infection (HAI) in Scottish Intensive Care Units (ICU) surveillance programme developed by the Scottish Intensive Care Society Audit Group (SICSAG) and Health Protection Scotland (HPS). The surveillance programme has been ongoing since 2009 and all 22 general adult ICUs and one neurological ICU in Scotland collect HAI surveillance data continuously as part of this collaborative surveillance programme.

The surveillance programme includes HAI data for pneumonia (including ventilator-associated pneumonia [VAP]), blood stream infection (BSI) and central venous catheter (CVC) related infection.

## 1.2 Aims and Objectives of HAI surveillance in Scottish intensive care

- 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 HELICS protocol[1] for surveillance of HAI in the intensive care setting. All surveillance data were collected electronically either via WardWatcher or HELICSwin data collection software.

Data were collected by a wide range of clinical staff and the systems for data collection varied between units in terms of the staff collecting data and the way in which the data were entered to HELICSwin and WardWatcher. In one of the units using HELICSwin for data collection, a dedicated data collector was employed. In all other units, data was collected by multiple data collectors. Staff collecting data have been trained and there is data validation built into the WardWatcher data collection system to improve data quality and inter-rater reliability.

## 2.2 Patient population

Data were collected from adult patients (aged 16 years or over) admitted to participating ICUs between 01/01/2011 and 31/12/2011, with a stay of more than two days in the ICU[1]. Any patients not discharged at the time of data transfer were 'arbitrarily discharged' (censored) on the last day for which the invasive device exposure data had been collected for the patient.

## 2.3 Infections included in the surveillance programme

Data relating to pneumonia (including VAP), blood stream infections and central venous catheter-related infection were collected. Central venous catheter-related infection (CRI) included Local CRI, General CRI and central venous catheter-related blood stream infection (CR-BSI). Local CRI refers to infection at the CVC insertion site or tunnel, General CRI refers to a patient with clinical signs of infection, a positive tip culture but no positive blood culture, and CR-BSI are blood stream infections that occur when a CVC is *in situ* at the time of onset or has been *in situ* in the 48 hours prior to onset of BSI.

All infections reported were identified in accordance with the HELICS surveillance methodology and met the case definitions specified in this protocol[1].

## 2.4 Micro-organism and antimicrobial resistance data

Up to three causative micro-organisms per infection were reported. Antimicrobial resistance (AMR) data were collected for *Staphylococcus aureus* isolates, these isolates were categorised as meticillin resistant *S. aureus* (MRSA) or meticillin sensitive *S. aureus* (MSSA) depending on their AMR profile.

## 2.5 Data cleansing

i. Patient records with essential data missing, such as discharge dates were removed from the analysis.

ii. Duplicate patient records were identified and removed.

iii. Duplicate infection records were excluded.

## 2.6 Quality Assurance

The data were quality checked according to a protocol to identify anomalous, erroneous and missing data.

## 2.7 Data analysis methods

i. 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 pneumonia episodes and a seven day interval for BSI and CRI[2].

ii. Data analyses were carried out using STATA™ version 9. The Wilson method was used to calculate 95% confidence intervals (CI)[3]. Rate ratios were calculated using the Wald method.

# 3. RESULTS

## 3.1 Participating intensive care units

A total of 23 adult ICUs in Scotland contributed HAI surveillance data for the period January to December 2011. Of the units contributing data, 15 (65.2%)* were solely ICUs, seven (30.4%) were combined ICU/ High Dependency Units (HDU) and one (4.4%) was a neurological ICU. The size of the contributing units ranged from three to 20 beds. For the purpose of this report all units including the combined ICU/HDU will be referred to as ICUs.

## 3.2 Patient population

Data from 6362 admissions (aged 16 years or over) to the participating ICUs between 01/01/2011 and 31/12/2011 with a stay of more than two days in the ICU were included. Two admissions had not been discharged at the time of data transfer and for analysis purposes these patients were 'arbitrarily discharged' on the last date for which device use data were available for these patients.

HAI surveillance data fields were not completed for 6% of the 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 6362 admissions, 3552 (55.8%) were male and 2810 (44.2%) 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)[4] score performed within the first 24 hours of the patient stay was 18.2 (standard deviation [SD], 7.2) and the median age was 62 [IQR= (48,72)]†.

## 3.3 HAI epidemiology

In total 356 infections (pneumonia, CRI and BSI) were reported from 301 (4.7%, 95% CI: 4.2 to 5.3) patients and met the criteria for inclusion in the analysis. Four duplicate infections were removed from the database.

Of the 356 infections, 198 (55.6%) were pneumonia, 136 (38.2%) were BSI (including CR-BSI) and 22 (6.2%) were Local CRI and General CRI. Figure 1 shows the percentage of each HAI type reported.

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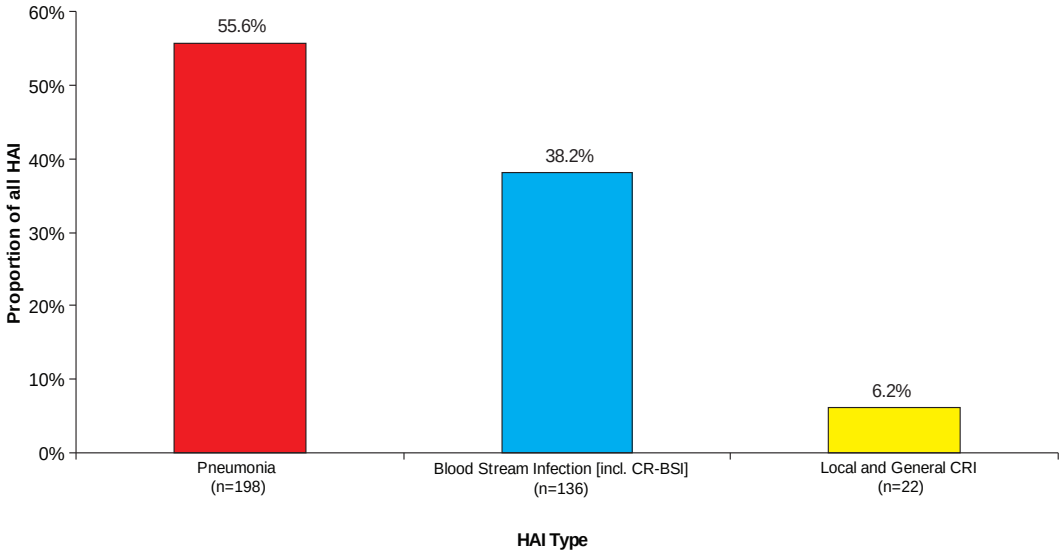
* One sole ICU closed and re-opened as a combined ICU/HDU in July 2011, this unit has been included within the combined units.

† Previous reports have described adjusted 'APACHE II scores', these scores were adjusted by the inclusion of the presedation Glasgow Coma Scale (GCS). These adjusted scores were used by SICSAG as they provided a better predictor for mortality in Scotland.
From this year onwards the APACHE II score described in this report will be an unadjusted APACHE II score, it will **not** include the pre-sedation GCS.

***FIGURE 1: Percentage of each infection type as a proportion of all HAI (n=356)***




Comparison of age, APACHE II[4] score (performed within the first 24 hours of the patient stay) and LOS for patients with an HAI and patients without an HAI is shown in Table 1. The mean APACHE II[4] score for patients with (19.0) and without an HAI (18.2) was not significantly different (p=0.06, Student T-test). The median LOS for patients with an HAI (17 days) and patients without an HAI (five days) was significantly different (p< 0.00001, Mann Whitney U test).

Analysis of the data in Table 2 shows that the distribution of age across the patient group with and without an HAI were similar, and show that there was no significant difference in age distribution across the two groups (p=0.17, Pearson chi-squared). These data are shown in Table 2.

***TABLE 1. Comparison of length of stay and APACHE II[4] score for patients with and without an HAI***

| | No HAI (n=6061) | | HAI (n=301) | | |
|---|---|---|---|---|---|
| **Variable** | **Median** | **IQR** | **Median** | **IQR** | **p value (Mann Whitney U)** |
| **Length of stay (days)** | 5 | 3,8 | 17 | 11, 28 | <0.00001 |
| | **Mean** | **95% CI (Lower CI, Upper CI)** | **Mean** | **95% CI (Lower CI, Upper CI)** | **p value (Student T-test)** |
| **APACHE II[4]** | 18.2 | 18.0, 18.4 | 19.0 | 18.2, 19.8 | 0.06 |

***TABLE 2: Distribution of age in patients with and without HAI***

| Age Group | No HAI | HAI | TOTAL |
|---|---|---|---|
| 16-29 | 398 (6.6%) | 28 (9.3%) | 426 (6.7%) |
| 30-49 | 1 272 (21.0%) | 66 (21.9%) | 1 338 (21.0%) |
| 50-64 | 1 752 (28.9%) | 85 (28.2%) | 1 837 (28.9%) |
| 65-79 | 2 086 (34.4%) | 104 (34.6%) | 2 190 (34.4%) |
| 80+ | 552 (9.1%) | 18 (6.0%) | 570 (9.0%) |
| **Total‡** | **6 060 (100%)** | **301 (100%)** | **6 361‡ (100%)** |

(Pearson Chi-squared p=0.17)

‡ Age was missing for one record

## 3.4 Pneumonia

A total of 198 pneumonia infections were reported from 179 (2.8%) patients. Of these infections, 175 (88.4%) were considered to be ventilator-associated pneumonia (VAP)§. The incidence density rates for pneumonia are shown in Table 3. The device utilisation rate for a invasive respiratory device was 650 per 1000 patient days.

***TABLE 3: Incidence density rates for pneumonia***

| HAI | Number | Incidence Rate | 95% CI (Lower CI, Upper CI) |
|---|---|---|---|
| **VAP** | 175 | 5.2 per 1000 invasive respiratory device days¶ | 4.5, 6.1 |
| **Pneumonia (no invasive respiratory device present)** | 23 | 0.4 per 1000 patient days | 0.3, 0.7 |
| **All** | 198 | 3.9 per 1000 patient days | 3.4, 4.4 |

§ Infections were considered to be VAP if the patient had an 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.

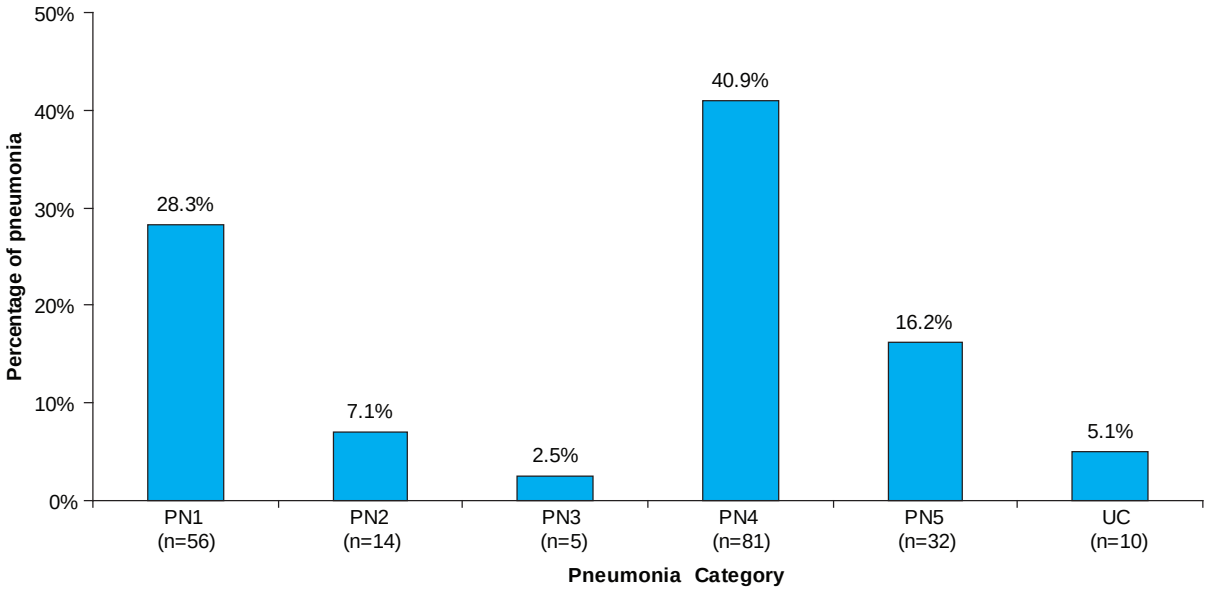
### *3.4.1 Diagnostic categories of pneumonia*

Pneumonia is categorised (PN1- PN5) for surveillance purposes, in accordance with the diagnostic microbiology methods used to identify the infection, as specified in the HELICS protocol[1]. The individual categories refer to the type of microbiology methods used to identify pneumonia, details of the categories are shown in Table 4. Figure 2 shows the distribution of pneumonia reported by diagnostic category. PN1 and PN4 account for 70% of all PN reported.

***TABLE 4: Pneumonia categories and diagnostic microbiology methods used to identify pneumonia***

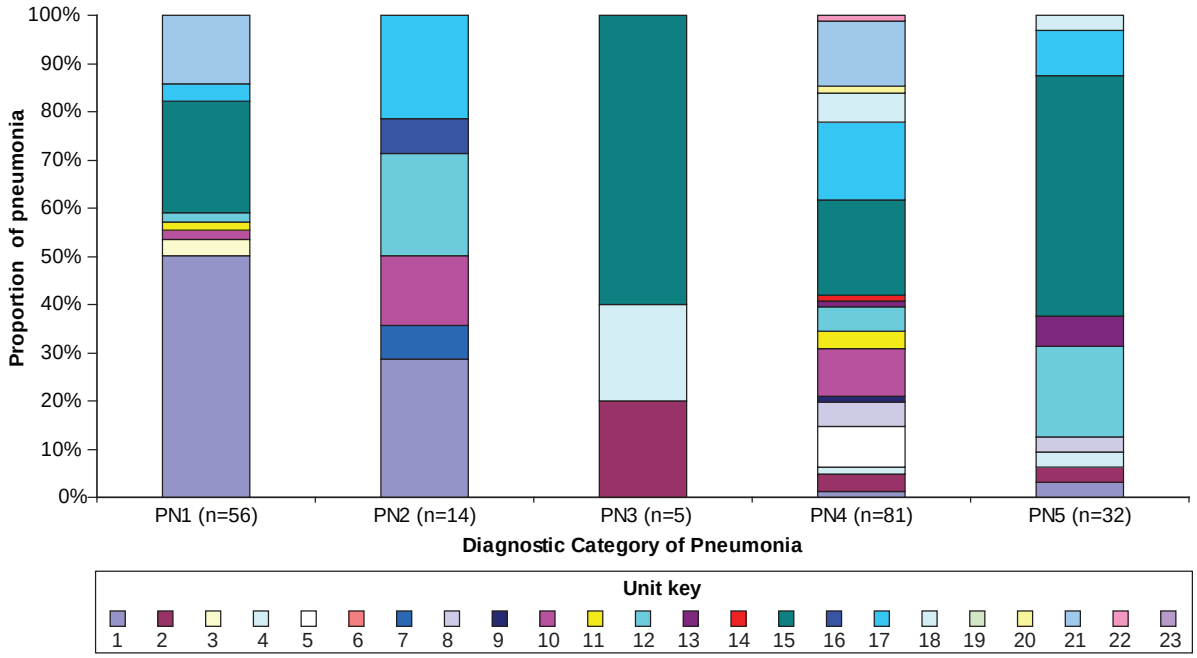
| Pneumonia Category | Diagnostic Microbiology Method |
|---|---|
| **PN1** | Positive quantitative culture from minimally contaminated lower respiratory tract (LRT) specimen e.g. broncho-alveolar lavage. |
| **PN2** | Positive quantitative culture from possibly contaminated LRT specimen e.g. endotracheal aspirate. |
| **PN3** | Alternative microbiology methods e.g. positive culture from pleural fluid, histological evidence for pneumonia and positive testing for viral or bacterial antigens. |
| **PN4** | Positive sputum culture or non-quantitative lower respiratory tract 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.* |

***FIGURE 2: The distribution of diagnostic categories of all pneumonia reported (n=198)***




As there are no standardised diagnostic microbiology testing methods for pneumonia in Scotland, the methods used to identify pneumonia vary across different hospitals and health boards. In order to capture the variation in the methodologies used, data relating to diagnostic categories reported by unit are shown in Figure 3. This stacked bar chart shows the percentage of pneumonia reported by different units for each diagnostic category. It also shows that the majority of units report PN1, PN4 and PN5, while fewer units report using the other diagnostic categories. Categories PN2 and PN3 are less frequently reported across all units and this reflects the infrequent use of the microbiology techniques required for these categories.

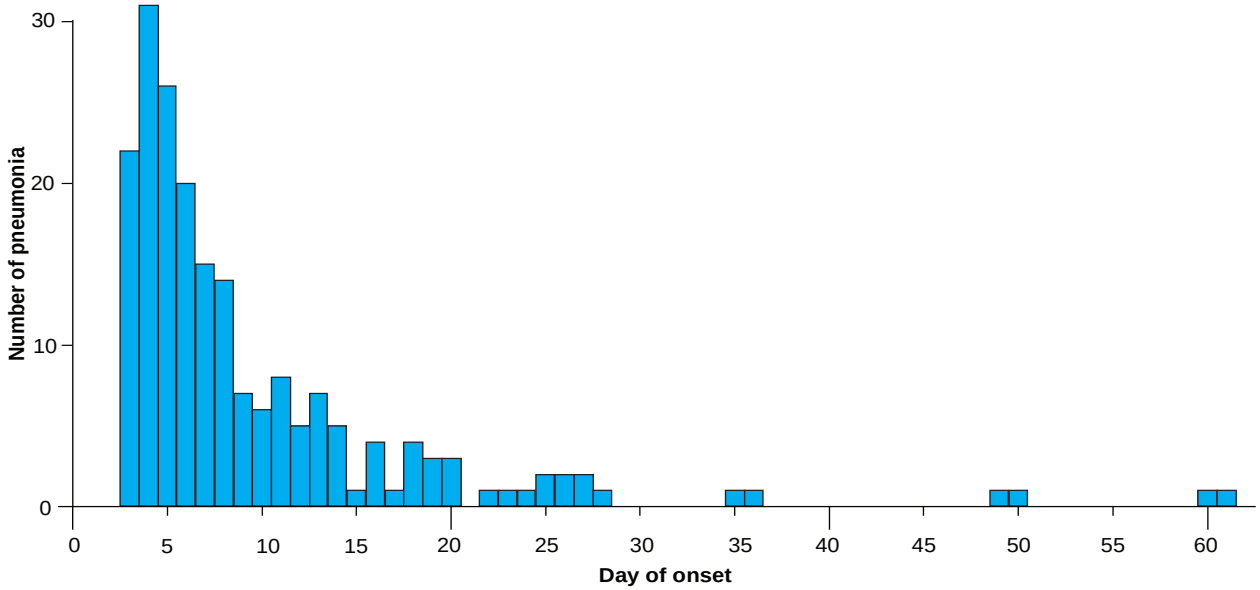
***FIGURE 3. The proportion of pneumonia reported for each diagnostic category by each unit (n=188, unclassified pneumonia are not included)***




### *3.4.2 Day of onset of pneumonia*

The median day of onset of pneumonia was 6.5 days [IQR= (4, 11)], the distribution of the day of onset of pneumonia (from day three of ICU stay onwards) is shown in Figure 4. The median day of onset of VAP was seven days [IQR= (4, 12)].

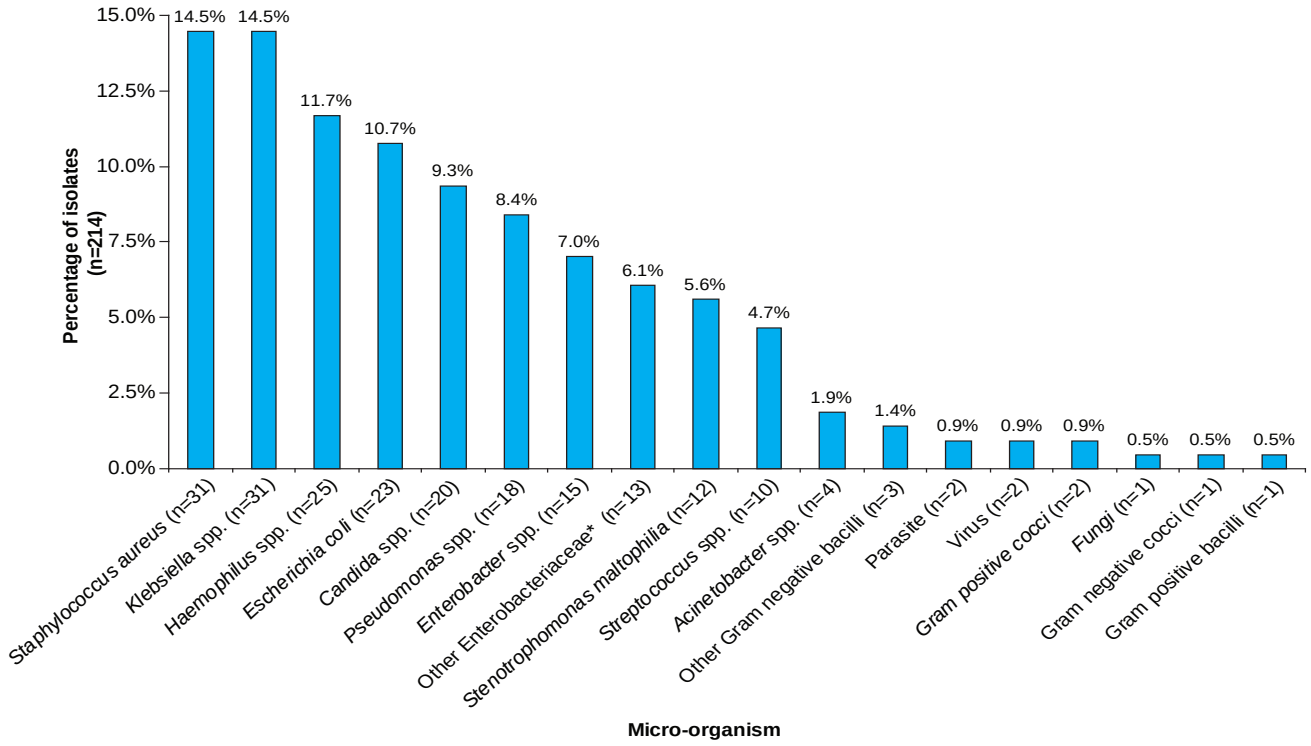
***FIGURE 4. Frequency of pneumonia infections by the day of onset.***



### 3.4.3 Distribution of micro-organisms isolated from pneumonia

Data for a total of 214 micro-organisms identified from patients with pneumonia were reported. Figure 5 shows the distribution of micro-organisms isolated from pneumonia and a complete breakdown of data at micro-organism level is given in Appendix I(a).

**FIGURE 5. The distribution of micro-organisms isolated from pneumonia**




*Other Enterobacteriaceae includes: *Serratia* sp. (4.7%), *Morganella* sp (0.5%), *Proteus* sp. (0.9%)

### 3.4.4 Key Summary Points - Pneumonia

- 2.8% of patients developed pneumonia during their stay in ICU.
- 88.4% of pneumonia were VAP.
- The incidence density of VAP was 5.2 per 1000 invasive respiratory device days.
- The incidence density of all pneumonia was 3.9 per 1000 patient days.
- The median day of onset for all pneumonia was 6.5 days and for VAP was seven days.
- PN1 and PN4 account for around 70% of all pneumonia reported.
- The most frequently isolated micro-organisms from pneumonia were *Klebsiella* spp. (14.5%) and *S. aureus* (14.5%), followed by *Haemophilus* spp. (11.7%) and *Escherichia coli* (10.7%). These organisms accounted for 50% of all isolates.

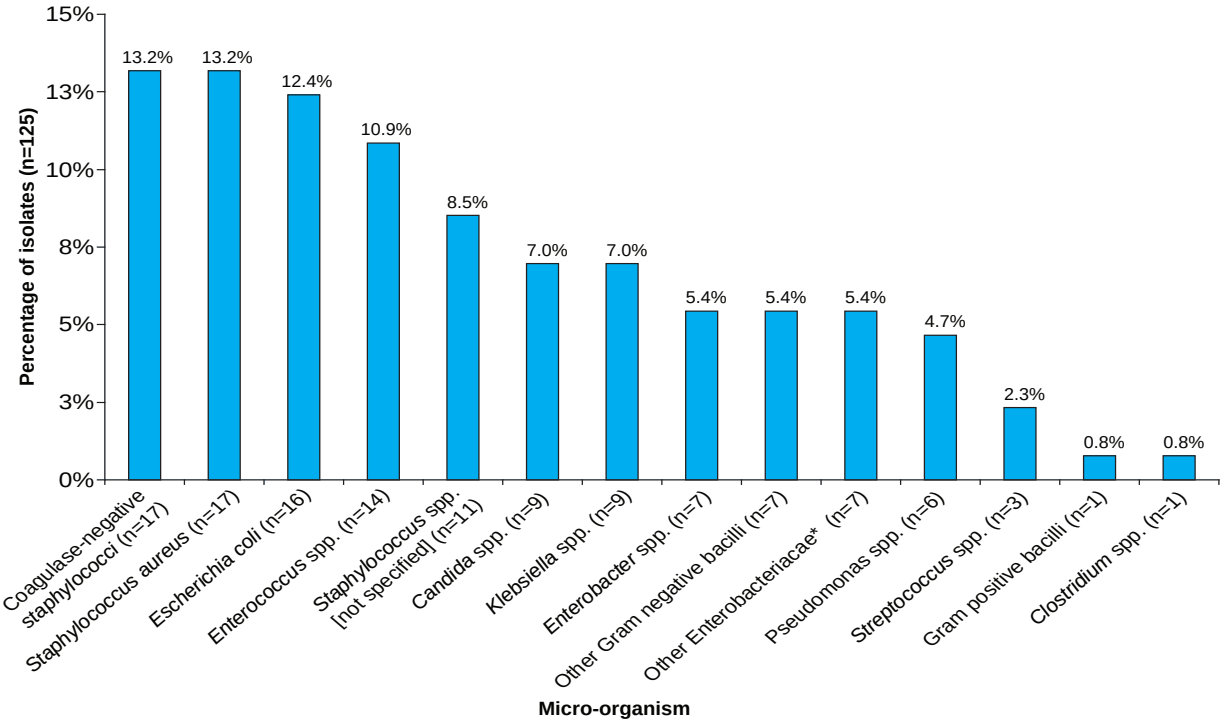
## 3.5 Blood Stream Infection

A total of 136 BSI were reported from 130 (2.0%) patients and the median day of onset was day nine [IQR= (5, 16)]. Of these, 20 (14.7%) were CR-BSI and the incidence density of CR-BSI was 0.6 per 1000 central venous catheter (CVC) days (95% CI: 0.4, 1.0). The incidence density of BSI (not including CR-BSI) was 2.3 per 1000 patient days, (95% CI: 1.9, 2.7). The device use ratio for CVC was 625 per 1000 patient days.

### *3.5.1 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 6 and a complete breakdown of micro-organism data is given in Appendix I(b).

***FIGURE 6: The distribution of micro-organisms isolated from blood stream infections***




*Other Enterobacteriacae includes: *Hafnia* sp. (n=1), *Serratia* spp. (n=6)

### *3.5.2 Presence of central venous catheters in patients with BSI not defined as CR-BSI*

Of the 116 BSIs (not including CR-BSI) reported, 91 (78.4%) 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, there was no positive microbiological CVC tip culture data available from these patients and therefore the HELICS case definition for CR-BSI[1] could not be met. It is assumed in this analysis that CVC tip culture data was not available because it was not carried out and that these 91 BSI can be classified as 'probable' CR-BSI. A summary of these data are shown in Table 5.

***TABLE 5: Summary of the CVC presence in patients with blood stream infection***

| Infection type | Number of infections |
|---|---|
| **BSI (no evidence of a CVC)** | 25 |
| **'Probable' CR-BSI (BSI with evidence of a CVC)** | 91 |
| **Confirmed CR-BSI** | 20 |
| **Total** | **136** |

Using the assumptions above, there were a total of 111 CR-BSI (91 probable and 20 confirmed BSI), the incidence rate for CR-BSI was 3.5 (95% C.I: 2.9-4.2) probable and assumed 'CR-BSI' per 1000 CVC days.

### *3.5.3 Key Summary Points- BSI*

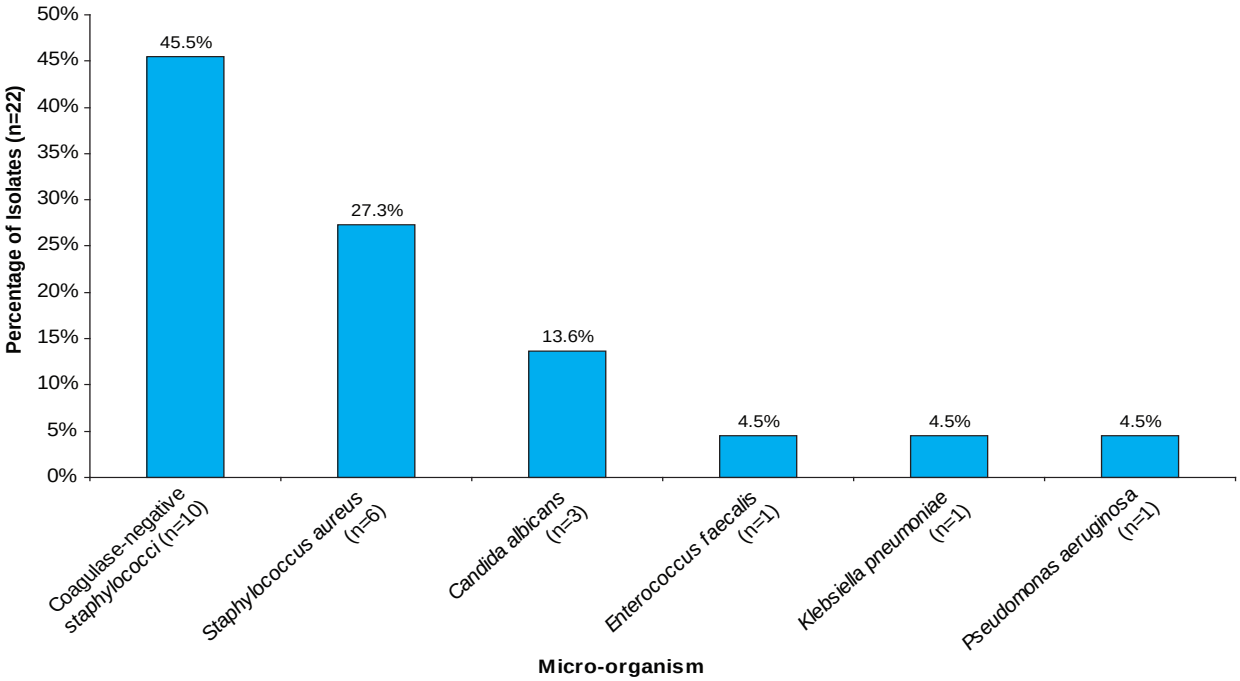
- 2.0% of patients developed a BSI.
- The incidence density of BSI (excl. CR-BSI) was 2.3 BSI per 1000 patient days.
- The incidence density of CR-BSI was 0.6 per 1000 CVC days.
- The incidence density of confirmed and 'probable' CR-BSI was 3.5 CR-BSI per 1000 CVC days.
- Of the 116 BSIs reported, a CVC was *in situ* or removed in the 48 hours prior to onset of BSI in 111 (81.6 %) cases.
- The most frequently isolated micro-organisms from BSI were coagulase negative staphylococci (13.2%), *S. aureus* (13.2%) and *E. coli* (12.4%). These organisms accounted for around 40% of all isolates.
- Enterobacteriaceae (including *E. coli*, *Klebsiella* spp, *Enterobacter* spp. accounted for 30% of all isolates from BSI.
- The high proportion of coagulase negative staphylococci isolated from BSI highlights the probable contamination of blood cultures.
- A total of nine units reported BSI where the causative organism was a coagulase negative staphylococcus.

## 3.6 CVC related infection (not including CR-BSI)

In total eight Local CRI and 14 General CRI were reported, the incidence density of Local CRI and General CRI was 0.7 per 1000 CVC days, (95% CI: 0.5, 1.0). The median time from admission to infection was nine days [IQR= (6, 17)].

Figure 7 shows the distribution of micro-organisms isolated from Local CRI and General CRI and a breakdown data at micro-organism level is given in Appendix I(c).

***FIGURE 7: The distribution of micro-organisms isolated from CVC related infection [not including CR-BSI]***




### *3.6.1 Key Summary Points- CRI (not including CR-BSI)*

- The incidence density of CRI (Local and General) was 0.7 per 1000 CVC days. Coagulase negative staphylococci (45.5%) and *S. aureus* (27.3%) were the most frequently isolated organisms from CRI.
- The numbers are very small and should therefore be interpreted with caution.

## 3.7 Antimicrobial resistance profile of *S. aureus* isolates

Antimicrobial resistance data were available from 51% of *S. aureus* isolated from all HAI types reported. Table 6 shows the antimicrobial resistance (AMR) phenotypes of *S. aureus* isolates from the HAI detailed in this report.

***TABLE 6: Antimicrobial resistance phenotypes of S. aureus isolates***

| | Isolated from (infection type) | | | |
|---|---|---|---|---|
| | **Pneumonia (n=21)** | **BSI (n=10)** | **CRI 1& 2 (n=4)** | **Total (n=35)** |
| MRSA | 3 (14.3%) | 1 (10%) | 0 (0%) | 4 (11.4%) |
| MSSA | 18 (85.7%) | 9 (90%) | 4 (100%) | 31 (88.6%) |

N.B. The AMR phenotype data was reported from 21 of the 23 contributing units.

### *3.7.1 Key Summary Points- AMR S. aureus*

- Antimicrobial resistance data was available for 51% of all *S. aureus* isolates.
- 11.4 % of all *S. aureus* isolated from HAI were MRSA.

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

Data from 2011 showed that 4.7% (95% CI 4.2, 5.3) of patients developed an HAI in ICU, this was a statistically significant reduction from 5.6% (95% CI 5.0, 6.2) in 2010 (Test of two proportions, p=0.04). Incidence rates for all HAI data collected in 2010 and 2011 are shown in Table 7. Analysis of these rates showed that there was a significant reduction in the BSI rate between 2010 and 2011.

***TABLE 7: Incidence rates by HAI type for 2010 and 2011***

| HAI type | Incidence Rate (Lower, upper 95% CI) | | Ratio of Rates (Wald test) | p value |
|---|---|---|---|---|
| | 2010 | 2011 | | |
| VAP per 1000 invasive respiratory device days | 5.1 (4.3, 6.0) | 5.2 (4.5, 6.1) | 1.03 (0.83, 1.28) | 0.79 |
| BSI (all) per 1000 patient days | 3.5 (3.0, 4.1) | 2.6 (2.2, 3.1) | 0.76 (0.60, 0.96) | 0.02 |
| BSI (excluding CR-BSI) per 1000 patient days | 2.9 (2.5, 3.5) | 2.3 (1.9, 2.7) | 0.77 (0.59, 0.98) | 0.04 |
| CR-BSI per 1000 CVC days | 0.8 (0.5, 1.2) | 0.6 (0.4, 1.0) | 0.77 (0.43, 1.39) | 0.39 |
| CRI (1 & 2) per 1000 CVC days | 0.7 (0.4, 1.0) | 0.7 (0.5, 1.0) | 1.02 (0.56, 1.87) | 0.95 |

The distribution of the top ten micro-organisms isolated from BSI and pneumonia 2011 and 2010 are shown in Figures 8 and 9. Detailed micro-organism data are shown in Appendix II.

***FIGURE 8: The distribution of the top ten organisms isolated from pneumonia infections in 2011 and the corresponding distribution of these organisms in 2010***

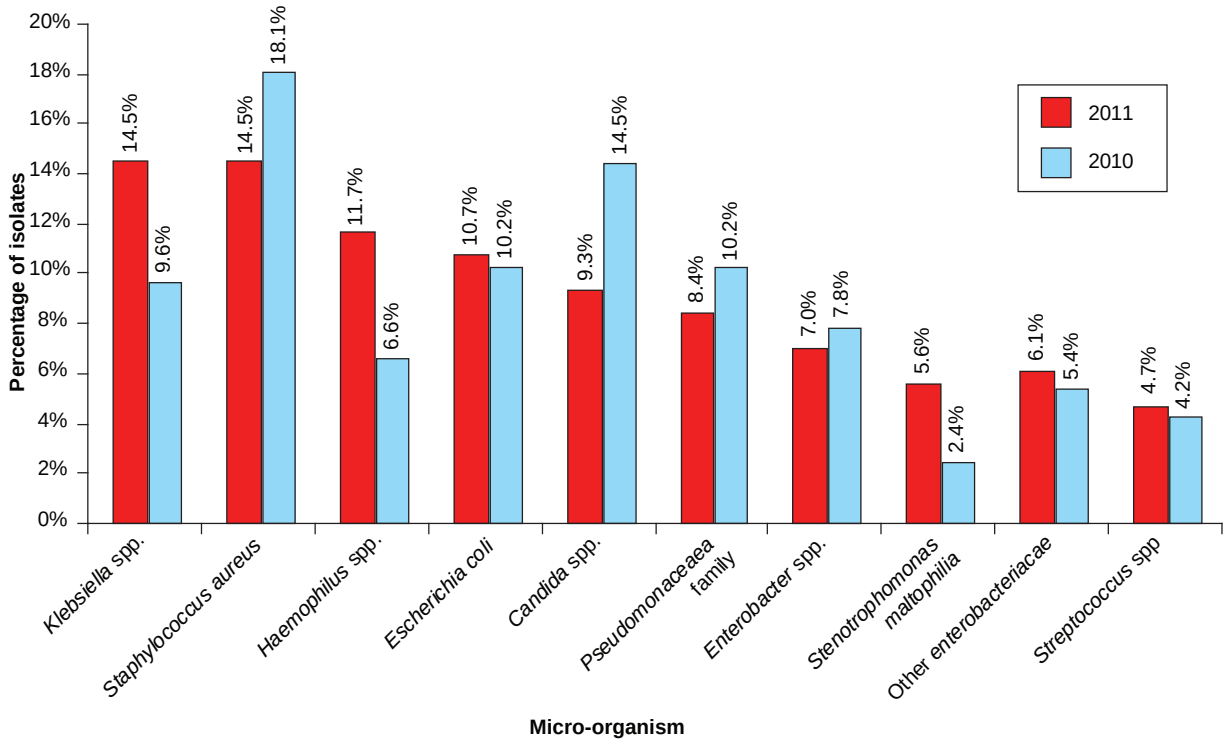
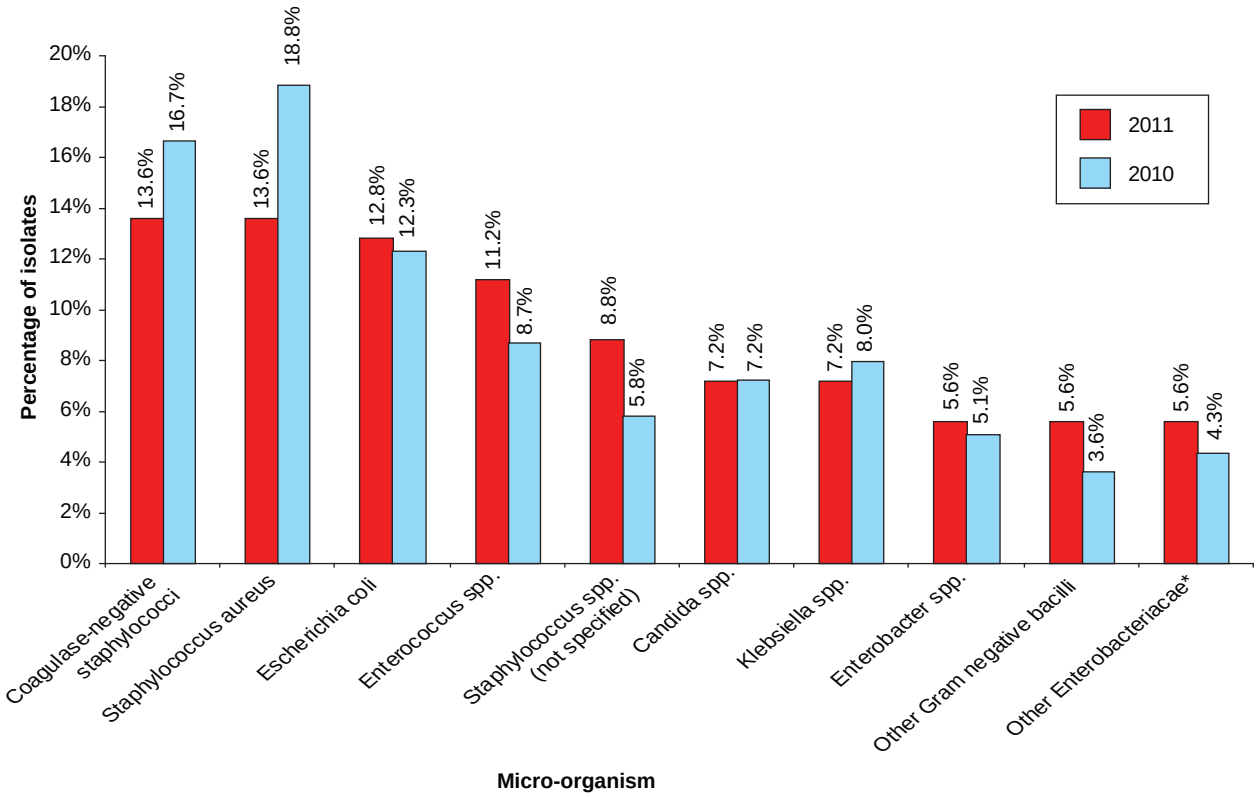


***FIGURE 9: The distribution of the top ten organisms isolated from blood stream infections in 2011 and the corresponding distribution of these organisms in 2010***




### *3.8.1 Summary points - Year on year comparison*

- The incidence rate of BSI (all) has reduced significantly from 3.5 to 2.6 BSI per 1000 patient days between 2010 and 2011.
- There has been no significant change in the other incidence rates of HAI reported between 2010 and 2011.
- Although there has been an increase in *Klebsiella* spp. and *Haemophilus* spp., and a decrease in *S. aureus* from pneumonia, there have been no statistically significant changes in the distribution of organisms reported between 2010 and 2011.
- Likewise for BSI, there has been a reduction in *S. aureus* which is not statistically significant.

## 4. DISCUSSION

This is the second annual report of healthcare associated infection surveillance data from the entire adult general ICU population in Scotland. The HAI surveillance data presented in this report were collected by 23 ICUs in Scotland over a 12 month period. The surveillance programme is voluntary and the current level of data collection demonstrates a huge commitment to monitoring and reducing HAI by the Scottish Critical Care workforce. While not all units have achieved complete and continuous data collection for 2011, it is anticipated that the current level of data collection can be improved upon in the future. SICSAG and HPS are committed to supporting units to improve data collection where required.

The overall findings of this report indicate that there has been a significant reduction in the proportion of patients developing an HAI in ICU. The percentage of infected patients dropped from 5.6% to 4.7% between 2010 and 2011. A reduction in BSI during 2011 from 3.5 to 2.6 BSI per 1000 patient days has also been seen. The incidence rate for all other infections included in the surveillance system remain similar to the rates for the 2010 data. The Scottish National Point Prevalence Survey of Healthcare Associated Infection and Antimicrobial Prescribing found that the prevalence of HAI in intensive care was 25.3% and in combined intensive care and high dependency wards the prevalence was 11.9%. These were the highest prevalence rates in acute care, and significantly higher than in general wards (4.8%).[5] Healthcare associated infection in the critical care setting should therefore remain a priority for surveillance in order to monitor trends and achieve the maximum possible reduction in HAI within this patient population.

The data presented in this report indicate that 2.8% of patients developed pneumonia and that almost 90% of these were VAP. The incidence of VAP presented in this report was 5.2 per 1000 invasive respiratory device days. This is similar to the Scottish rate of 5.1 per 1000 invasive respiratory device days for the previous year.[6] These rates are also within the range published by Europe, the European rates are calculated from aggregated data from 12 European countries, including Scotland. In the last European report of these data, the European incidence rate for pneumonia was 7.8 pneumonia per 1000 patient days and VAP varied across countries from 3.9 to 19.1 per 1000 invasive respiratory device days.[7]

The most frequently isolated micro-organisms from pneumonia were *Klebsiella* spp. (14.5%) and *S. aureus* (14.5%). The proportion of several organisms isolated from pneumonia has increased between 2010 and 2011. *Haemophilus* spp. increased from 6.6% to 11.7%, *Klebsiella* spp. increased from 9.6% to 14.5% and there was a reduction in *S. aureus* isolated from 18.1% to 14.5%. These numbers are relatively small, thus there are no statistically significant changes to the organisms isolated and caution is therefore required when interpreting these data. However, it is important that we take note of any emerging trends and shifts in the microbiology of HAI that develop over time and act on these appropriately.

Reporting of pneumonia by diagnostic categories PN1 and PN4 accounts for 70% of all pneumonia reported. This is similar to the patterns of reporting in 2010 and indicates that there has been no marked shift in diagnostic testing across Scotland that might influence incidence rates or the micro-organisms isolated. Analysis of data by the diagnosis category of pneumonia (e.g. PN1-5) indicates that there is considerable variation in diagnostic testing methods across Scotland. The data show that most units report using the PN1, PN4 and PN5 criteria and that a much smaller number of units report PN2 and PN3. This provides evidence around the variation in microbiology testing across Scotland and this variation may result

in variations in the incidence of pneumonia between units. Therefore, use of the data for benchmarking between units would not be appropriate. However, at unit level the data are collected consistently and as part of a National dataset they are consistent and are useful for country level benchmarking. At unit level, the data can be used as a measure of infection for monitoring and improvement purposes.

The data presented in this report indicate that 2.0% of patients within the patient population developed a BSI while in ICU during 2011. This is lower than the most recently published data reported from Europe stating that 4.7% of patients acquired a BSI in the ICU.[7] The incidence of all BSI was 2.6 per 1000 patient days, this was a significant reduction from 3.5 per 1000 patient days published from data collected in 2010. This reduction in BSI is encouraging and reflects the reductions that have been seen via other surveillance systems in Scotland, including the Scottish National Point Prevalence Survey of HAI and the *S. aureus* bacteraemia surveillance system for Scotland.[5] As only two years of data are available for comparison, this does not represent a trend and the limitations of the data discussed later should be considered when interpreting these findings.

A total of 14.7% of BSI were categorised as CR-BSI which is similar to 15.5% reported in 2010, thus suggesting that microbiology testing practice across Scotland has not changed in the last year. Recently published European data states that 41.3% of BSI are CR-BSI,[7] this is clearly greater than the proportion presented here. As discussed in a previous report of data from this surveillance system, the reasons for this are not clear but it is likely that this variation reflects the microbiology testing practice in Scotland.[6] Microbiology testing across Scotland does not routinely include CVC tip culture. As positive tip culture is an essential part of the CR-BSI case definition, it is not always possible to fulfil this.

In an attempt to address this issue, data from patients with a non-CVC related BSI have been investigated for the presence of a CVC at the time of, or in the 48 hours before BSI onset. The data we examined suggests that some CR-BSI may not be reported as the tip culture data required for fulfilment of the CR-BSI definition was not available. Seventy eight percent of non-CVC related BSI were found to have had a CVC *in situ* on the day of onset or in the 48 hours prior to onset. If these infections are considered to be 'probable' CR-BSI and the numbers are combined with the confirmed CR-BSI reported via the surveillance system, the combined incidence rate for 'probable' and confirmed CVC related BSI is 3.5 BSI per 1000 CVC days and in total 82% of BSI reported can be categorised as either 'probable' or confirmed CR-BSI.

Enhanced surveillance at one Scottish ICU suggests that over 50% of the 'probable' infections reported here may in fact be secondary blood stream infections. Data from Europe states that 35.7% of BSI were secondary to another infection.[7] Therefore it is likely that the 'true' CR-BSI incidence rate lies between the confirmed CR-BSI reported through the surveillance system and 'probable' rate presented here. However, without data to determine whether the BSI has another source it is not possible to determine a good estimate of CR-BSI by using the presence of a CVC around the time of infection as a proxy for positive tip culture data. Without routine culture of CVC tips, or a complete dataset on other infection sources, a reliable estimate of CR-BSI cannot be calculated. As WardWatcher cannot currently be adapted to facilitate the collection of additional data, this issue remains a challenge for HPS and SICSAG.

The most frequently isolated organisms from BSI were coagulase negative staphylococci (13.2%), *S. aureus* (13.2%) and *E. coli* (12.4%). The number of BSI reported as having coagulase negative staphylococci as the causative organism is of some concern. This high level (13.2%) of coagulase negative staphylococci isolates suggests that contamination of blood for culture may be an issue. In addition to the issue of contamination, the case definition for a BSI permits coagulase negative staphylococci to be reported as a causative organism providing the criteria in the HELICS 'BSI-B' case definition are met[1]. The European Centre for Disease Prevention and Control published a new protocol in 2011[8] which supersedes the HELICS protocol for ICU surveillance and has removed the less rigorous 'BSI-B' case definition which permitted a single blood culture positive for a skin contaminant together with other criteria. Due to the nature of the data collection system in Scotland and limited opportunity to update the WardWatcher software, Scotland have continued to allow 'BSI-B' to be reported. Future reporting of BSI will be reviewed by SICSAG and HPS in light the changes to the original case definitions and appropriate consideration will be given to promoting good practice to avoid blood culture contamination across Scotland.

Of the *S. aureus* isolates for which antimicrobial resistance data were available, 11.8% were MRSA, this was a reduction from 20% in 2010.[6] The reduction in MRSA isolates seen in this report does correlate with the data from the Scottish *S. aureus* bacteraemia surveillance system, where a total of 14% of *S. aureus* bacteraemia across Scotland were MRSA, this was a reduction from 19% in 2010.[9] The data reported here show a similar trend but the numbers in this report are small and include isolates from pneumonia and CVC related infections as well. Therefore the data should be interpreted with caution.

## Limitations of the data

All units collected data during the full 12 month period, however some units were unable to provide a complete data set for the full period, and therefore direct comparisons with data from 2010 should be viewed with caution. Units vary in size, patient characteristics, compliance with data collection and therefore some units may be over or under represented in the data.

Whilst all units are working from a standardised protocol and definitions for infection ascertainment, there is variability across the country in terms of microbiological sampling and diagnostic testing. For example, for the investigation of a suspected VAP, some units routinely carry out broncheoalveolar lavage while others carry out only semi-quantitative diagnostics methods. Likewise, in the categorisation of a BSI, some units routinely send tip cultures for investigation, others do not. Aspects of subjectivity in some of the case definitions will also lead to variability. For example the HELICS case definition for VAP includes 'change in character of sputum', 'worsening gas exchange' and 'rales or bronchial breath sounds', all of which are open to interpretation by the observer. Subjectivity such as this could lead to variability in reporting.

## Future work

HPS and SICSAG will continue to support and work with the Critical Care Community in Scotland to improve care through the use of surveillance data. SICSAG have recently implemented a number of Quality Indicators for Critical Care,[10] including participation in the surveillance programme for HAI and it is anticipated that this will improve compliance with data collection and promote the use of surveillance data for local improvement.

In terms of the issues with the case definitions, and in particular the CR-BSI definition, SICSAG and HPS will continue to seek ways to address this and will collaborate with UK counterparts in this regard. SICSAG and HPS will also seek to raise awareness around the issues of variable diagnostic testing across Scotland and the implications of this for surveillance data.

As a next step for this surveillance programme, SICSAG and HPS will investigate the options for utilising a wider range of existing microbiology and antimicrobial resistance data to inform this aspect of the surveillance programme through data linkage if possible.

## 5. REFERENCES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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 inter quartile 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 inter quartile 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.

### Device Utilisation
Total number of days that a patient had a CVC or invasive respiratory device in situ as a proportion of the sum of the patient days contributed by each patient in the study population. The proportion is expressed as the number of CVC or invasive respiratory device per 1000 patient days.

# APPENDIX I

## Micro-organisms isolated from each HAI type

### *a) Micro-organisms isolated from pneumonia (n=214)*

| Genus | Micro-organism | Number of isolates | Percentage of isolates |
|---|---|---|---|
| Enterobacteriaceae (n=82) | *Klebsiella* spp. | 31 | 14.5% |
| | *Escherichia coli* | 23 | 10.7% |
| | *Enterobacter* spp. | 15 | 7.0% |
| | *Serratia marcescens* | 6 | 2.8% |
| | Serratia spp. | 4 | 1.9% |
| | *Morganella* sp. | 1 | 0.5% |
| | *Proteus vulgaris* | 1 | 0.5% |
| | *Proteus* sp. | 1 | 0.5% |
| Gram negative bacilli (n=62) | *Haemophilus* sp. | 25 | 11.7% |
| | *Pseudomonas* spp. | 18 | 8.4% |
| | *Stenotrophomonas maltophilia* | 12 | 5.6% |
| | *Acinetobacter* sp. | 4 | 1.9% |
| | Other Gram-negative bacilli | 2 | 0.9% |
| | *Flavobacterium* sp. | 1 | 0.5% |
| Gram positive bacilli (n=1) | *Bacillus* sp. | 1 | 0.5% |
| Gram negative cocci (n=1) | *Neisseria meningitidis* | 1 | 0.5% |
| Gram positive cocci (n=43) | *Staphylococcus aureus* | 31 | 14.5% |
| | *Streptococcus* spp. | 6 | 28% |
| | *Streptococcus pneumoniae* | 4 | 1.9% |
| | *Enterococcus* sp., not specified | 2 | 0.9% |
| Parasites, Viruses & Fungi (n=25) | *Candida* spp. | 20 | 9.3% |
| | Other parasites | 2 | 0.9% |
| | Influenza A virus | 1 | 0.5% |
| | Virus | 1 | 0.5% |
| | *Aspergillus* sp. | 1 | 0.5% |
| **All** | | **214** | **100%** |

### *b) Micro-organisms isolated from BSI (n=125)*

| Genus | Micro-organism | Number of isolates | Percentage of isolates |
|---|---|---|---|
| Anaerobic bacilli (n=1) | *Clostridium* spp. | 1 | 0.8% |
| Enterobacteriaceae (n=39) | *Escherichia coli* | 16 | 12.8% |
| | *Klebsiella* spp, (not specified) | 4 | 3.2% |
| | *Serratia marcescens* | 4 | 3.2% |
| | *Enterobacter cloacae* | 3 | 2.4% |
| | *Klebsiella pneumoniae* | 3 | 2.4% |
| | *Enterobacter* spp. (not specified) | 3 | 2.4% |
| | *Klebsiella oxytoca* | 2 | 1.6% |
| | *Serratia* spp. (not specified) | 2 | 1.6% |
| | *Enterobacter gergoviae* | 1 | 0.8% |
| | *Hafnia* sp.(not specified) | 1 | 0.8% |
| Fungi (n=9) | *Candida* spp. (not specified) | 6 | 4.8% |
| | *Candida albicans* | 2 | 1.6% |
| | *Candida glabrata* | 1 | 0.8% |
| Gram negative bacilli (n=13) | *Pseudomonas* spp.(not specified) | 4 | 3.2% |
| | *Achromobacter* spp.(not specified) | 2 | 1.6% |
| | Other Gram-negative bacilli | 2 | 1.6% |
| | *Pseudomonas aeruginosa* | 2 | 1.6% |
| | *Stenotrophomonas maltophilia* | 2 | 1.6% |
| | *Acinetobacter* sp. (not specified) | 1 | 0.8% |
| Gram positive bacilii (n=1) | *Bacillus* sp. | 1 | 0.8% |
| Gram positive cocci (n=62) | *Staphylococcus aureus* | 17 | 13.6% |
| | *Staphylococcus* spp. (not specified) | 11 | 8.8% |
| | *Staphylococcus epidermidis* | 10 | 8.0% |
| | *Enterococcus* spp. (not specified) | 6 | 4.8% |
| | *Enterococcus faecalis* | 5 | 4.0% |
| | Coagulase negative staphylococci | 4 | 3.2% |
| | *Enterococcus faecium* | 3 | 2.4% |
| | *Staphylococcus haemolyticus* | 3 | 2.4% |
| | *Streptococcus* spp. (not specified) | 3 | 2.4% |
| **All** | | **125** | **100%** |

### *c) Micro-organisms isolated from CRI-1 and CRI-2 (n=22)*

| Genus | Micro-organism | Number of isolates | Percentage of isolates |
|---|---|---|---|
| Enterobacteriacae (n=2) | *Enterococcus faecalis* | 1 | 4.5% |
| | *Klebsiella pneumoniae* | 1 | 4.5% |
| Gram positive cocci (n=16) | *Coagulase negative staphylococci* (not specified) | 6 | 31.8% |
| | *Staphylococcus aureus* | 6 | 27.3% |
| | *Staphylococcus epidermidis* | 2 | 9.1% |
| | *Staphylococcus haemolyticus* | 2 | 4.5% |
| Gram negative bacilli (n=1) | *Pseudomonas aeruginosa* | 1 | 4.5% |
| Fungi (n=3) | *Candida albicans* | 3 | 13.6% |
| **All** | | **22** | **100%** |

# APPENDIX II

### *(a) Top ten micro-organisms isolated from pneumonia in 2011 and corresponding frequencies for 2010*

| Organism | Year | |
|---|---|---|
| | 2011 | 2010 |
| | Number (percentage) of total isolates [Lower, upper 95% CI] | |
| *Klebsiella* spp. | 31(14.5%) [10.4, 19.8] | 16 (9.6%) [6.0, 15.0] |
| *Staphylococcus aureus* | 31 (14.5%) [10.4, 19.8] | 30 (18.1%) [13.0, 24.6] |
| *Haemophilus* spp. | 25 (11.7%) [8.0, 16.7] | 11 (6.6%) [3.7, 11.5] |
| *Escherichia coli* | 23 (10.7%) [7.3, 15.6] | 17 (10.2%) [6.5, 15.8] |
| *Candida* spp. | 20 (9.3%) [6.1, 14.0] | 24 (14.5%) [9.9, 20.6] |
| *Pseudomonas* spp. | 18 (8.4%) [5.4, 12.9] | 17 (10.2%) [6.5, 15.8] |
| *Enterobacter* spp. | 15 (7.0%) [4.3, 11.2] | 13 (7.8%) [4.6, 12.9] |
| *Stenotrophomonas maltophilia* | 12 (5.6%) [3.2, 9.5] | 4 (2.4%) [1.0, 6.3] |
| Other enterobacteriaceae | 13 (6.1%) [3.6, 10.1] | 9 (5.4%) [2.9, 10.0] |
| *Streptococcus* spp. | 10 (4.7%) [2.6, 8.4] | 7 (4.2%) [2.1, 8.5] |

### *(b) Top ten micro- organisms isolated from BSI in 2011 and corresponding frequencies for 2010*

| Organism | Year | |
|---|---|---|
| | 2011 | 2010 |
| | Number (percentage) of total isolates [Lower, upper 95% CI] | |
| *Coagulase negative staphylococci* | 17 (13.6%) [8.7, 20.1] | 23 (16.7%) [11.4, 23.8] |
| *Staphylococcus aureus* | 17 (13.6%) [8.7, 20.1] | 26 (18.8%) [13.2, 26.2] |
| *Escherichia coli* | 16 (12.8%) [8.0, 19.8] | 17 (12.3%) [7.8, 18.8] |
| *Enterococcus spp.* | 14 (11.2%) [6.8, 17.9] | 12 (8.7%) [5.0, 14.6] |
| *Staphylococcus spp. (not specified)* | 11 (8.8%) [5.0, 15.1] | 8 (5.8%) [3.0, 11.0] |
| *Candida spp.* | 9 (7.2%) [3.8, 13.1] | 10 (7.2%) [4.0, 12.8] |
| *Klebsiella spp.* | 9 (7.2%) [3.8, 13.1] | 11 (8.0%) [4.5, 13.7] |
| *Enterobacter spp.* | 7 (5.6%) [2.7, 11.1] | 7 (5.1%) [2.5, 10.1] |
| Other Gram negative bacilli | 7 (5.6%) [2.7, 11.1] | 5 (3.6%) [1.6, 8.2] |
| *Other Enterobacteriacae** | 7 (5.6%) [2.7, 11.1] | 6 (4.3%) [2.0, 9.2] |

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