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Acronyms

ABHR	Alcohol Based Hand Rub
AMR	Antimicrobial Resistance
AMT	Antimicrobial Management Team
AOBD	Acute Occupied Bed Days
BSI	Bloodstream Infection
CAUTI	Catheter Associated Urinary Tract Infection
CDI	*Clostridium difficile* Infection
CEO	Chief Executive Officer
CI	Confidence Intervals
CRA	Clinical Risk Assessment
CNO	Chief Nursing Officer
CPE	Carbapenemase-producing Enterobacteriaceae
CVC	Central Vascular Catheter
DALY	Disability-adjusted Life Year
ECDC	European Centre for Disease Prevention and Control
ECOSS	Electronic Communication of Surveillance in Scotland
ENT	Ear, Nose and Throat
EU	European Union
HAI	Healthcare Associated Infection
HCW	Healthcare Worker
HDU	High Dependency Unit
HIS	Healthcare Improvement Scotland
HPS	Health Protection Scotland
ICD	Infection Control Doctor
ICU	Intensive Care Unit
IPC	Infection Prevention and Control
IPCN	Infection Prevention and Control Nurse
IPCT	Infection Prevention and Control Team
IQR	Inter-quartile range
IRR	Inter-rater reliability
ISD	Information Services Division
IVOST	Intravenous to Oral Switch Therapy
MDR	Multidrug Resistant
MDRO	Multidrug Resistant Organisms
MRSA	Meticillin Resistant *Staphylococcus aureus*
MSSA	Meticillin Sensitive *Staphylococcus aureus*
NHS	National Health Service

NHSN	National Healthcare Safety Network
NICE	National Institute for Health and Care Excellence
NICU	Neonatal Intensive Care Unit
OBGYN	Obstetrics and Gynaecology
OBD	Occupied Bed Days
OR	Odds Ratio
PBPP	Public Benefit and Privacy Panel for Health and Social Care
PIA	Privacy Impact Assessment
PPS	Point Prevalence Survey
PVC	Peripheral Vascular Catheter
SAPG	Scottish Antimicrobial Prescribing Group
SICPs	Standard Infection Control Precautions
SSI	Surgical Site Infection
SST	Skin and Soft Tissue
SWISS	Scottish Workforce Information Standard System
TATFAR	Transatlantic Taskforce on Antimicrobial Resistance
TB	Tuberculosis
UTI	Urinary Tract Infection
WHO	World Health Organisation
WTE	Whole Time Equivalent

NHS board abbreviations

AA	Ayrshire & Arran
BR	Borders
DG	Dumfries & Galloway
FF	Fife
FV	Forth Valley
GGC	Greater Glasgow & Clyde
GR	Grampian
HG	Highland
LN	Lanarkshire
LO	Lothian
NWTC	National Waiting Times Centre
OR	Orkney
SH	Shetland
TY	Tayside
WI	Western Isles

Executive Summary

Scottish National HAI and Antimicrobial Prescribing PPS 2016

Approximately **1** in **22** acute adult inpatients had at least 1 HAI

LOWER THAN IN 2011

Approximately **1** in **3** acute adult inpatients were receiving antimicrobials

HIGHER THAN IN 2011

HAI OCCURRING IN ACUTE ADULT PATIENTS

	2016	2011
Urinary tract	24.5%	23.1%
Pneumonia	22.4%	17.6%
Surgical Site Infection	16.5%	19.2%
Laboratory-confirmed BSI	8.7%	9.7%
Skin and soft tissue	7.2%	4.1%
Eye, ear, nose or throat	5.5%	9.0%
Gastrointestinal tract infection	5.1%	6.8%
Other	10.2%	10.7%

HAI and AMR remain a public health threat across all care settings in Scotland.

A continued focus on IPC quality improvement and antimicrobial stewardship is required to ensure patient safety and minimise the threat of AMR.

Antimicrobial Stewardship Priorities

- Promote documentation of indication and compliance with local policy in all clinical settings
- Reduce unnecessary prescribing by undertaking timely reviews, promoting IV to oral switch and improving documentation
- Reduce unnecessary prolongation of surgical prophylaxis beyond once only doses
- Improve compliance with local carbapenem and piperacillin/tazobactam prescribing policies
- Improve compliance with local prescribing policies for broad spectrum antimicrobials associated with an increased risk of *Clostridium difficile* infection

INFECTIONS BEING TREATED WITH ANTIMICROBIALS IN ACUTE ADULT PATIENTS

	2016	2011
Respiratory	35.3%	31.1%
SST, bone and joint	17.5%	18.4%
Gastrointestinal	15.4%	13.4%
Urinary tract	13.8%	14.0%
Systemic	9.3%	10.5%
Other	8.6%	12.3%

IPC Quality Improvement Priorities

- Multimodal national programmes to prevent pneumonia in non-ventilated patients and UTI in non-catheterised patients
- Local multimodal quality improvement strategies
- Implementation of invasive device insertion and maintenance bundles with a focus on reviewing the need for the continued use of the device
- Interventions to reduce the risk of UTI and other infections in older people across all settings
- Prevention of Gram negative infections across health and social care
- Prevention of sepsis and bloodstream infections in neonates
- Improved availability of ABHR at point of care and the availability of a 7 day microbiology service
- Increased single room and isolation capacity
- Integrated public health approach to prevention of infection
- Review of the specialised workforce to deliver strategies to reduce infection risk in all settings

Characteristics of the patient population

The patients included in the survey of acute hospitals were older and sicker compared with the 2011 survey. More than half of the patients in acute hospitals were over 65 years and a quarter over 80 years. More than two fifths of patients had the most severe co-morbidity scores and this was higher than in 2011. In non-acute care, more than three quarters were aged over 65 years and half over 80 years. Two thirds of patients had the most severe co-morbidity scores.

HAI occuring in paediatric patients

The prevalence of HAI was 2.7%; this was not significantly different from 2011. The majority of the infections occurred in neonates, including those in neonatal ICU. The most common HAI types reported in these patients were clinical sepsis and bloodstream infections.

HAI occurring in non-acute patients

A 25% random sample of non-acute hospitals was included in the survey. The prevalence of HAI in the sample was 3.2%. Urinary tract infections accounted for more than half of all HAI in this patient group.

Microbiology

The most common organism reported in acute and non-acute care was *Escherichia coli*; this organism has now replaced *Staphylococcus aureus* as the most commonly reported organism. Microbiology data were reported only for HAI where there was available microbiology at the time of survey.

Invasive device use

A third of acute adult patients had a PVC in situ on the day of survey and the prevalence was higher in 2016 compared with 2011 after adjustment for changes in the patient case mix. One in five patients were catheterised and there was no difference in the prevalence between 2016 and 2011.

Antimicrobial prescribing in paediatric patients

One in three paediatric patients were receiving antimicrobials at the time of survey and this was not significantly different from 2011. The most common reason for prescribing was treatment of systemic infections such as clinical sepsis and febrile neutropenia. One in five paediatric patients were receiving antimicrobials as medical prophylaxis.

Antimicrobial prescribing in non-acute patients

One in eight non-acute patients were receiving antimicrobials at the time of survey. Approximately half of antimicrobials were prescribed to treat urinary or respiratory tract infection and one in five were prescribed as medical prophylaxis.

Antimicrobial prescribing quality indicators

Compliance with local policy and documentation in acute care was significantly higher in 2016 compared with 2011. However, approximately a quarter of broad spectrum antimicrobials associated with an increased risk of CDI and a fifth of very broad spectrum antimicrobials, namely carbapenems and piperacillin/tazobactam, were not compliant with local prescribing policy.

Epidemiology of key infection types and associated antimicrobial prescribing

A summary of 4 key infection types: urinary tract infection, pneumonia, surgical site infection and bloodstream infection are provided in separate summary infographics.

IPC and antimicrobial stewardship structure and process indicators

These indicators have been collected for the first time in Scotland and will inform future development of local and national IPC programmes. The following areas for improvement were identified: improving ABHR availability and the availability of data on ABHR use; single room provision and isolation capacity; improving coverage of a seven day microbiology service; development of multimodal strategies for prevention of pneumonia and urinary tract infections that are not device associated; and the role of ICNs, ICDs and the resources dedicated to antimicrobial stewardship.

Introduction

Healthcare associated infections (HAI) are a major public health concern and a significant cause of morbidity and mortality globally.[1] The European Centre for Disease Prevention and Control (ECDC) estimates that 3.2 million patients develop a HAI every year in Europe.[2] In 2011, it was estimated that one in twenty Scottish inpatients had an infection associated with healthcare delivered in a Scottish hospital.[3] The inpatient cost of HAI originating in Scottish acute care hospitals was estimated to be £137 million a year with an additional 318 172 bed days required in order to care for patients with HAI; the equivalent of a large teaching hospital occupied for one year.[4] A significant proportion of HAI are considered to be avoidable and prevention of these infections provides an opportunity to improve patient outcome and reduce unnecessary costs within healthcare systems.[5]

A robust and current evidence base that is specific to Scottish hospital settings is necessary to inform the development of local and national strategies to reduce HAI and contain antimicrobial resistance (AMR).[6] National point prevalence surveys (PPS) are undertaken every five years in Scotland in order to take stock of the current epidemiological situation and to review local and national policy.

Background

To date, there have been two Scottish national PPS of HAI and antimicrobial use; one undertaken in 2005/6 and a second in 2011. The first survey reported that one in ten inpatients at any one time had an infection that was associated with healthcare delivery in Scottish hospitals.[7] The second survey was undertaken as part of a Europe-wide survey and included collection of comprehensive antimicrobial prescribing data.[2] This survey reported that the prevalence of HAI was 4.9% in acute hospital inpatients and that almost a third of patients were receiving antimicrobials at any one time.[3] Due to differences in the protocol adopted in the two surveys, the results were not directly comparable but it was estimated that the prevalence of HAI was a third lower in 2011 compared with the 2005/6 survey.

The Scottish Government tasked Health Protection Scotland (HPS) with coordinating a third Scottish National PPS of HAI and Antimicrobial Prescribing and advised the NHS boards of the requirement to participate.[8] The results from this third PPS of HAI and antimicrobial prescribing provide an opportunity to review the current epidemiology of HAI and antimicrobial prescribing and, for the first time, describe infection prevention and control (IPC) and antimicrobial stewardship structures and processes in Scottish hospitals. The intelligence will inform the development of key priority areas and recommendations for the prevention and control of HAI, and quality improvement interventions for IPC and antimicrobial stewardship. This will assist the Scottish Government in the further development of national policy to reduce HAI, improve antimicrobial prescribing and contain AMR in Scotland.

Aims and objectives

The objectives of the 2016 prevalence survey were to:

- Measure the specific types and overall prevalence of HAI
- Measure the overall prevalence of antimicrobial prescribing and types of antimicrobials prescribed, as well as compliance with Scottish Antimicrobial Prescribing Group (SAPG) prescribing quality indicators
- Describe the organisation of IPC and antimicrobial stewardship programmes
- Identify priority areas for future interventions to prevent and control HAI, and for antimicrobial stewardship quality improvement strategies
- Contribute to the ECDC prevalence survey and inform the European strategy to reduce HAI and antimicrobial resistance.

Methods

Study design

A rolling point prevalence survey was carried out in Scottish hospitals during September, October and November 2016. The Scottish protocol was developed using the ECDC protocol for PPS.[9] A Privacy Impact Assessment (PIA) was undertaken and the project was reviewed and approved by the Public Benefit and Privacy Panel for Health and Social Care (PBPP) (Application Number: 1516-0599).

Data were collected by NHS board staff members from local IPC and Antimicrobial Management Teams (AMTs). Each ward surveyed was completed within one day (Monday to Friday) and wards where elective procedures were carried out were surveyed between Tuesday and Friday.

Data were extracted from a number of sources available on the ward at the time of survey. These included nursing notes, medical notes, temperature charts, drug charts, electronic prescribing systems, surgical notes, laboratory reports e.g. microbiology results, and other relevant charts e.g. wound charts, stool charts and care plans. Data collectors were advised to seek clarification from ward staff if the information held in the records was not clear.

Full details of the study design and data collection methods are provided in the PPS protocol.[10]

Training and support

A one day training course was developed using standardised ECDC training materials and was delivered to approximately 200 staff across Scotland. A further cascade training pack was developed to enable pharmacists who attended the one day course to deliver the training to other pharmacists in a cascaded manner; this training approach permitted those trained in this way to assist with the collection of antimicrobial data only.

A helpdesk facility was provided by HPS to support the local data collection teams. This was operational during normal working hours in the months of September, October and November 2016. Queries to the helpdesk were used to develop a weekly Frequently Asked Questions document which was provided to the data collectors.

Inclusion and exclusion criteria

The survey included all NHS acute, NHS paediatric and independent hospitals, and a 25% sample of NHS non-acute hospitals. Non-acute hospitals were defined using Information Services Division (ISD) classification of Scottish hospitals.[11]

All wards with the exception of day units and residential care units within acute hospitals were included. All patients who were admitted to the ward at 8am on the morning of the survey, with the exception of day patients, were eligible for inclusion in the survey. Patients admitted to or transferred into the ward after 8am were excluded. Patients who left the ward before they were surveyed were not followed up and were therefore excluded from the survey.

Data definitions

Risk factor data

Data were collected on risk factors for HAI including age and the McCabe score[12], which was used to measure the underlying medical condition of the patient at the time of survey (or prior to HAI onset in patients with a HAI). National Healthcare Safety Network (NHSN) operative procedure categories[13] were used to categorise patients who had undergone minimally invasive or invasive surgery since admission to the survey hospital. Each patient was surveyed to identify invasive devices in situ at the time of survey. Patients with peripheral vascular catheters (PVC), central vascular catheters (CVC), urinary catheters and patients who were intubated regardless of whether they were receiving mechanical ventilation, were identified. The length of time the patient had spent in hospital prior to survey was calculated. For patients with HAI, the length of time between admission and onset of HAI was used to reduce length of stay bias introduced by extended lengths of stay in patients with HAI.

HAI data

The ECDC case definitions for HAI were used.[9] Neonatal HAI case definitions were used for babies in the neonatal ward only. General HAI case definitions were used for all other patients including babies and children in paediatric wards.

HAI data were collected for patients with an active HAI at the time of survey.

A HAI was considered active if:

- the HAI met one of the HAI case definitions on the day of survey
- the patient was receiving antimicrobials for a HAI on the day of survey and the HAI had previously met one of the case definitions between day 1 of antimicrobial treatment and day of survey

In addition, the onset of infection must have occurred within one of the following time frames:

- day 3 of current admission onwards (if day of admission is Day 1)
- present on admission (or presenting on day 1 or 2) in patients discharged from hospital (acute or non-acute) in previous 2 days
- surgical site infection present on admission (or presenting on day 1 or 2)
- *Clostridium difficile* infection (CDI) present on admission (or presenting on day 1 or 2) in patients discharged from hospital (acute or non-acute) in previous 28 days
- device-associated infection (pneumonia, urinary tract infection (UTI), bloodstream infection (BSI)) following insertion of device (including day 1 or 2 of admission)

Infections originating in other acute and non-acute hospitals were included but those originating in long term care facilities, care homes, or nursing homes were excluded and no further data were collected for these infections.

Data were collected for each HAI including the infection type, date of onset and the origin of the infection. HAI that were associated with the survey hospital were reviewed to determine whether the HAI was associated with the survey ward. Infections that were present on admission to the survey hospital were also identified. Additional data were collected for BSI, pneumonia and UTI to identify HAI where a relevant device (PVC/CVC, intubation and urinary catheter, respectively) had been in situ in a specified period prior to onset.

Microbiology data

Microbiology data were recorded for HAI when laboratory results were available at the time of survey. Pending laboratory results were not followed up after the survey of the ward was complete. Antimicrobial resistance data were collected where available for a number of organisms of public health significance.

Antimicrobial data

Antimicrobial data were collected for all patients receiving antimicrobials at the time of survey. All antimicrobials with the exception of topical antimicrobials, antivirals and antimicrobials prescribed for the treatment of *Mycobacterium tuberculosis* (TB) were included in the survey.

A patient was defined as receiving antimicrobials if:

- they were prescribed antimicrobials at the time of survey for;
    - treatment
    - medical prophylaxis
- they had received at least one dose of surgical prophylaxis in the 24 hours prior to 8am on the morning of the survey

Data were recorded for each antimicrobial including the name of antimicrobial, route of administration, dosage per day, indication for prescribing and diagnosis.

The indication for prescription was recorded as treatment of infection (community acquired, hospital acquired, long/intermediate care acquired); surgical prophylaxis (single dose, more than one dose given within 24 hours, more than one dose given over more than 24 hours); medical prophylaxis; or reason other than treatment or prevention of infection. The definition of hospital acquired infection used when describing the indication for prescribing was an infection that the clinician considered to be a hospital acquired infection or where the symptoms started 48 hours or more after admission to hospital. Diagnosis was defined by the anatomical site of infection being treated or, by the site of infection or surgical procedure for which prophylaxis was given. The start date of the antimicrobial was recorded and if that differed from the start date of the treatment regime, the reason for change in antimicrobial was recorded.

In addition, data were collected to assess two quality indicators for prescribing:

- reason for prescribing was recorded in the medical notes at the time of prescribing
- empirical prescribing for treatment of infection or surgical prophylaxis was compliant with local prescribing policy (where the reason was recorded in the notes).

Hospital structure and process indicator data

The hospital structure and process indicator data were collected using a number of different sources. Where possible, data were sought from national administrative datasets or sources (hospital activity, staffing levels, participation in national surveillance networks). The whole time equivalent (WTE) number of nurses and nursing assistants was provided by the workforce team at ISD using the Scottish Workforce Information Standard System (SWISS).[15] Bank and agency staff were excluded. The number of patient days (acute occupied bed days (AOBDs) for acute hospitals and occupied bed days (OBDs) for non-acute hospitals)[16] and number of discharges[17] for the period 2015/16 were provided by ISD.

It was necessary to collect several of the data items on the ward at the time of survey: single room availability, alcohol based hand rub (ABHR) availability and number of observed hand hygiene opportunities in a year.

The remainder were collected by local board contacts using the PPS hospital indicator protocol.[14] These data include data pertaining to IPC and antimicrobial management staffing levels; IPC and

stewardship programme organisation; IPC and antimicrobial policies and educational initiatives. The WTE equivalent number of intensive care unit (ICU) nurses and nursing assistants was also provided at hospital level by the board contact points. Structure and process indicator data were provided at either hospital or board level depending on the availability of data at the local level.

Data management

Data were collected on Teleform® scannable paper forms, one form per ward and one form per patient. These were sent securely to HPS by post adhering to strict National Services Scotland (NSS) data protection and confidentiality guidelines. Each form was scanned and verified by data entry staff and imported into a bespoke SQL Server database® with built in validation rules for cleaning the data.

Analysis

Sampling strategy

All NHS and independent acute hospitals were included in the survey. A 25% random sample of non-acute hospitals was selected using a stratified method. All non-acute hospitals were stratified by NHS board and a target of 25% of the non-acute hospitals within the board set, with the sampling of hospitals within each board proportional to size of the hospital (probability proportional to size method). In addition, as the 2011 survey showed that the prevalence of HAI was lower in psychiatric hospitals[3], which also tended to be large, only two psychiatric hospitals were included in the sample (rather than five which would have represented 25% of all non-acute psychiatric hospitals). The sampling of hospitals within each category was proportional to size of the hospital.

Changes to data presentation

Changes to the way patients included in the survey are reported were introduced in the 2016 survey. The patients included in the 2011 survey were grouped according to the type of hospital they were surveyed in: acute, non-acute, paediatric and independent hospitals. Paediatric patients, including those in acute hospitals, are described as a single population in the 2016 survey as the epidemiology of HAI and the antimicrobials prescribed in paediatric patients differ from adult patients. The independent hospitals are included in the acute adult patient population to align with the way ECDC report independent hospitals and as the number of patients, HAI and antimicrobials included were small.

Descriptive analyses

Tables and figures were used to summarise the frequency and prevalence of HAI, device use and antimicrobial prescribing throughout the report. These were produced in Microsoft Excel and checked in SPSS (version 21), STATA (version 13) and R (version 3.3.1). Prevalence was estimated with the number of patients recorded as positive (had an active HAI, had a device in situ, or were receiving antimicrobials at the time of survey) as the numerator and the total number of positive or negative patients (i.e. all surveyed patients excluding the 'not recorded') as the denominator. The prevalence estimates had 95% confidence intervals (95% CI) applied. Wilson's unadjusted CI were used when the prevalence was low or sample size small (within the non-acute or paediatric populations, or when looking within subgroups/specialty-level of the acute population), and survey means clustered CI were used when the sample size was large (i.e. within the total acute adult populations).

The distribution of age in 2016 and 2011 was compared using a Mann–Whitney U test and median ages estimated. Pearson's chi square tests with a continuity correction or Fisher's Exact tests were used to compare the prevalence between two groups (e.g. HAI prevalence between years or HAI prevalence between ICU and medical specialties) and to determine if the two groups where significantly different. A Fisher's Exact test was used when one or more of the cells in a 2 x 2 table had an observed

frequency of ≤5. Pearson's chi square was used in all other calculations. All tests of independence were carried out in R (version 3.3.1) and statistical significance was set at $p<0.05$.

Statistical analyses

The survey was analysed as a cluster sample with wards nested within hospitals. For the non-acute hospitals, a weighting adjustment was necessary to account for the underrepresentation of psychiatric facility beds in the sample. The weights were based upon the ratio of the number of psychiatric and non-psychiatric facility beds in the sample to the corresponding numbers in the non-acute hospital population. Both the crude and weighted prevalences of HAI, devices and antimicrobial prescribing are presented for non-acute facilities.

Factors associated with HAI and antimicrobial prescribing prevalence in 2016

Univariate and multivariate regression analyses were conducted to identify risk factors associated with HAI and antimicrobial prescribing prevalence using R version 3.3.1 (R package 'survey'). Five multivariate models were investigated: HAI prevalence in acute adult inpatients, HAI prevalence in non-acute inpatients, antimicrobial prescribing in acute adult inpatients, antimicrobial prescribing in non-acute inpatients and antimicrobial prescribing in paediatric inpatients. Due to the small number of HAI cases, multivariate modelling was not carried out for HAI prevalence in paediatric patients and only univariate results are presented.

A survey weighted binomial model was used which accounted for the clustering of beds within wards. An additional weight was applied to the models of HAI and antimicrobial prevalence in non-acute inpatients to account for underrepresentation of psychiatric hospital beds in the sample.

Univariate risk factors were initially screened and those with a p-value below 0.5 were included in the multivariate modelling process. A backward elimination approach and a forward stepwise approach were applied to select the most parsimonious model. Statistical significance was set at $p<0.05$. A category-level p-value (using the Wald test), odds ratios (OR) and 95% CI were calculated for each of the risk factors in the final models. The large sample approximation for the log odds ratio was used to calculate 95% confidence intervals.

Comparing 2011 and 2016 prevalence

To account for any differences in the patient case mix between the 2016 and 2011 PPS, the survey weighted binomial model described above was used to estimate adjusted prevalences, odds ratios and 95% CI for HAI, device (CVCs, PVCs, urinary catheters and intubation) and antimicrobial use in the acute adult population (including independent hospitals). A combined dataset of 2016 and 2011 acute adult inpatient data was used to create six models for each of the prevalence outcomes. Interactions between year and another single risk factor were investigated but no interactions were found to be significant at the Bonferroni-adjusted significance cut-off and hence no interactions were included in the multivariate model. An adjusted odds ratio for year was calculated using 2011 as the reference group. This odds ratio is a measure of any significant change in prevalence between the two surveys whilst accounting for the effects of changes in patient case mix between 2011 and 2016.

In addition, three survey weighted binomial models were used to estimate any significant difference in prevalence of broad spectrum antimicrobial prescribing, piperacillin/tazobactam prescribing or carbapenem prescribing in the acute adult population (including independent inpatients) after accounting for differences in the patient case mix between the 2016 and 2011 surveys. This could not be done in the paediatric population due to small numbers.

Univariate models were used to investigate the difference in HAI, each device and antimicrobial use in paediatric patients between the 2016 and 2011 surveys. This was unadjusted due to a small sample size and low prevalences and therefore crude odds ratios and 95% CI are described.

No comparisons were made for non-acute facilities owing to the difference in sampling strategies between the surveys.

Benchmarking analyses

Four multivariate models were developed to enable benchmarking between hospitals using the modelling methodology described above (survey weighted binomial model). The results from the models were used to calculate hospital level HAI and antimicrobial prescribing prevalence figures that were adjusted for any differential case-mix. In order to provide adjusted acute hospital level prevalence, the acute adult and paediatric patient groups were combined. The model used for benchmarking analyses in non-acute hospitals was the same model as that used to describe risk factors associated with prevalence (see above). The adjustment and funnel plot methods are described below.

Adjusted HAI prevalence and antimicrobial prescribing prevalence are presented as funnel plots[19] with 95% CI. The prevalence figures were adjusted for patient case mix in the hospitals using output from one of the multivariate logistic regression models for acute and non-acute hospitals (see section above).

These analyses provided estimates of the probability of a prevalent HAI (or of a patient receiving an antimicrobial) for each individual inpatient, which were then summed over all relevant inpatients to give the expected number of patients with at least one HAI (or receiving at least one antimicrobial) (E) for each hospital. The adjusted prevalence was calculated by the formula: Adjusted(P) = P*(O/E) where O was the observed number of patients with HAI (or receiving antimicrobials); E was the expected number of patients with HAI (or receiving antimicrobials); P was the overall HAI (or antimicrobial prescribing) prevalence.

The plots show the adjusted prevalence of HAI or antimicrobial prescribing plotted against the number of patients on which the prevalence is based. The solid lines of each funnel plot indicate the 95% confidence limits, calculated from confidence intervals throughout the range of values.

Hospital structure and process indicator data and analysis

The hospital structure and process indicator data were reported for acute (including paediatrics) and non-acute hospitals. Independent hospitals were excluded due to small numbers and the unavailability of some data from the national datasets.

Data obtained at the time of survey on the ward were summed. Wards where data were missing were excluded from the calculation. The number of wards that the data pertain to is reported to assist with interpretation.

It was necessary to apportion the number of WTE antimicrobial stewardship staff, IPC Nurses (IPCNs) and Infection Control Doctors (ICDs) to acute and non-acute hospitals when data were provided at board level. The WTE were apportioned based on bed numbers and were apportioned equally over acute and non-acute hospitals to reflect that these staff cover both acute and non-acute care.

The average length of stay in the survey hospitals was calculated as the total number of patient days in the hospital divided by the total number of discharges from the hospital. This represents the average length of stay in the survey hospital from admission to discharge or transfer to a different hospital.

The number of blood culture sets per hospital between January and December 2016 was extracted from the Electronic Communication of Surveillance in Scotland (ECOSS) database and the number of inpatient stool tests performed for *Clostridium difficile* infection (CDI) was estimated from a voluntary laboratory questionnaire undertaken by the *C. difficile* health protection programme at HPS.

The multimodal strategy data were reported as the percentage of all hospitals that had each of the components of the strategy in place across the hospitals (excluding ICU) and specifically in ICU. Hospitals where data were not recorded were excluded from the analysis.

Validation of the 2016 PPS

The validity of the 2016 PPS was assessed using two methods: 1) assessment of validity and reliability using case studies following training, and 2) on-site gold standard validation undertaken by an external team of national experts in PPS data collection. ECDC also undertook international validation in a single hospital and the Scottish national experts were assessed by a European expert.

Gold standard validation and inter-rater reliability exercise following Scottish training sessions

Prior to data collection and following each training session, participants (n=171) were required to complete two case studies. These case studies were marked to measure the sensitivity and specificity and the inter-rater reliability (IRR) of the participant responses.

The sensitivity, specificity and agreement between data collectors (kappa statistic) were estimated for whether a patient had prevalent HAI (yes/no). The sensitivity was also measured for whether the patient was receiving antimicrobials (yes/no). The specificity and kappa statistic were not calculated for the antimicrobial data as all patients in the exercise case studies were receiving antimicrobials. The percentage of data collectors who reported the correct McCabe score was also calculated.

Fleiss' kappa was used to calculate the kappa statistic in STATA (version 13). A kappa statistic of between 0.81-1.0 is considered excellent, of 0.61-0.80 is considered good and a score of between 0.41-0.60 is considered moderate.

Onsite gold standard validation study

A gold standard validation study was carried out concurrently with the national PPS using the Scottish PPS validation protocol.[20] The purpose of the study was to assess data validity. ECDC required that all member states undertake a validation study when undertaking PPS as part of the European Union (EU)-wide PPS and the Scottish protocol was based on the ECDC PPS Validation Protocol.[21] The HPS validation team consisted of at least one ECDC trained data collector along with other staff to support the data collection process. Nine acute hospitals were selected for inclusion in the validation study from a sampling frame of hospitals that, travel time permitting, could be surveyed within one day. Hospitals with only electronic patient notes were excluded from the study due to issues with gaining access to the electronic systems, which would have resulted in the validation team not being blinded to the primary results. Purposive sampling was used to select wards for the study; wards with higher expected prevalence (e.g. intensive care units) were oversampled to ensure sufficient HAI were identified to maximise precision in the validity analysis. All patients in the selected wards were surveyed, at least until the required number of validation records per hospital were obtained (n=30).

The validation team obtained validation data using the same data sources available to the primary data collection teams in participating hospitals. Following completion of the survey, the validation team did not discuss or cross-check results with the primary PPS data collectors in order to minimise bias. The sensitivity and specificity for the presence of HAI and antimicrobials were calculated with 95% CI.

Extrapolation of the gold standard validation results to HAI and antimicrobial prescribing prevalence

The results from the gold standard validation were used to calculate an adjusted prevalence of HAI that accounted for possible under- or over-reporting by the local data collection teams. The sensitivity and specificity were used to adjust the prevalence and bootstrapping methods were used to calculate the 95% CI around the adjusted prevalence. The bootstrapping methods accounted for sampling variation in the sensitivity/specificity estimates and the prevalence estimate.

Estimation of the burden of HAI

The Rhame and Sudderth equation was applied to the prevalence figure adjusted to control for the potential under-reporting identified by the gold standard validation:

*Incidence = prevalence * (length of stay / (date of survey - date of onset))*

The average length of stay in Scottish acute adult patients was estimated using ISD length of stay data. Paediatric, accident and emergency, community, dental and "GP other than obstetrics" specialties were excluded from the length of stay calculation. The mean and median difference between date of onset of HAI and date of survey were used in the equation. The incidence calculated using the mean and the median was averaged. The resulting incidence was then applied to the annual number of acute adult inpatient stays (using the exclusions above) to estimate the number of HAI per year in acute adult inpatients in Scotland.

Results

Survey Characteristics

A total of 12 710 inpatients in 70 hospitals were included in the survey, 93.8% of all eligible patients. All NHS acute hospitals (n=37), paediatric hospitals (n=3) and independent hospitals (n=6) and a 25% random sample of non-acute hospitals (n=24) were included in the survey. The total number of hospitals, wards, beds and patients included in the 2016 PPS are described in Table 1.

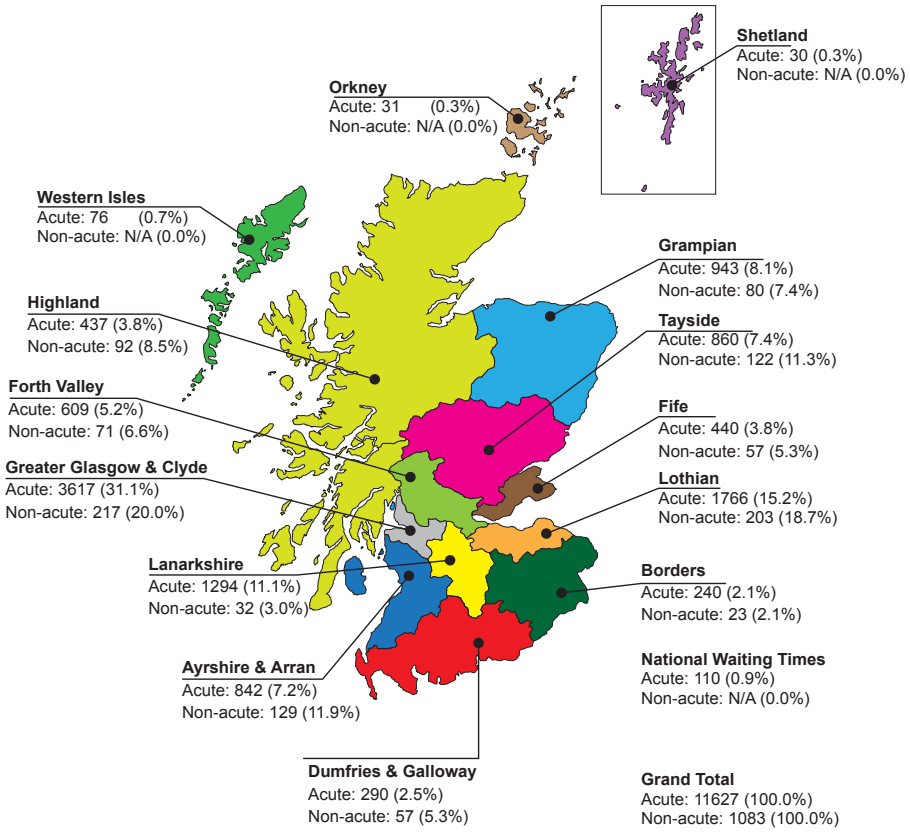
Table 1: Number of hospitals, wards, beds and patients surveyed in 2016, by patient group

Patient group	Number of hospitals surveyed	Number of wards surveyed	Number of beds	Number of patients*	Number of eligible patients	Number of eligible patients surveyed
Acute inpatients*	46	709	14962	12742	12459	11627
Non-acute inpatients	24	77	1305	1096	1093	1083
Total	**70**	**786**	**16267**	**13838**	**13552**	**12710**

*this group includes acute adult inpatients, all paediatric inpatients and independent hospital inpatients

The number of inpatients surveyed by NHS board region is described in Figure 1. In addition, 42 patients were surveyed in six independent hospitals.

Figure 1: Total number of acute and non-acute inpatients surveyed, by NHS board

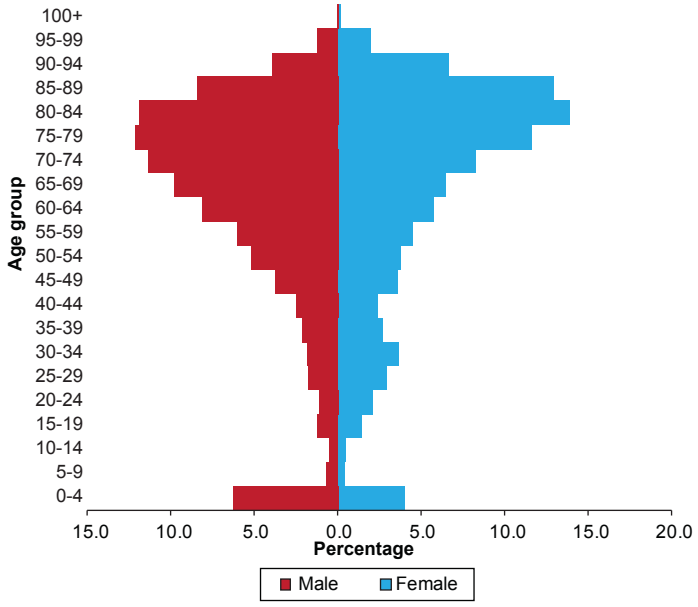


Description of the survey population

The age and sex distribution of the acute hospital inpatient population (acute adult inpatients, acute paediatric inpatients and independent hospital inpatients) is described in Figure 2. The median age of patients surveyed in acute hospitals was 71 years (range 0 to 102, inter-quartile range (IQR) 52 to 82)

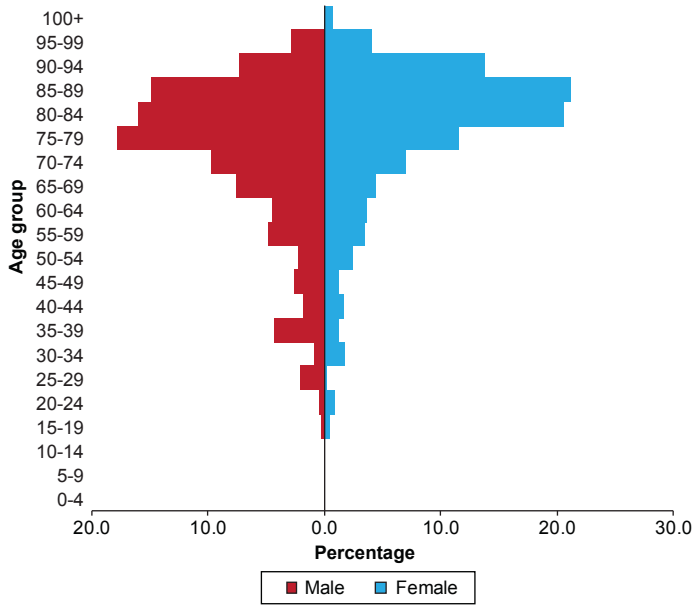
and 45.1% of patients were male (n=5242). Patients aged less than one year (n=531) accounted for 4.6% of the population and 6.3% of patients were under 16 years of age (n=732). A total of 179 healthy newborn babies were included in the survey; 1.4% of the total survey population. Patients aged over 65 years (n=6880) and over 80 years (n=3303) accounted for 59.2% and 28.4% of the total acute patient population, respectively. The median age of patients surveyed in 2016 was significantly higher than the median age in 2011 (71 years versus 70 years, p<0.001).

Figure 2: Number of inpatients surveyed in acute hospitals in 2016, by age and sex



The age and sex distribution of inpatients included in the sample of non-acute hospitals is described in Figure 3. The median age of non-acute patients included in the survey was 80 years (range 17 to 104, IQR 69 to 87) and 41.6% of patients were male (n=450). Patients aged over 65 years (n=857) and over 80 years (n=530) accounted for 79.1% and 48.9% of the total non-acute population, respectively. The median age of patients surveyed in 2016 was not compared with 2011 due to differences in the sampling strategies used in the two surveys which resulted in populations that were not comparable.

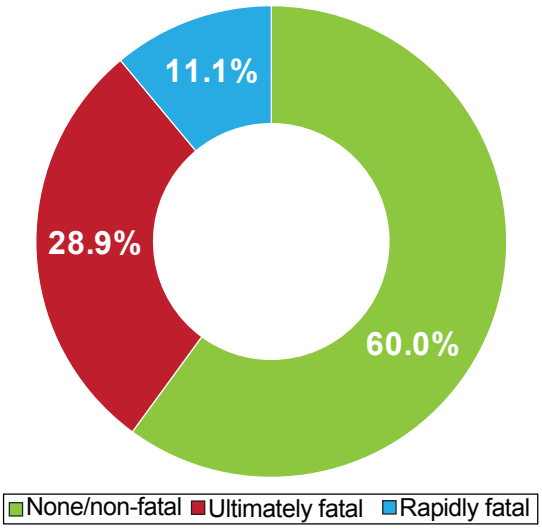
Figure 3: Number of inpatients surveyed in non-acute hospitals in 2016, by age and sex



Two fifths of patients surveyed in acute hospitals (40.0%, n=4609) and 65.7% in non-acute hospitals (n=697) had the most severe co-morbidity scores (ultimately fatal or rapidly fatal McCabe score). The distribution of McCabe scores in acute and non-acute patients are presented in Figure 4 and 5, respectively.

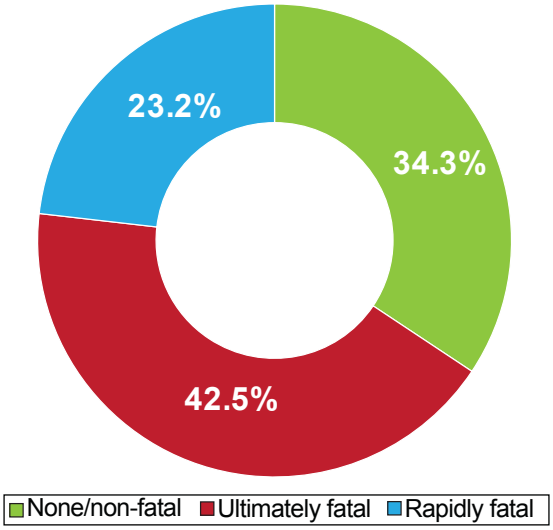
The percentage of acute hospital patients with an ultimately fatal or rapidly fatal McCabe score was significantly higher in 2016 compared with 2011 (40.0% versus 33.7%, p<0.001). The McCabe scores of the non-acute populations in 2016 and 2011 were not compared due to differences in the sampling strategy resulting in the populations not being comparable.

Figure 4: Distribution of McCabe score in acute inpatients (including independent hospital and paediatric inpatients) in 2016



Note: McCabe score was not recorded for 91 patients

Figure 5: Distribution of McCabe score in non-acute inpatients in 2016



Note: McCabe score was not recorded for 22 patients

Healthcare Associated Infection in Scottish hospitals

Prevalence of HAI

Acute and non-acute hospitals

The prevalence of HAI by patient group is described in Table 2. The highest prevalence was observed in acute adult patients where approximately one in 22 patients had a HAI at the time of survey (4.6%, 95% CI: 4.1 to 5.1, n=497). The prevalence of HAI in paediatric patients was 2.7% (95% CI: 1.8 to 4.2, n=20) and 3.2% (95% CI: 2.3 to 4.4, n=34) in non-acute inpatients.

Table 2: Prevalence of HAI in 2016, by patient group

Patient group	Number of patients surveyed*	2016			
		Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI
Acute adult inpatients (including independent hospital inpatients)	10 813	497	4.6	4.1	5.1
Paediatric inpatients	734	20	2.7	1.8	4.2
Total acute inpatients	**11 547**	**517**	**4.5**	**4.0**	**5.0**
Non-acute inpatients	1079	34	3.2	2.3	4.4

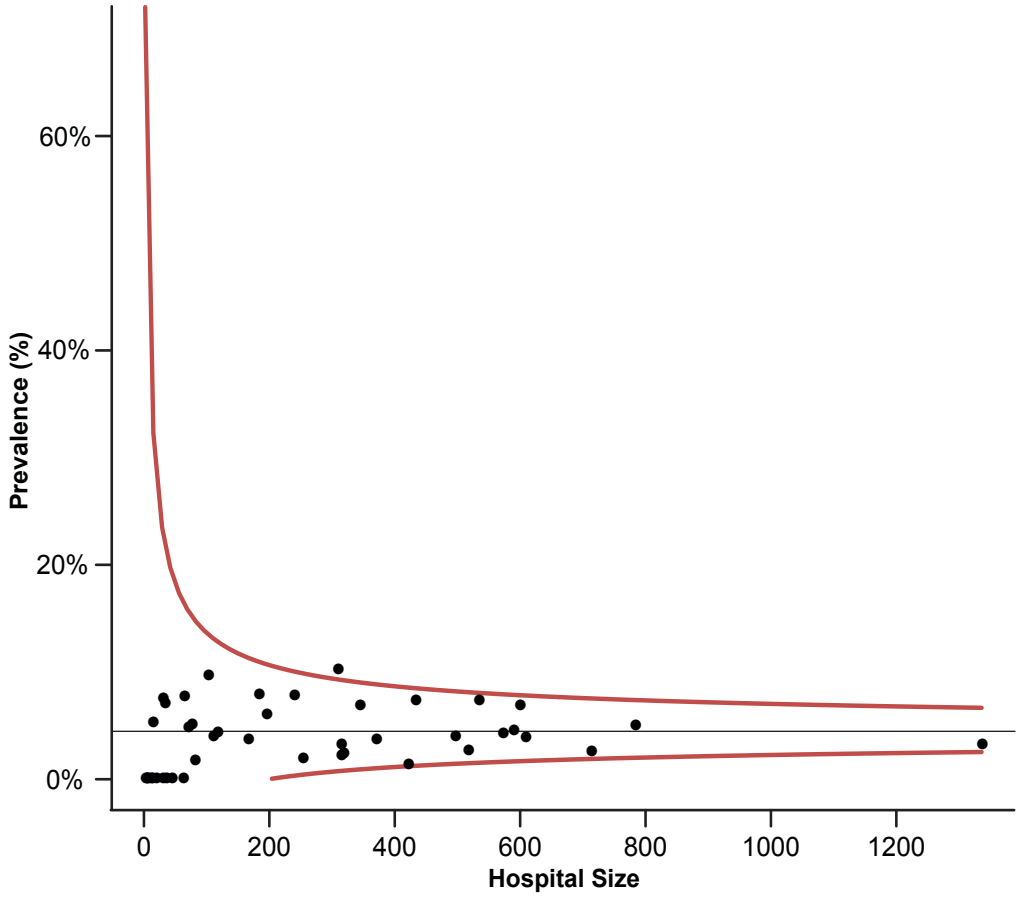
* Number of patients surveyed with HAI status recorded. HAI data for acute adult, paediatric and non-acute patients were not recorded for 76, 4 and 4 patients, respectively

The weighted HAI prevalence in 2016 in the non-acute sample was 2.3% (95% CI: 1.3 to 3.3). This weighted prevalence accounts for the sampling strategy where psychiatric patients were under-represented and estimates the true population prevalence in the Scottish non-acute hospital population.

Appendix Tables A1 and A2 describe the prevalence of HAI for each hospital included in the survey and include prevalence estimates that have been adjusted for any differences in the patient case mix between the hospitals.

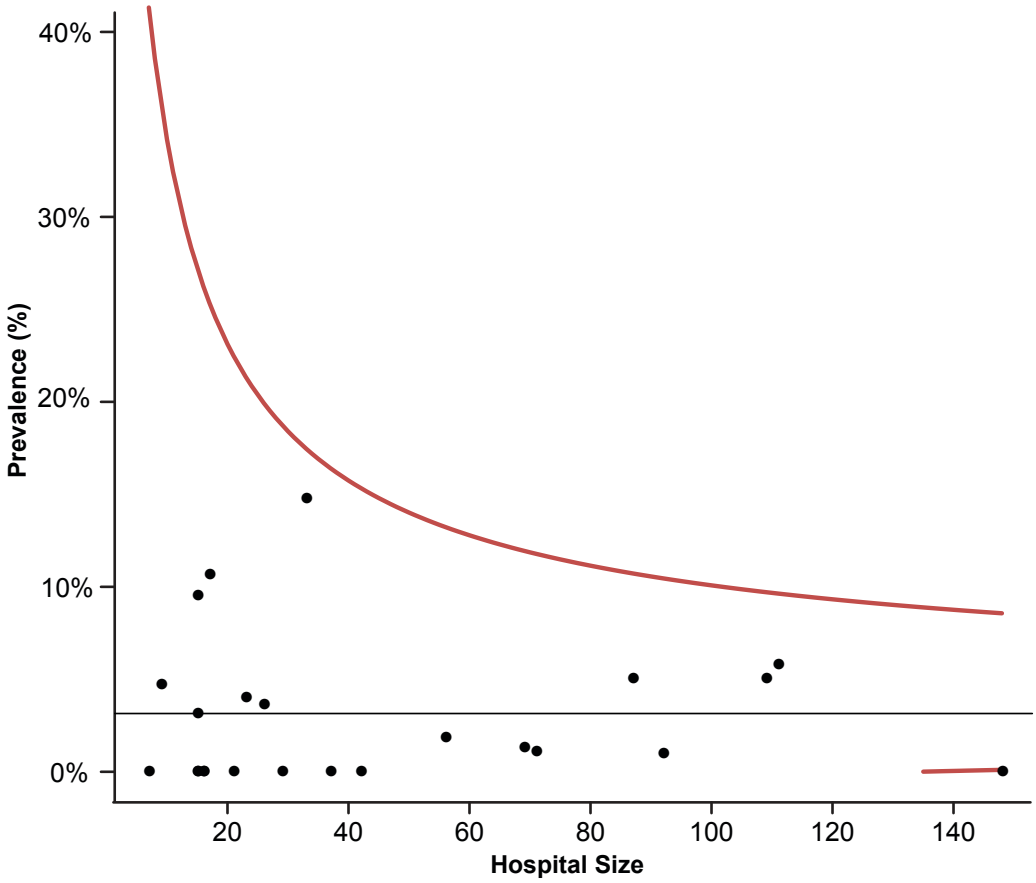
Figures 6 and 7 describe adjusted hospital level HAI prevalence relative to the mean Scottish prevalence. The plots indicate that one acute hospital had a higher than expected HAI prevalence based on their patient case mix. None of the non-acute hospitals had a higher than expected prevalence.

Figure 6: Adjusted prevalence of HAI in acute inpatients (including independent hospital and paediatric inpatients) in 2016



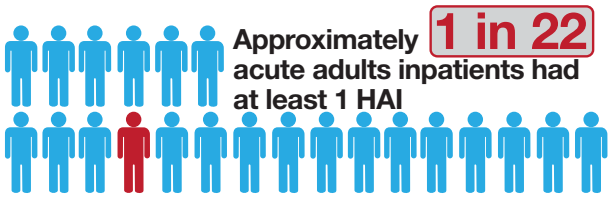
Note: two hospitals were excluded from the plot due to small numbers.

Figure 7: Prevalence of HAI in non-acute inpatients in 2016



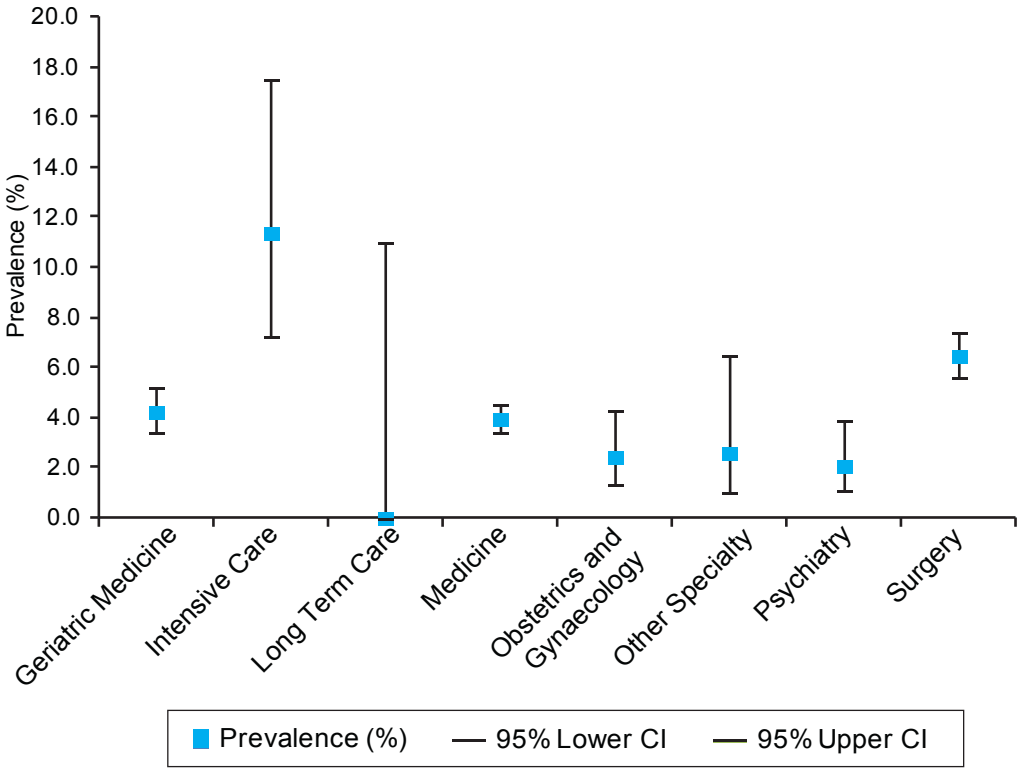
Acute adult inpatients

A total of 497 adult patients in acute hospitals (including independent hospitals) had a HAI at the time of the survey. The overall prevalence was 4.6% (95% CI: 4.1 to 5.1), and this was significantly lower compared with the 2011 survey (4.6% versus 5.0%, adjusted OR= 0.84, 95% CI: 0.72 to 0.98, p=0.03). The prevalence of HAI in the 2016 and 2011 surveys and the comparison results are described in Appendix Table A3. This comparison accounted for differences in the patient case mix between the two surveys.



The prevalence of HAI varied by specialty in acute adult inpatients and is described by specialty category in Figure 8 and by specialty in Appendix Table A4. One in nine ICU patients had a HAI at the time of survey (11.4%, 95% CI: 7.2 to 17.5, n=17). The prevalence of HAI in surgical patients was 6.5% (95% CI: 5.6 to 7.4, n=184) and was 4.0% (95% CI: 3.4 to 4.5, n=188) in medical patients. The prevalence of HAI in ICU patients was significantly higher compared with medical patients (11.4% versus 4.0%, p<0.001) and surgical patients (11.4% versus 6.5%, p=0.03).

Figure 8: Prevalence of HAI by specialty in acute adult inpatients (including independent hospital inpatients) in 2016



Note: patients whose specialty of care was not recorded were excluded from the chart due to small numbers

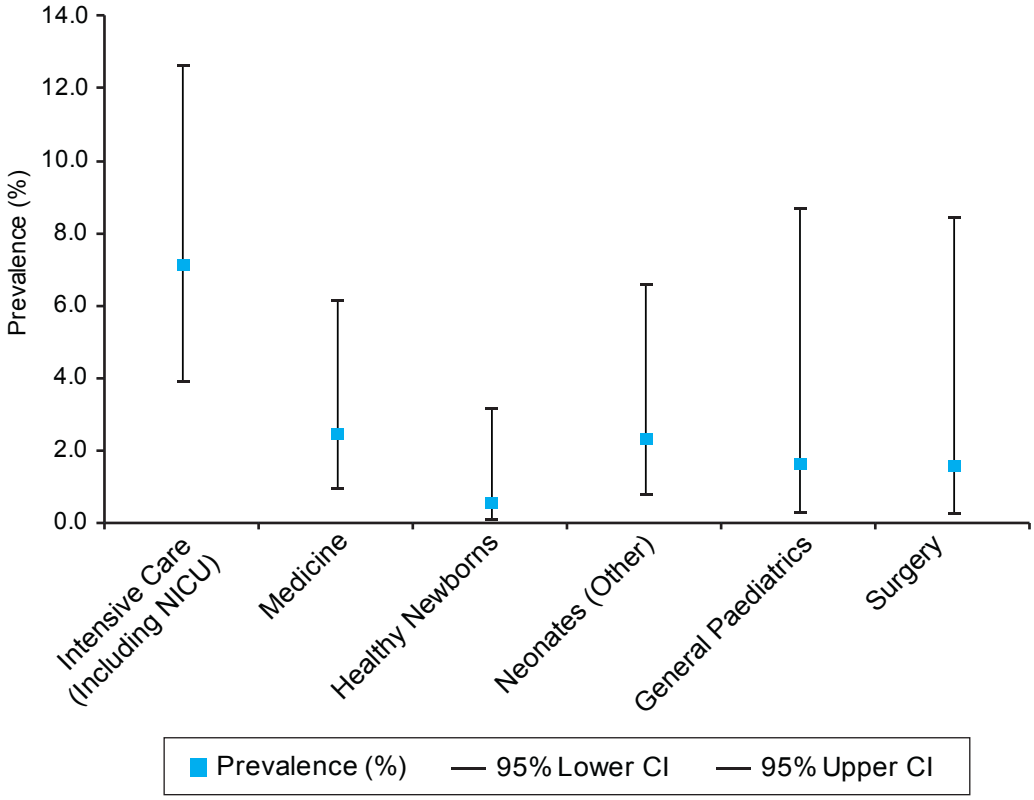
Risk factors associated with HAI prevalence

The results from univariate analysis to describe HAI prevalence by key risk factors for HAI and the univariate association between these risk factors and HAI prevalence are provided in Appendix Table A5. The results from multivariate analyses to identify risk factors that were independently associated with HAI prevalence are provided in Appendix Table A6. The multivariate results indicate that a higher McCabe score ($p<0.001$), increased length of stay ($p=0.001$) and whether a patient had undergone surgery since admission to hospital ($p<0.001$) were associated with a higher prevalence of HAI.

Paediatric patients

A total of 20 paediatric patients had a HAI at the time of the survey. The overall prevalence was 2.7% (95% CI: 1.8 to 4.2). The prevalence of HAI excluding healthy newborn babies was 3.4% (95% CI: 2.2 to 5.3). The overall prevalence of HAI was not significantly different between the 2016 and 2011 surveys (2.7% versus 3.1%, crude OR=0.9, 95% CI: 0.4 to 1.9, $p=0.77$). Due to the small number of HAI cases in this patient group, differences in the patient case mix could not be controlled for in this comparison therefore the results should be interpreted with caution. The prevalence by specialty category is described in Figure 9 and by specialty in Appendix Table A7.

Figure 9: Prevalence of HAI by specialty in paediatric inpatients in 2016



Note: patients cared for in psychiatric specialties were excluded from the chart due to small numbers

Risk factors associated with HAI prevalence

The results from the univariate analyses to measure the association between key risk factors for HAI and HAI prevalence in paediatric inpatients are provided in Appendix Table A8. Multivariate analyses were not undertaken due to the small number of HAI cases in this patient group. At univariate level, whether a patient had undergone surgery since admission to hospital was associated with HAI prevalence (p=0.003) and an increased length of stay was associated with higher HAI prevalence (p=0.002).

Non-acute hospital inpatients

In non-acute hospitals, there were 34 patients with a HAI at the time of survey. The prevalence was 3.2% (95% CI: 2.3 to 4.4). The prevalence by specialty category is described in Figure 10 and by specialty in Appendix Table A9. The prevalence of HAI in 2016 was not compared with that reported in 2011 as changes to the sampling strategy resulted in patient populations that were not comparable. The weighted prevalence which accounts for the under-representation of psychiatric hospitals in the 25% sample was 2.3% (95% CI: 1.3 to 3.3).

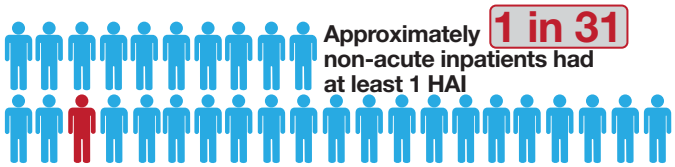
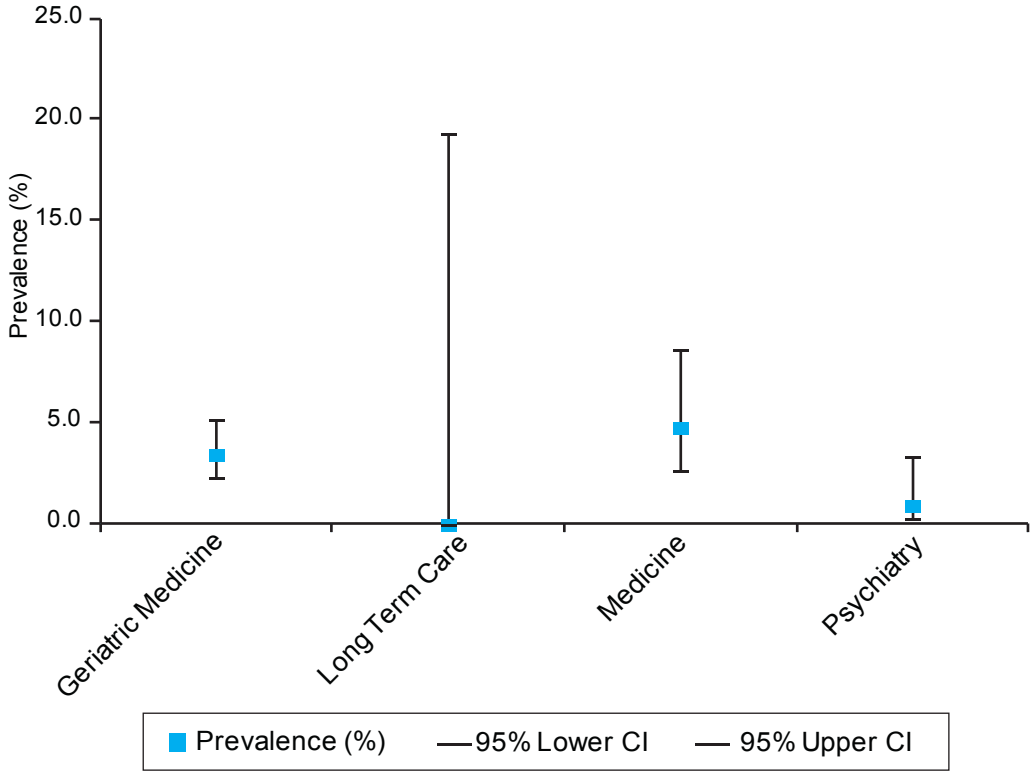


Figure 10: Prevalence of HAI by specialty in non-acute inpatients in 2016



Note: patients whose specialty of care was not recorded and patients in surgical and obstetrics/gynaecology specialties were excluded from the chart due to small numbers.

Risk factors associated with HAI prevalence

The results from the univariate analyses to determine associations between key risk factors for HAI and HAI prevalence are provided in Appendix Table A10. The multivariate analysis indicated that patient age group was the only risk factor independently associated with HAI prevalence (p=0.03) with increased age significantly associated with higher HAI prevalence.

Characteristics of HAI occurring in Scottish hospitals

HAI in acute adult inpatients

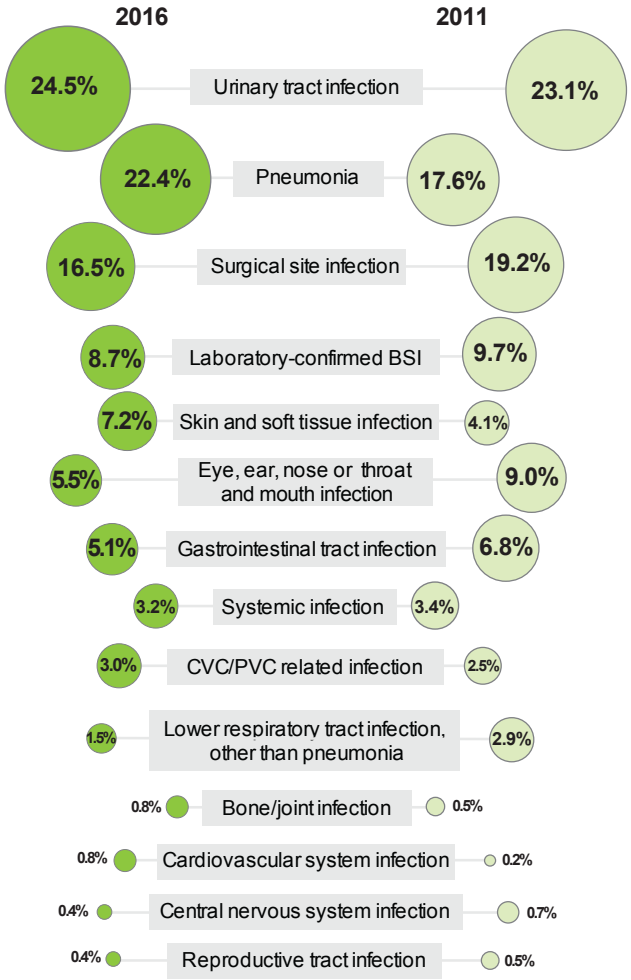
A total of 527 HAI occurring in 497 acute adult inpatients were reported during the 2016 survey. The distribution of HAI reported in 2016 are described in Table 3 and in more detail in Appendix Table 11. The most common HAI reported in the 2016 survey were UTI (24.5%, n=129) and pneumonia (22.4%, n=118); which accounted for almost half of all HAI. Surgical site infections (SSI) accounted for one in six HAI (16.5%, n=87) and 8.7% of HAI were bloodstream infections (n=46). A total of 38 SST infections were reported; almost a third of these were infected decubitus ulcers (31.6%, n=12).

Table 3: Distribution of HAI types in acute adult inpatients (including independent hospital inpatients) in 2016

HAI Type	HAI	
	N	%
Urinary tract infection	129	24.5
Pneumonia	118	22.4
Surgical site infection	87	16.5
Laboratory-confirmed BSI	46	8.7
Skin and soft tissue infection	38	7.2
Eye, ear, nose, throat or mouth infection	29	5.5
Gastrointestinal tract infection	27	5.1
Systemic infection	17	3.2
CVC/PVC related infection	16	3.0
Lower respiratory tract infection, other than pneumonia	8	1.5
Bone/joint infection	4	0.8
Cardiovascular system infection	4	0.8
Central nervous system infection	2	0.4
Reproductive tract infection	2	0.4
Total	**527**	**100.0**

The distribution of the types of HAI reported in the 2016 and 2011 surveys are described in Figure 11. The proportions of HAI that were UTI (24.5% versus 23.1%, p=0.60), pneumonia (22.4% versus 17.6%, p=0.06), CVC/PVC related infections (3.0% versus 2.5%, p=0.75) and SSI (16.5% versus 19.2%, p=0.28) were not significantly different in 2016 compared with 2011. The proportion of HAI that were SST infections was significantly higher in 2016 (7.2% versus 4.1%, p=0.03).

Figure 11: Distribution of HAI types in acute adult inpatients (including independent hospital inpatients) in 2016 and 2011



Urinary tract infections

The most prevalent HAI in acute adult patients in 2016 were UTI which accounted for a quarter of all HAI (24.5%, n=129). Approximately half of these UTI, where data relating to prior catheterisation was recorded, developed in patients who had been catheterised at some point in the seven days prior to onset of the UTI (48.7%, n=55). The prevalence of UTI was not significantly different in 2016 compared with 2011 (1.2% versus 1.2%, p=0.87). A summary of the epidemiology of healthcare associated UTI in acute care patients is provided in a separate summary infographic. Patients with UTI had a median age of 80 years and 58.9% were female (n=76). Approximately two thirds of these patients had an ultimately fatal or rapidly fatal McCabe co-morbidity score (n=129) with one fifth having the most severe McCabe score of rapidly fatal (19.4%, n=25). These patients were being cared for in a range of specialties including medical, surgical and geriatric specialties.

Pneumonia

Pneumonia accounted for 22.4% of all HAI (n=118) and of these, 28.0% developed in patients who had been intubated in the 48 hours prior to onset (n=28). The prevalence of pneumonia was not significantly different in 2016 compared with 2011 (1.1% versus 0.9%, p=0.28). A summary of the epidemiology of healthcare associated pneumonia in acute inpatients is provided as a separate infographic (note: this infographic represents pneumonia in acute care and includes two pneumonia reported in paediatric patients). Patients with pneumonia had a median age of 74 years and two thirds were male (64.4%, n=76). Approximately two thirds had a McCabe score that indicated ultimately or rapidly fatal co-morbidities (64.4%, n=76) with a quarter having rapidly fatal co-morbid conditions (23.7%, n=28). Patients with healthcare associated pneumonia were also cared for in range of specialties including medical, surgical and geriatric specialties.

Surgical site infections

A total of 87 SSI were reported in acute adult inpatients in the survey (16.5% of all HAI); more than half of these were deep or organ space SSI (54.0%, n=47). The prevalence of SSI was not significantly different in 2016 compared with 2011 (0.8% versus 1.0%, p=0.10). A summary of the epidemiology of SSI in acute inpatients is provided as a separate infographic (note: this infographic represents SSI in acute care and includes two SSI reported in paediatric patients, n=89). Patients with SSI had a median age of 63 years and half were male (50.6%, n=44). More than a quarter of these patients had an ultimately fatal or rapidly fatal McCabe co-morbidity score (28.7%, n=25). The most common procedure categories associated with prevalent SSI were general surgery (40.2%, n=35) and orthopaedic surgery (13.8%, n=12). Table 4 describes the surgical categories the patients belonged to and the types of SSI occurring following the surgery. A more detailed description of the procedures and SSI types is provided in Appendix Table A12.

Table 4: Number and percentage of SSI in acute adult inpatients (including independent hospital inpatients) in 2016, by site and type of SSI

Surgical procedure category	Superficial SSI		Deep SSI		Organ space SSI		All SSI	
	N	%	N	%	N	%	N	%
General*	15	37.5	9	32.1	11	57.9	35	40.2
Orthopaedics	5	12.5	6	21.4	1	5.3	12	13.8
Vascular	6	15	0	0.0	1	5.3	7	8.0
Obstetrics and Gynaecology	3	7.5	2	7.1	2	10.5	7	8.0
Ear, Nose and Throat	3	7.5	1	3.6	0	0.0	4	4.6
Cardiac	0	0	1	3.6	1	5.3	2	2.3
Neurosurgery	2	5	0	0.0	0	0.0	2	2.3
Urology	1	2.5	0	0.0	0	0.0	1	1.1
Not recorded	5	12.5	9	32.1	3	15.8	17	19.5
Total	**40**	**100.0**	**28**	**100.0**	**19**	**100.0**	**87**	**100.0**

* This category included colon surgery (n=16), exploratory laparotomy (n=5), gallbladder surgery (n=4), appendix surgery (n=4), gastric surgery (n=3) and other general surgeries (n=3).

Bloodstream infections

A total of 56 BSI were reported in the survey and the sources of these BSI are described in Table 5. Nearly a quarter of all BSI were associated with a vascular catheter (25.0%, n=14); ten with a microbiological link and four with a clinical link only. Urinary tract infections were the most common

primary source of the BSI (12.5%, n=7). Five BSI were reported to be secondary to a surgical site infection (8.9%) and five secondary to a digestive tract infection (8.9%). The source of the BSI was confirmed to be of unknown origin for 14.3% of the BSI (n=8) and was not recorded for a further eight BSI. The prevalence of BSI was not significantly different in 2016 compared with 2011 (0.5% versus 0.6%, p=0.59). A summary of the epidemiology of BSI in acute hospitals is provided in a separate infographic (note: this infographic includes four BSI identified in paediatric patients). Patients with BSI had a median age of 62.5 years and 53.3% were male. These patients were most commonly being cared for in medical and surgical specialties and approximately half had a McCabe score of ultimately or rapidly fatal (49.2%, n=29) with less than one in ten with a rapidly fatal co-morbidity score (8.5%, n=5).

Table 5: Distribution of sources of BSI in acute adult inpatients (including independent hospital inpatients) in 2016

Source of BSI	BSI	
	N	%
Urinary tract Infection	7	12.5
Other infection (e.g. meningitis, osteomyelitis etc)	6	10.7
Digestive tract infection	5	8.9
Central vascular catheter - microbiologically confirmed	5	8.9
Surgical site infection	5	8.9
Peripheral vascular catheter - microbiologically confirmed	4	7.1
Central vascular catheter - clinical relationship with catheter	2	3.6
Skin and soft tissue infection	2	3.6
Peripheral vascular catheter - clinical relationship with catheter	2	3.6
Pulmonary infection	1	1.8
Vascular catheter - microbiologically confirmed (catheter type not recorded)	1	1.8
Confirmed to be of unknown origin	8	14.3
Not recorded	8	14.3
Total	**56**	**100.0**

Origin of infection and association with the survey ward

The majority of HAI were associated with the hospital where the patient was surveyed (91.7%, n=463), though 8.3% (n=42) were associated with a different hospital. Of the HAI that were associated with the survey hospital, 84.3% were associated with the ward on which the patient was surveyed on (n=365). The distribution of where the HAI originated is described in Figures 12 and 13.

Figure 12: Origin of infection in HAI reported in acute adult inpatients (including independent hospital inpatients) in 2016

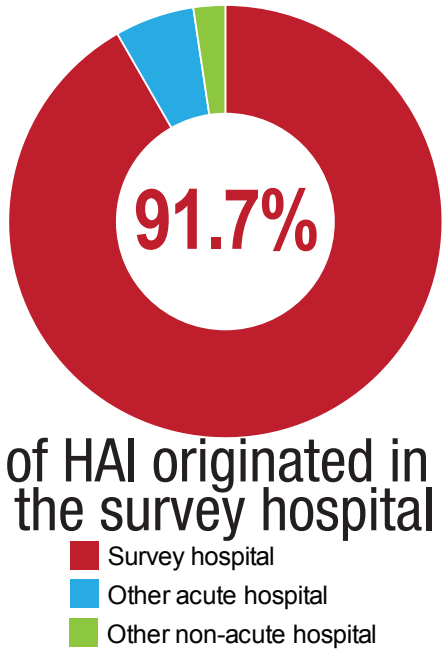
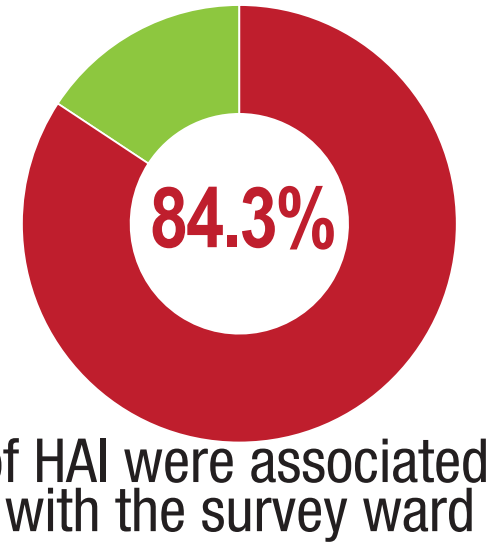


Figure 13: Percentage of HAI that were associated with the survey ward in acute adult inpatients (including independent hospital inpatients) in 2016



Almost one in five HAI were present on admission to the survey hospital (17.7%, n=92). The distribution of HAI that were present on admission or developed during the inpatient stay is described in Figure 14 and by HAI group in Appendix Table A14. The most common HAI that were present on admission to hospital were SSI (n=42). Almost half of all SSI were present on admission to the survey hospital (48.8%, n=42). Of the HAI that were present on admission, more than half were associated with the current hospital (53.8%, n=43) and the remainder were associated with another acute hospital (31.3%, n=25) or another non-acute hospital (15.0%, n=12) (Figure 15).

Figure 14: Percentage of HAI that were present on admission to hospital in acute adult inpatients (including independent hospital inpatients) in 2016

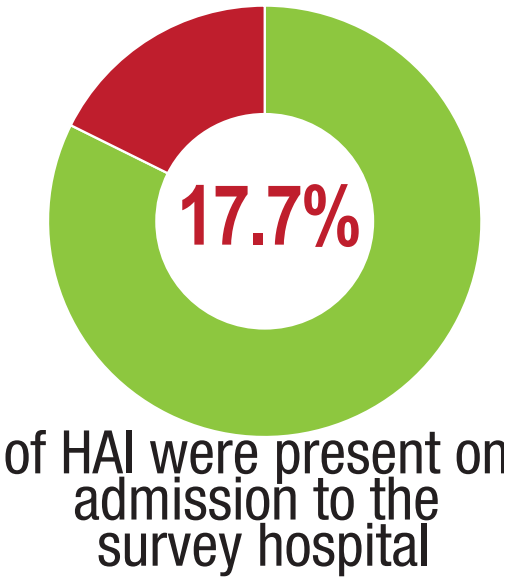
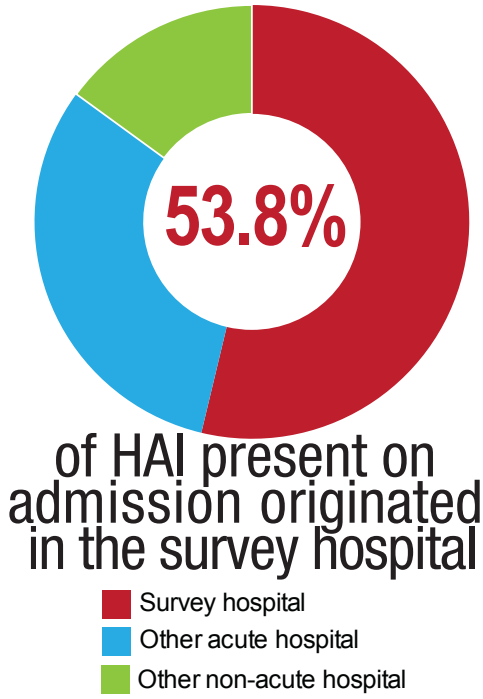


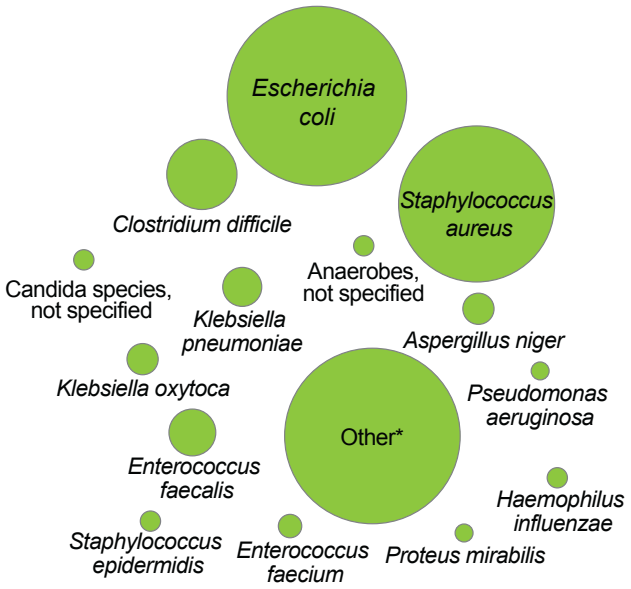
Figure 15: Origin of infection in HAI that were present on admission to hospital in acute adult inpatients (including independent hospital inpatients) in 2016



Microbiology

Figure 16 and Appendix Table A13 describe the distribution of causative microorganisms reported for HAI where microbiology data were available at the time of survey. The most commonly reported organisms in this survey were *Escherichia coli* (*E. coli*) (22.7%, n=64); accounting for nearly a quarter of all microbiology reports. Two-fifths of all reports were Gram negative bacilli (40.4%, n=114) and more than a third were from the Enterobacteriaceae family (36.9%, n=104). One in five microbiology reports were of *Staphylococcus aureus* (*S. aureus*) (20.2%, n=57). A total of 288 HAI met the case definition without there being positive microbiology at the time of survey (42.8%).

Figure 16: Distribution of microorganisms reported in acute adult inpatients (including independent hospital inpatients) in 2016



* This group includes a further 62 microbiology reports, with less than five reports per organism or organism group, of which 30.6% were Gram negative bacilli.

HAI in paediatric inpatients

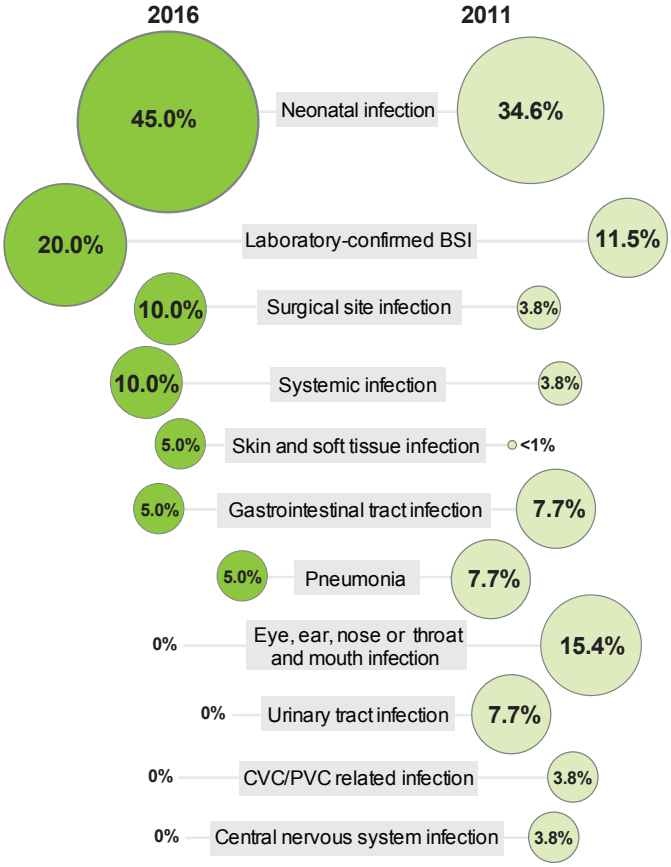
A total of 20 HAI occurring in 20 paediatric inpatients were prevalent at the time of survey. The distribution of HAI reported in 2016 are described in Table 6 and in more detail in Appendix Table A15. Neonatal infections accounted for the largest proportion of HAI (n=9). The most common HAI reported in paediatric patients was neonatal clinical sepsis (35.0%, n=7); accounting for more than a third of all HAI in this patient group. There were four BSI; two of which were associated with a vascular catheter, one was secondary to a digestive tract infection and one where the source was not recorded. There were two superficial SSI reported in paediatric patients; one secondary to a laparotomy and the other to a limb amputation.

Table 6: Distribution of HAI types in paediatric inpatients in 2016

HAI Type	N	%
Neonatal infection	9	45.0
Laboratory-confirmed BSI	4	20.0
Surgical site infection	2	10.0
Systemic infection	2	10.0
Skin and soft tissue infection	1	5.0
Gastrointestinal tract infection	1	5.0
Pneumonia	1	5.0
Total	**20**	**100.0**

The distribution of the types of HAI reported in the 2016 and 2011 surveys are described in Figure 17. None of the proportions of the key HAI types were significantly different in 2016 compared with 2011. Due to the small number of HAI reported in this patient group, the comparison with 2011 should be interpreted with caution.

Figure 17: Distribution of HAI types in 2016 versus 2011 in paediatric inpatients



All of the HAI reported in this patient group were associated with care delivered in the survey hospital. Two patients were admitted to hospital with HAI, though both HAI were associated with the hospital where the patient was surveyed. The majority of HAI were associated with the ward where the patient was being cared for at the time of survey (95.0%, n=19).

A description of the microorganisms reported in paediatric patient HAI is provided in Appendix Table A16. Seven of the HAI reported had positive microbiology results at the time of survey (35.0%). A total of eight positive microbiology reports were included; two reports each of *Enterococcus faecalis*, *E. coli* and *S. aureus*; and one report each of *Staphylococcus epidermidis* and *Staphylococcus haemolyticus*. A total of thirteen HAI met the case definition without there being positive microbiology at the time of survey (65.0%).

HAI in non-acute inpatients

A total of 34 HAI occurring in 34 non-acute inpatients were reported during the 2016 survey. The distribution of HAI types is described in Table 7 and a more detailed description of the HAI types reported in this patient group in 2016 is provided in Appendix Table A18.

The most common HAI reported were UTI (58.8%, n=20). Half of the UTI, where data relating to prior catheterisation was recorded, occurred in patients who had been catheterised at some point in the seven days prior to onset (50.0%, n=9). Four pneumonia were reported in non-acute patients (11.8%) and none of these were reported in patients who had been intubated at some point in the 48 hours prior to onset. Three SSI were reported; two following limb amputation surgery (one superficial and one deep SSI) and one following kidney surgery (deep SSI). One BSI was reported and the source of this could not be determined.

Table 7: Distribution of HAI types in non-acute inpatients in 2016

HAI type	HAI	
	N	%
Urinary tract infection	20	58.8
Pneumonia	4	11.8
Surgical site infection	3	8.8
Gastrointestinal tract infection	2	5.9
Skin and soft tissue infection	2	5.9
Laboratory-confirmed BSI	1	2.9
Lower respiratory tract infection, other than pneumonia	1	2.9
Systemic infection	1	2.9
Total	**34**	**100.0**

Four of the HAI were present when the patient was admitted to the non-acute hospital (11.8%); three of which were associated with a different acute hospital. Of the 27 HAI that were associated with the survey hospital, all with the exception of one were associated with the ward on which the patient was surveyed.

The majority of microorganisms reported were Gram negative bacilli (94.4%, n=17). The most common microorganism reported in HAI occurring in non-acute inpatients was *E. coli* (61.1%, n=11). The distribution of causative organisms is provided in Appendix Table A19. A total of 19 HAI met the case definition without there being positive microbiology at the time of survey (41.9%).

Prevalence of device use in the survey population

Acute adult inpatients

The prevalence of peripheral vascular catheter (PVC), central vascular catheter (CVC) and urinary catheter use and of intubation in acute adult inpatients is described in Table 8. The prevalence of device use by specialty of care is provided in Appendix Table A21.

Approximately half of acute adult inpatients (49.5%) had at least one device in situ at the time of survey (n=5335). More than a third of patients had a PVC in situ (36.3%, 95% CI: 34.3 to 38.3, n=3924) and one in five patients had a urinary catheter at the time of survey (20.8%, 95% CI: 20.0 to 22.1, n=2249). The prevalence of CVC use was 4.5% (95% CI: 3.7 to 5.2, n=482) and approximately one patient in every 100 surveyed were intubated (0.9%, 95% CI: 0.5 to 1.2, n=92). The highest prevalence of all devices was reported in intensive care patients. Almost half of all patients in surgical specialties (48.6%, 95% CI: 46.7 to 50.4, n=1384) and 41.3% of patients in medical specialties (95% CI: 39.9 to 42.7, n=1956) had a PVC in situ at the time of survey. Approximately, a quarter of patients in surgical (22.7%, 95% CI: 21.2 to 24.2, n=647) and geriatric medicine (24.4%, 95% CI: 22.6 to 26.4, n=483) specialties had urinary catheter in situ and one in five patients in medical specialties were catheterised (18.8%, 95% CI: 17.7 to 19.9, n=887).

Table 8: Prevalence of device use in acute adult inpatients (including independent hospital inpatients) in 2016

Device	Number of patients surveyed*	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI
Peripheral vascular catheter	10 803	3924	36.3	34.3	38.3
Central vascular catheter	10 824	482	4.5	3.7	5.2
Urinary catheter	10 790	2249	20.8	20.0	22.1
Intubation	10 823	92	0.9	0.5	1.2

* Number of patients surveyed with device use recorded. Data for PVC, CVC, urinary catheters and intubation use were not recorded for 86, 65, 99 and 66 patients, respectively

The prevalence of device use in acute adult inpatients in 2016 and in the previous 2011 survey is presented in Appendix Table A22. After controlling for changes in patient case mix, the prevalence of PVC use was significantly higher in 2016 versus 2011 (OR=1.25, 95% CI: 1.14 to 1.38, p<0.001) whilst the prevalence of intubation was significantly lower (OR=0.55, 95% CI: 0.34 to 0.89, p=0.015). The prevalence of CVC use (OR=1.01, 95% CI: 0.78 to 1.29, p=0.9) and the prevalence of urinary catheterisation (OR=1.03, 95% CI: 0.92 to 1.16, p=0.57) were not significantly different in 2016 versus 2011.

Paediatric inpatients

The prevalence of device use in paediatric inpatients is described in Table 9. The prevalence of device use by specialty of care is provided in Appendix Table A23.

Approximately 38.7% of paediatric patients had at least one device in situ at the time of survey (n=281). The most commonly reported device in paediatric patients was PVC (30.0%, 95% CI: 26.8 to 33.4, n=219) though the prevalence was significantly lower than that of acute adult inpatients (p<0.001). More than one in ten patients had a CVC in situ (11.9%, 95% CI: 9.7 to 14.4, n=87) and the prevalence in paediatric inpatients was significantly higher than that in acute adult inpatients (11.9% versus 4.5%, p<0.001). The prevalence of intubation was also significantly higher in paediatric patients compared with acute adults (5.6% versus 0.9%, p<0.001).

Table 9: Prevalence of device use in paediatric inpatients in 2016

Device	Number of patients surveyed*	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI
Peripheral vascular catheter	731	219	30.0	26.8	33.4
Central vascular catheter	734	87	11.9	9.7	14.4
Urinary catheter	726	15	2.1	1.3	3.4
Intubation	729	41	5.6	4.2	7.5

* Number of patients surveyed with device status recorded. Data for PVC, CVC, urinary catheters and intubation were not recorded for 7, 4, 12 and 9 patients, respectively

The prevalence of device use in paediatric inpatients in 2016 and in the previous 2011 survey is presented in Appendix Table A24. The prevalence of PVC use (30.0% versus 23.6%, crude OR=1.4, 95% CI: 1.0 to 2.0, p=0.09), CVC use (11.9% versus 8.6%, crude OR=1.4, 95% CI: 0.7 to 3.0, p=0.35), urinary catheterisation (2.1% versus 2.2%, crude OR=0.9, 95% CI: 0.3 to 2.7, p=0.89) and intubation (5.6% versus 4.9%, crude OR=1.2, 95% CI: 0.5 to 2.8, p=0.77) were not significantly different in 2016 versus 2011. These odds ratios are crude as comparisons could not be adjusted for changes in patient case mix between 2016 and 2011 due to the small number of cases.

Non-acute inpatients

Table 10 describes the prevalence of device use in non-acute inpatients. The prevalence of device use by specialty of care is provided in Appendix Table A25.

Approximately 22.3% of non-acute patients had at least one device in situ at the time of survey (n=239). Urinary catheters were the most common devices in situ at the time of survey. One in five patients were catheterised (21.0%, 95% CI: 18.7 to 23.6, n=226) and the prevalence was not significantly different to that in acute adult inpatients (20.9% versus 20.8%, p=0.09). Patients who were catheterised were almost exclusively cared for in medical (26.2%, 95% CI: 20.7 to 32.5, n=55) and geriatric medicine specialties (25.8%, 95% CI: 22.5 to 29.3, n=163). There were no patients with a CVC or who were intubated at the time of survey and the prevalence of PVC use was 2.0% (95% CI 1.3 to 3.1, n=22).

Table 10: Prevalence of device use in non-acute inpatients in 2016

Device	Number of patients surveyed*	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI
Peripheral vascular catheter	1080	22	2.0	1.3	3.1
Central vascular catheter	1080	0	0.0	0.0	0.4
Urinary catheter	1074	226	21.0	18.7	23.6
Intubation	1078	0	0.0	0.0	0.4

* Number of patients surveyed with device use recorded. Data for PVC, CVC, urinary catheters and intubation were not recorded for 3, 3, 9 and 5 patients, respectively

The weighted prevalence estimates which account for the under-representation of psychiatric hospitals in the 25% sample were 1.5% (95% CI: 0.7 to 2.3) and 16.0% (95% CI: 12.0 to 20.0) for PVC use and urinary catheterisation, respectively.

The prevalence of device use in 2016 was not compared with the prevalence in 2011 as the sampling strategy used in 2016 differed from that in 2011 and the populations were not comparable.

Antimicrobial Prescribing in Scotland

Prevalence of antimicrobial prescribing in Scottish hospitals

The prevalence of antimicrobial prescribing by patient group is described in Table 11. More than a third of patients in acute care hospitals were receiving at least one antimicrobial at the time of survey (35.3%, 95% CI: 33.8 to 36.7, n=4094). The highest prevalence was reported in acute adult inpatients (35.7%, 95% CI: 34.2 to 37.2, n=3878) although one in three paediatric patients were also receiving antimicrobials at the time of survey (29.3%, 95% CI: 26.2 to 32.7, n=216). The lowest prevalence was reported in the non-acute patient group (13.8%, 95% CI: 11.8 to 16.0, n=148). The prevalence of antimicrobial prescribing in each of these patient groups is described in the following sections.

Table 11: Prevalence of antimicrobial prescribing in 2016, by patient group

Patient group	Number of patients surveyed*	2016			
		Number of patients receiving an antimicrobial	Prevalence (%)	95% Lower CI	95% Upper CI
Acute adult inpatients (including independent hospital inpatients)	10 869	3878	35.7	34.2	37.2
Paediatric inpatients	736	216	29.3	26.2	32.7
Total acute inpatients	**11 605**	**4094**	**35.3**	**33.8**	**36.7**
Non-acute inpatients	1074	148	13.8	11.8	16.0

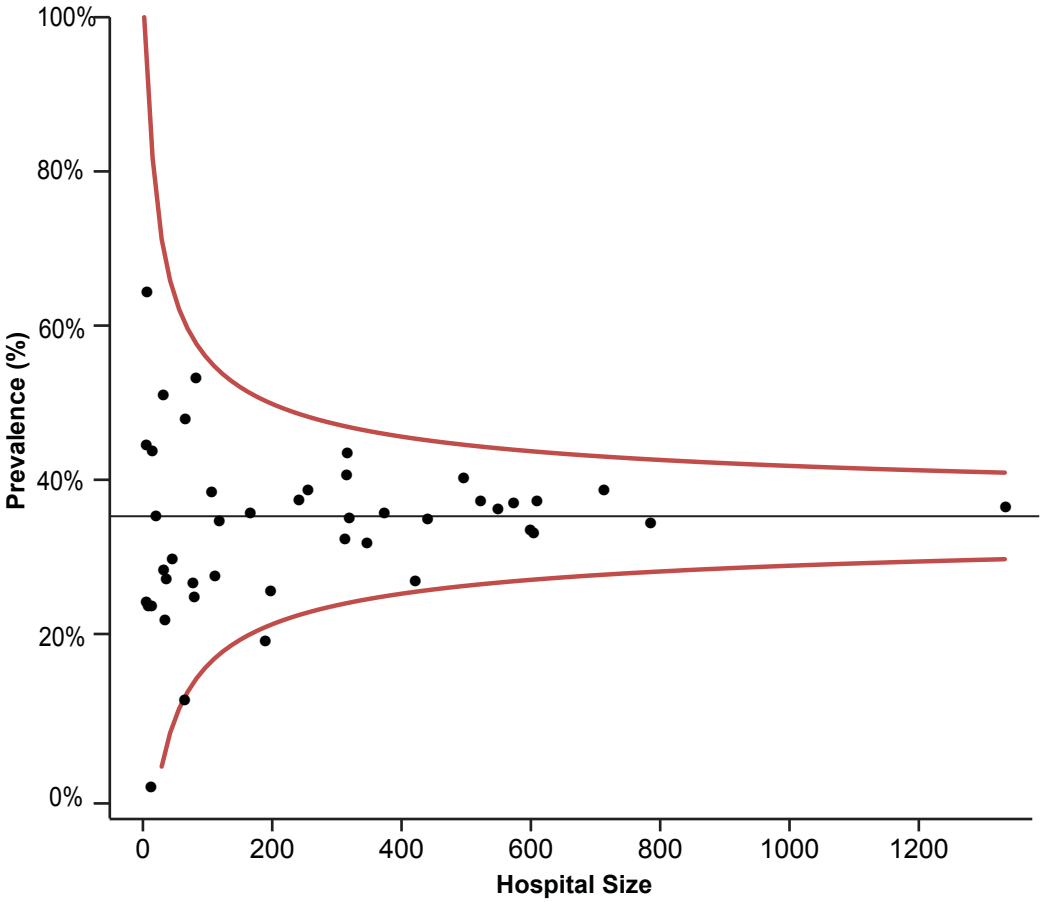
* Number of patients surveyed with antimicrobial status recorded. Antimicrobial data for acute adult, paediatric and non-acute patients, were not recorded for 20, 2 and 9 patients respectively

The weighted antimicrobial prevalence in 2016 in the non-acute sample was 12.9% (95% CI: 9.9 to 15.9). This weighted prevalence accounts for the sampling strategy where psychiatric patients were under-represented and estimates the true population antimicrobial prevalence in the whole Scottish non-acute hospital population.

Appendix Table A26 describes the prevalence of antimicrobial prescribing for each hospital included in the survey and includes prevalence estimates that have been adjusted for any differences in the patient case mix between the hospitals.

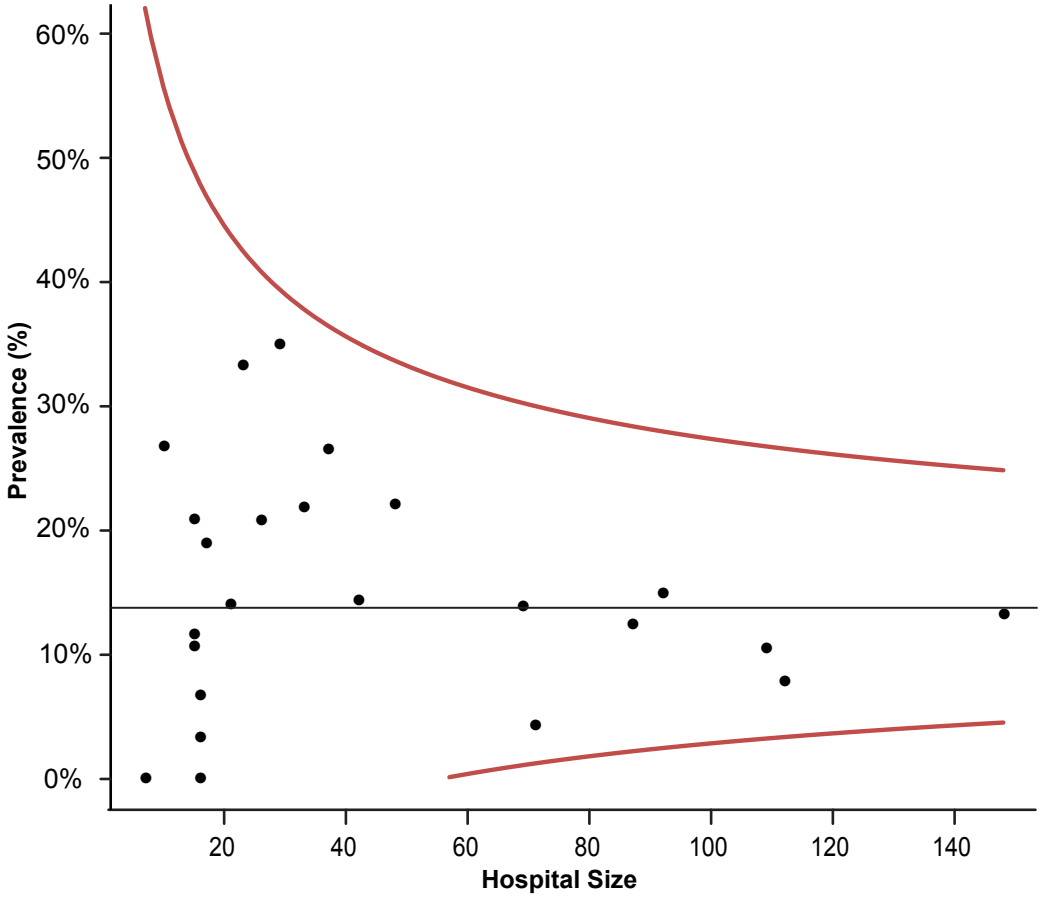
Figures 18 and 19 describe adjusted hospital level HAI prevalence relative to the mean Scottish prevalence. The plots indicate that antimicrobial prescribing prevalence was not higher than expected based on patient case mix and the national mean prevalence in any of the acute or non-acute hospitals.

Figure 18: Adjusted prevalence of antimicrobial prescribing in acute hospitals (including independent hospital and paediatric inpatients) in 2016



Note: two hospitals were excluded from the plot due to small numbers

Figure 19: Adjusted prevalence of antimicrobial prescribing in non-acute hospitals in 2016

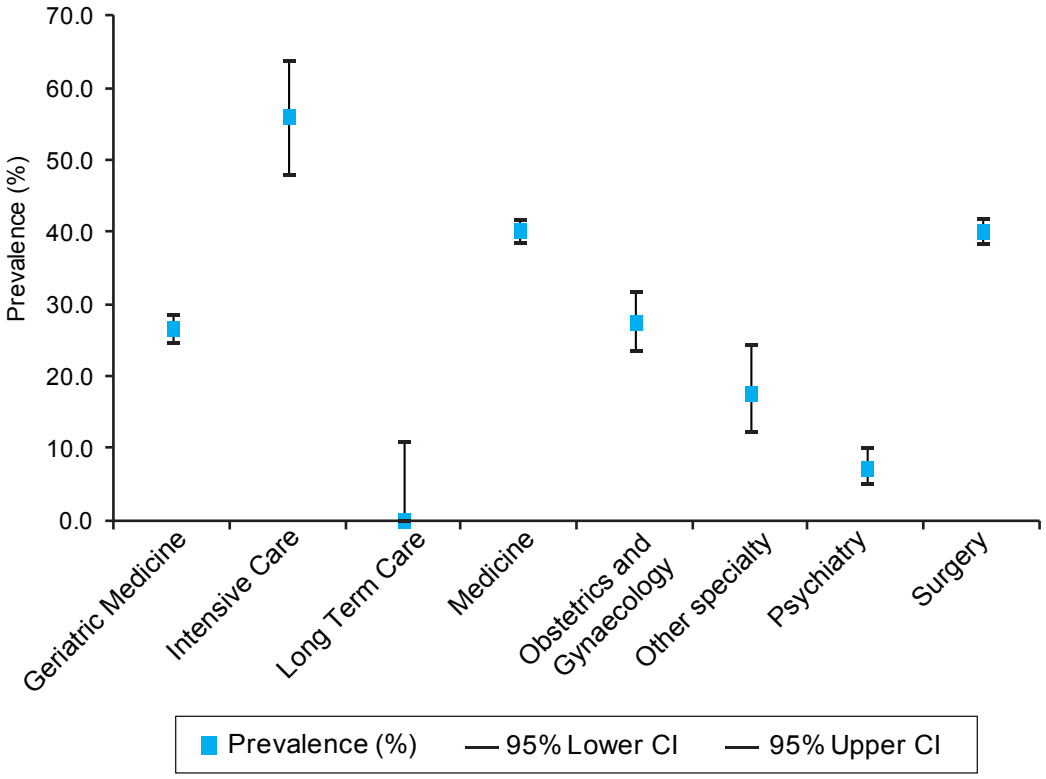


Acute adult inpatients

A total of 3878 acute adult inpatients were receiving at least one antimicrobial at the time of the survey. The overall prevalence was 35.7% (95% CI: 34.2 to 37.2). The prevalence of antimicrobial prescribing defined as the percentage of patients receiving at least one antimicrobial was significantly higher in 2016 compared with 2011 (35.7% versus 33.2%, adjusted OR= 1.11, 95% CI: 1.02 to 1.21, p=0.01). The prevalence of antimicrobial prescribing in 2016 and 2011 and the comparison results are described in Appendix Table A28. This comparison accounted for differences in the patient case mix between the two surveys.

The prevalence of antimicrobial prescribing varied by specialty and is described by specialty category in Figure 20 and in more detail by specialty in Appendix Table A29. The highest prevalence of patients receiving one or more antimicrobials was reported in intensive care patients (56.1%, 95% CI: 48.0 to 63.8, n=83), medical patients (40.2%, 95% CI: 38.9 to 41.6, n=1920) and surgical patients (40.2%, 95% CI: 38.4 to 42.0, n=1153).

Figure 20: Prevalence of antimicrobial prescribing by specialty in acute adult inpatients (including independent hospital inpatients) in 2016



Note: patients whose specialty of care was not recorded were excluded from the chart due to small numbers

The number of antimicrobials prescribed per patient is described in Table 12. One in ten patients who were receiving antimicrobials were receiving three or more antimicrobials (10.2%, n=395). This was not significantly different from 2011 when 10.1% of patients were receiving three or more antimicrobials (p=0.93). The number of antimicrobials prescribed for key infection types is provided in Appendix Table A30.

Table 12: Number of antimicrobials prescribed per patient in acute adult inpatients (including independent hospital inpatients) in 2016 and 2011

Number of antimicrobials prescribed per patient	2016		2011	
	Number of patients	%	Number of patients	%
0	6991	64.3	7359	66.8
1	2426	22.3	2254	20.5
2	1057	9.7	1030	9.4
3	323	3.0	301	2.7
4	60	0.6	54	0.5
5	6	0.1	9	0.1
6	6	0.1	4	0.0
7	0	0.0	1	0.0
Total	**10 869**	**100.0**	**11 012**	**100.0**

Risk factors associated with antimicrobial prescribing prevalence

The results from univariate analyses undertaken to describe antimicrobial prescribing prevalence by key risk factors for infection and the univariate association between these risk factors and prevalence are provided in Appendix Table A31. The results from multivariate analyses to identify risk factors that were independently associated with antimicrobial prescribing prevalence are provided in Appendix Table A32.

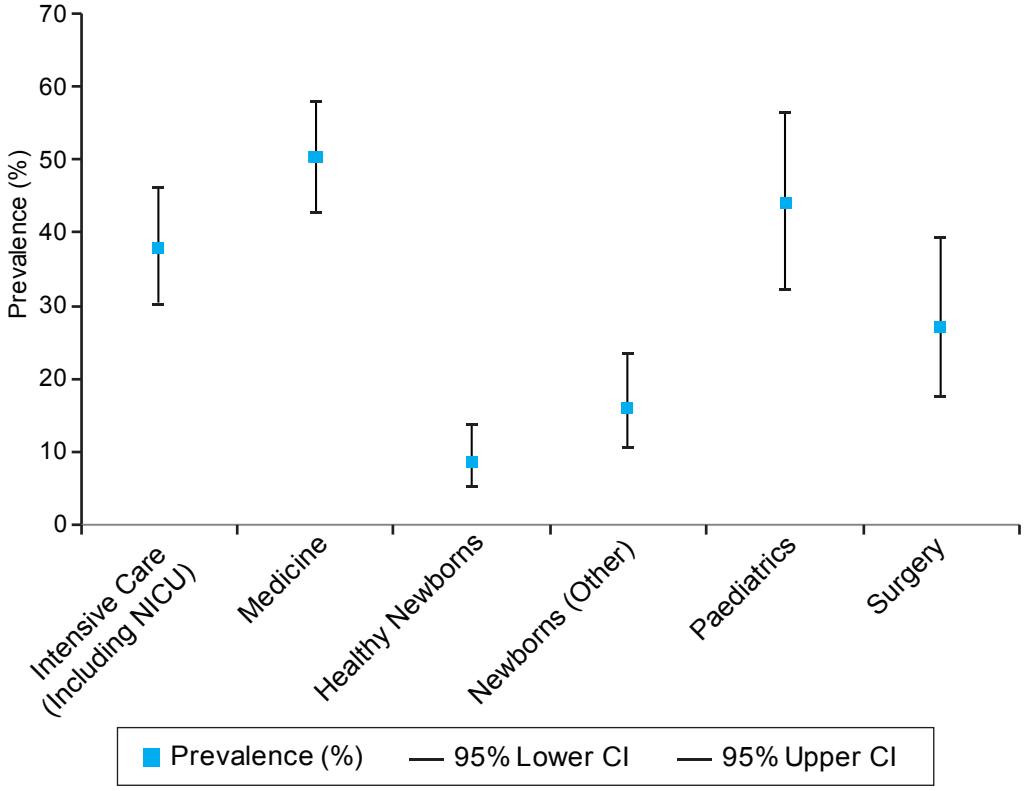
The multivariate results indicate that patient age was significantly associated with the prevalence of antimicrobial prescribing ($p=0.006$) with patients aged 80 years and older having significantly lower prevalence of antimicrobial prescribing than patients aged less than 80 years. A higher McCabe score ($p<0.001$), having undergone surgery since admission to hospital ($p<0.001$), being cared for in an ICU ward ($p=0.005$) and being under the care of a medical or surgical consultant ($p<0.001$) were all associated with a higher prevalence of antimicrobial prescribing. Longer lengths of stay were significantly associated with lower prevalence of antimicrobial prescribing when compared with lengths of stay of less than one week ($p<0.001$).

Paediatric inpatients

A total of 216 paediatric inpatients were receiving at least one antimicrobial at the time of the survey. The overall prevalence was 29.3% (95% CI: 26.2 to 32.7) in the total population and was 35.9% (95% CI: 32.0 to 40.0) in the population excluding the healthy newborn babies. The prevalence of antimicrobial prescribing was not significantly different in 2016 compared with 2011 (29.3% versus 25.3%, crude OR= 1.2, 95% CI: 0.8 to 1.8, $p=0.34$). The prevalence of HAI in 2016 and 2011 and the comparison results are described in Appendix Table A28. This comparison did not account for differences in the patient case mix between the two surveys. The prevalence by specialty category is described in Figure 21 and by specialty in Appendix Table A33.

Approximately 1 in 3 paediatric inpatients were receiving at least one antimicrobial

Figure 21: Prevalence of antimicrobial prescribing by specialty in paediatric inpatients in 2016



Note: patients cared for in psychiatric specialties were excluded from the chart due to small numbers

The number of antimicrobials prescribed per patient is described in Table 13. Of the patients who were receiving antimicrobials, 18.5% were receiving three or more antimicrobials (n=40) in 2016 compared with 17.1% in 2011 (n=35) (p=0.79). The number of antimicrobials prescribed for key infection types is provided in Appendix Table A34.

Table 13: Number of antimicrobials prescribed per patient in paediatric inpatients in 2016 and 2011

Number of antimicrobials prescribed per patient	2016		2011	
	Number of patients	%	Number of patients	%
0	520	70.7	605	74.7
1	86	11.7	87	10.7
2	90	12.2	83	10.2
3	31	4.2	21	2.6
4	7	1.0	11	1.4
5	1	0.1	1	0.1
6	1	0.1	2	0.2
7	0	0.0	0	0.0
Total	**736**	**100.0**	**810**	**100.0**

Risk factors associated with antimicrobial prescribing prevalence

The results from univariate analysis to describe antimicrobial prevalence by key risk factors for infection and the univariate association between these risk factors and antimicrobial prevalence are provided in Appendix Table A35.

The results from multivariate analyses to identify risk factors that were independently associated with antimicrobial prevalence are provided in Appendix Table A36. The multivariate results indicate that an ultimately fatal McCabe score was associated with significantly higher antimicrobial prescribing

(p<0.001). Healthy newborns, neonates (other than those cared for in the neonatal intensive care unit (NICU)) and surgical patients had a significantly lower antimicrobial prevalence than patients cared for in medical specialties (p<0.001) and prevalence was significantly lower in patients with a length of stay of more than 35 days (p=0.01).

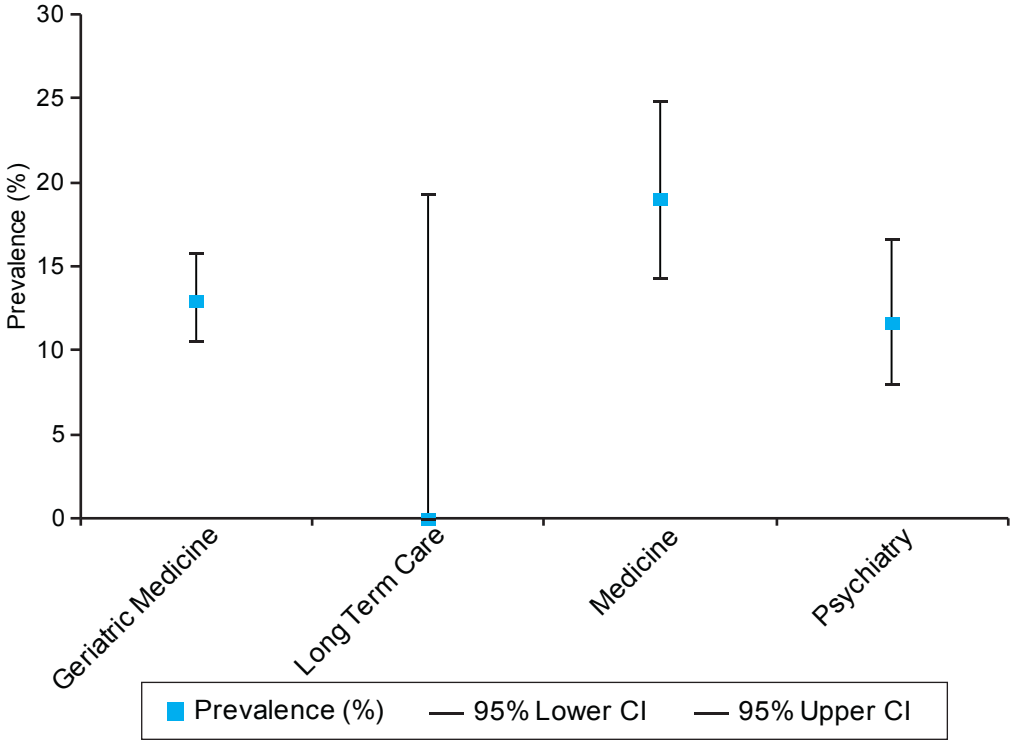
Non-acute inpatients

A total of 148 non-acute inpatients were receiving 168 antimicrobials at the time of the survey. The overall prevalence was 13.8% (95% CI: 11.8 to 16.0). The weighted prevalence of antimicrobial prescribing which accounts for the under-representation of psychiatric hospitals in the 25% sample was 12.9% (95% CI: 9.9 to 15.9).

The prevalence by specialty category is described in Figure 22 and by specialty in Appendix Table A37. The prevalence of antimicrobial prescribing in 2016 was not compared with that reported in 2011 as changes to the sampling strategy resulted in patient populations that were not comparable.

Approximately **1 in 8** non-acute inpatients were receiving at least one antimicrobial

Figure 22: Prevalence of antimicrobial prescribing by specialty in non-acute inpatients in 2016



Note: patients whose specialty of care was not recorded and patients in surgical and obstetrics/gynaecology specialties were excluded from the chart due to small numbers.

The number of antimicrobials prescribed per patient in 2016 is described in Table 14. Two non-acute inpatients were receiving three or more antimicrobials at the time of survey (1.4%). The number of antimicrobials prescribed for key infection types is provided in Appendix Table A38.

Table 14: Number of antimicrobials prescribed per patient in non-acute inpatients in 2016

Number of antimicrobials prescribed per patient	Number of patients	%
0	926	86.2
1	131	12.2
2	15	1.4
3	1	0.1
4	1	0.1
5	0	0.0
6	0	0.0
7	0	0.0
Total	**1074**	**100.0**

Risk factors associated with antimicrobial prescribing prevalence

The results from univariate analysis to describe antimicrobial prevalence by key risk factors for infection and the univariate association between these risk factors and antimicrobial prevalence are provided in Appendix Table A39. The results from multivariate analyses to identify risk factors that were independently associated with antimicrobial prescribing prevalence are provided in Appendix Table A40. The multivariate results indicate patient age was significantly associated with antimicrobial prescribing prevalence (p=0.008); with patients aged 80 years and older having a significantly higher prevalence than patients aged less than 80 years. A higher McCabe score (p=0.003) and the specialty of care (p=0.04) were also significantly associated with higher prevalence of prescribing. Longer lengths of stay were significantly associated with lower prevalence than those with a length of stay less than 14 days (p=0.004).

Characteristics of antimicrobials prescribed in Scottish inpatients

Indication for prescribing

A total of 6381 antimicrobials were prescribed in the surveyed patients. The number of antimicrobials by indication for prescribing and patient group is described in Table 15.

The majority of antimicrobials in each of the patient groups were prescribed for treatment of infection. The most common indication for prescribing in acute adult and paediatric patients was for the treatment of a community acquired infection, though almost a quarter were prescribed for hospital acquired infection in acute adults (23.8%, n=1386) and a fifth in paediatric patients (18.6%, n=74). More than half of all antimicrobials prescribed in non-acute patients were given for the treatment of a hospital acquired infection (51.8%, n=87). One in twenty antimicrobials in acute adults were prescribed as medical prophylaxis (5.3%, n=310). The percentage of antimicrobials prescribed as medical prophylaxis was higher in paediatric (20.6%, n=82) and non-acute patients (19.0%, n=32). Approximately one in twenty antimicrobials in acute adults were prescribed to prevent infections following surgery (5.8%, n=335). Four antimicrobials were being given as surgical prophylaxis in paediatric inpatients and there were none prescribed in non-acute inpatients.

Table 15: Distribution of antimicrobials by indication for prescribing and patient group in 2016

Indication		Acute adult inpatients		Paediatric inpatients		Non-acute inpatients		Total	
		N	%	N	%	N	%	N	%
Treatment of infection	Community acquired	3258	56.0	172	43.2	27	16.1	3457	54.2
	Hospital acquired	1386	23.8	74	18.6	87	51.8	1547	24.2
	Long term care acquired	76	1.3	1	0.3	1	0.6	78	1.2
	Total	**4720**	**81.2**	**247**	**62.1**	**115**	**68.5**	**5082**	**79.6**
Prevention of infection	Surgical prophylaxis	335	5.8	4	1.0	0	0.0	339	5.3
	Medical prophylaxis	310	5.3	82	20.6	32	19.0	424	6.6
Other	Other reason	129	2.2	32	8.0	1	0.6	162	2.5
	Not recorded	321	5.5	33	8.3	20	11.9	374	5.9
Total		**5815**	**100.0**	**398**	**100.0**	**168**	**100.0**	**6381**	**100.0**

A more detailed characterisation of antimicrobial prescribing for treatment of infection, surgical prophylaxis and medical prophylaxis is provided in the following sections.

Treatment of Infection

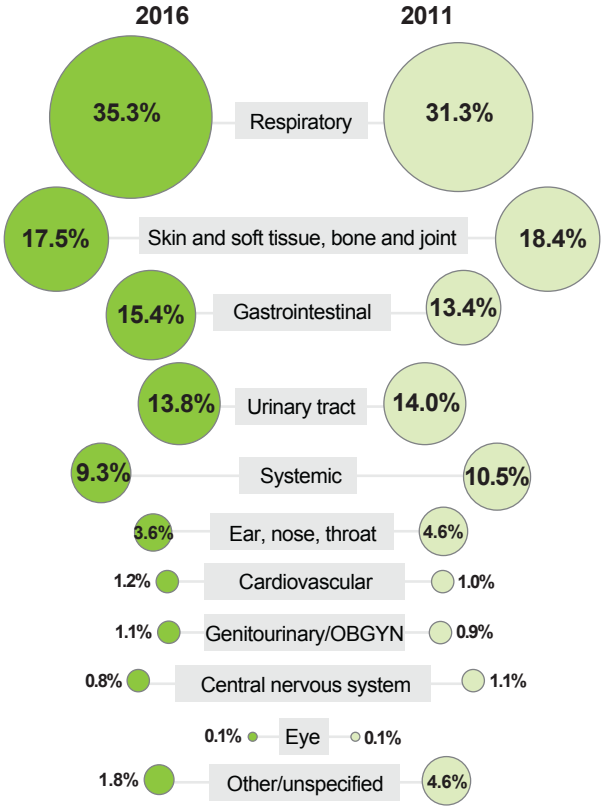
Acute adult inpatients

A total of 4720 antimicrobials were prescribed for treatment of infection in acute adult patients. This accounted for 81.2% of all antimicrobials prescribed in this patient group. The majority of these antimicrobials were prescribed for the treatment of community acquired infection (69.0%, n=3258) though almost a third were prescribed for infections considered to be hospital acquired (29.4%, n=1386).

The distributions of the types of infections being treated at the time of survey in 2011 and 2016 are described in Figure 23. In addition, a more detailed description of the diagnoses in 2016 is provided in Table Appendix A41. The most commonly reported infection type were respiratory tract infections; more than a third of all antimicrobials prescribed for treatment of infection were for respiratory tract infections (35.3%, n=1666) and a quarter were prescribed specifically for treatment of pneumonia (26.7%, n=1258). Antimicrobials were also commonly prescribed for SST, bone and joint infections (17.5%, n=828); gastrointestinal infections (15.4%, n=727) including intra-abdominal sepsis (13.3%, n=629); and UTI (13.8%, n=652). The percentage of antimicrobials that were prescribed for respiratory infections was significantly higher in 2016 (35.3% versus 31.3%, p<0.001).

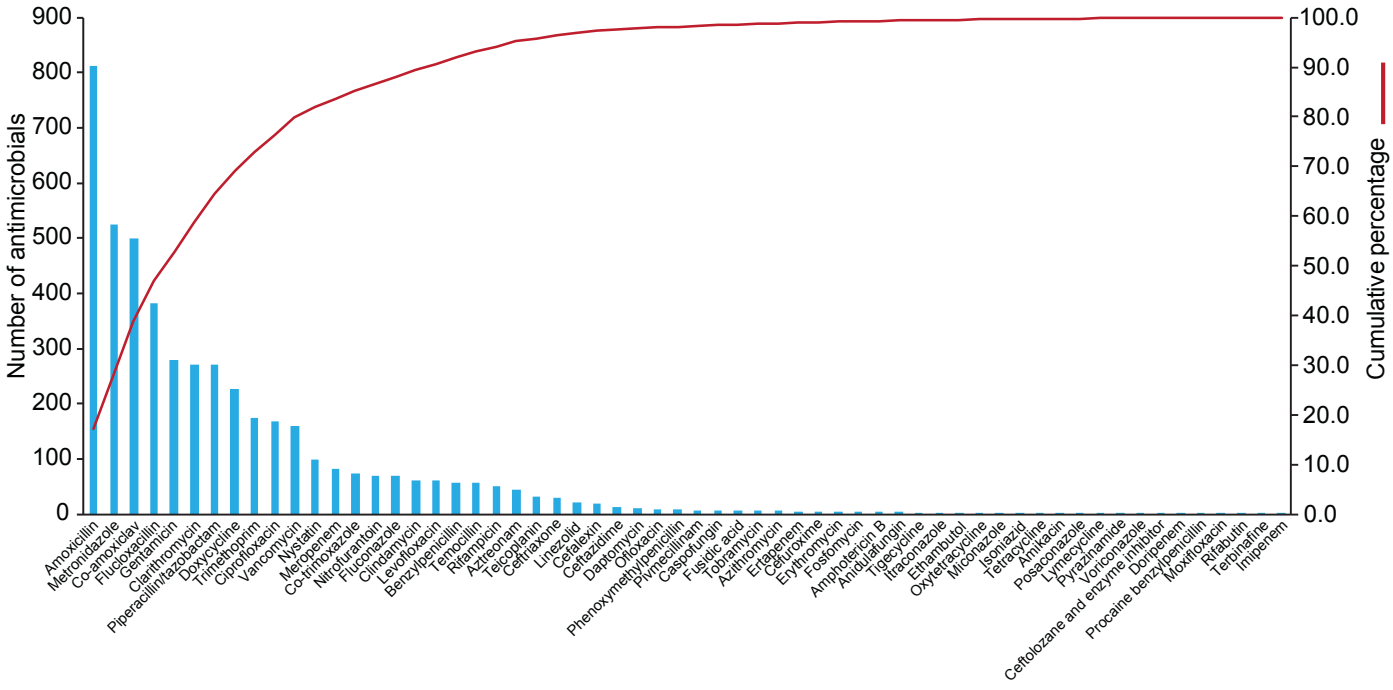
The most common diagnoses for the treatment of hospital acquired infection were respiratory tract infection (33.1%, n=459), SST, bone and joint infections (18.0%, n=249) and UTI (14.6%, n=203). The most common diagnoses for the treatment of community acquired infection were respiratory tract infection (36.1%, n=1176), SST, bone and joint infections (17.4%, n=566), gastrointestinal infections (17.2%, n= 562) and UTI (13.3%, n=434).

Figure 23: Distribution of diagnoses for prescribing for treatment of infection in acute adult inpatients (including independent hospital inpatients) in 2016 and 2011



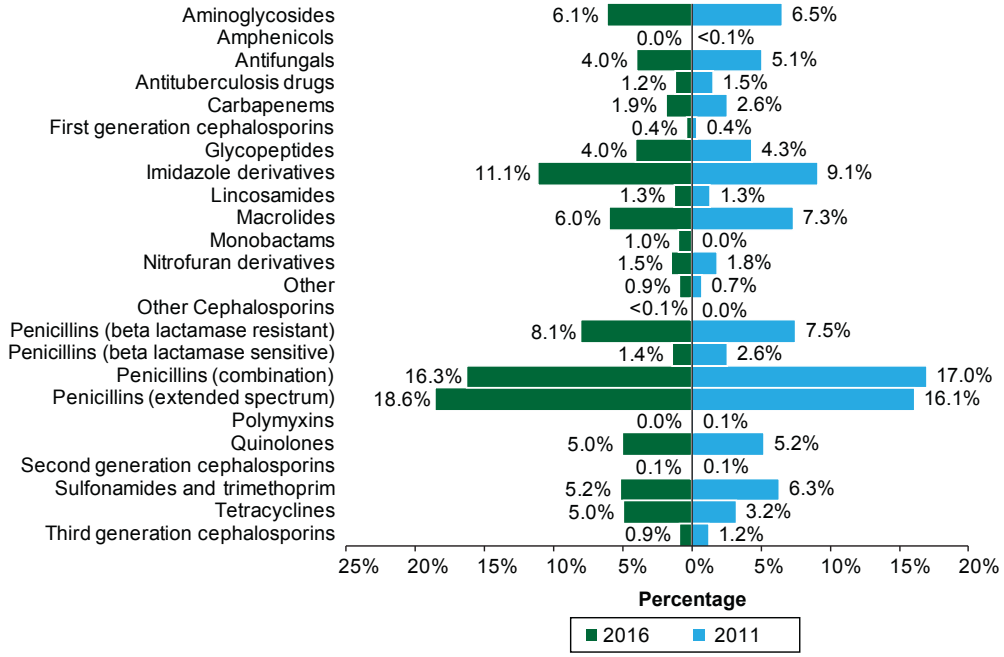
A pareto chart describing the antimicrobials prescribed for treatment of infection is presented in Figure 24. The distribution of antimicrobials is also provided in Appendix Table A42. The most commonly prescribed antimicrobial was amoxicillin (17.2%, n=812) and along with metronidazole, co-amoxiclav and flucloxacillin accounted for 47.0% of all antimicrobials prescribed for treatment of infection in this patient group. The antimicrobials prescribed for the treatment of key infection types in all patients surveyed (including paediatric and non-acute patients) are described in Appendix Figures A1 to A4.

Figure 24: Number and cumulative percentage of antimicrobials prescribed for the treatment of infection in acute adult inpatients (including independent hospital inpatients) in 2016



The antimicrobial groups prescribed for treatment of infection in 2016 and 2011 are described in Figure 25. Extended spectrum penicillins and combination penicillins were the most commonly prescribed antimicrobial groups in 2016 and in 2011.

Figure 25: Distribution of antimicrobial groups prescribed for treatment of infection in 2016 and 2011 in acute adult inpatients (including independent hospitals)



Antimicrobials that were prescribed for treatment of infection were administered orally (49.9%, n=2354), parenterally (49.9%, n=2354) and rectally (<0.1%, n=2). Data pertaining to the route of administration were not recorded for ten antimicrobials.

The duration of treatment at the time of the survey for oral and parenteral antimicrobials is described in Table 16. These analyses were restricted to antimicrobials that had not been changed or where the route had not changed during the course of treatment. Nearly half of all parenteral antimicrobials where there had been no change in the route of administration had been given for more than three days at the time of survey (48.4%, n=783) and 14.8% had been given for more than seven days (n=238). The infection types for which a parenteral antimicrobial had been given for more than three days are described in Figure 26. Respiratory tract infections (25.5%, n=200); SST, bone/joint infections (24.3%, n=190); and gastrointestinal infections including intra-abdominal sepsis (22.1%, n=173) were the most common infection types where parenteral antimicrobials were given for more than three days. A total of 198 oral antimicrobials had been prescribed for more than seven days at the time of survey (14.3%) and the most common diagnoses were respiratory tract infections (27.3%, n=54), SST and bone/joint infections (25.3%, n=50) and ear, nose and throat (ENT) infections (16.7%, n=33).

Table 16: Duration of treatment of infection at time of survey in acute adult inpatients (including independent hospital inpatients) in 2016, by route of administration

Duration at time of survey (days)	Parenteral		Oral	
	Number of antimicrobials	%	Number of antimicrobials	%
0	142	8.8	96	6.9
1	397	24.6	312	22.5
2	283	17.5	212	15.3
3	232	14.3	197	14.2
4	150	9.3	157	11.3
5	80	4.9	110	7.9
6	83	5.1	98	7.1
7 or more	238	14.7	198	14.3
Not recorded	12	0.7	6	0.4
Total	**1617**	**100.0**	**1386**	**100.0**

Note: These analyses were restricted to antimicrobials that had not been changed (including a change in route) during the course of treatment of the infection

Figure 26: Diagnosis groups for parenteral (IV) antimicrobials prescribed for over 3 days in acute adult inpatients (including independent hospital inpatients) in 2016

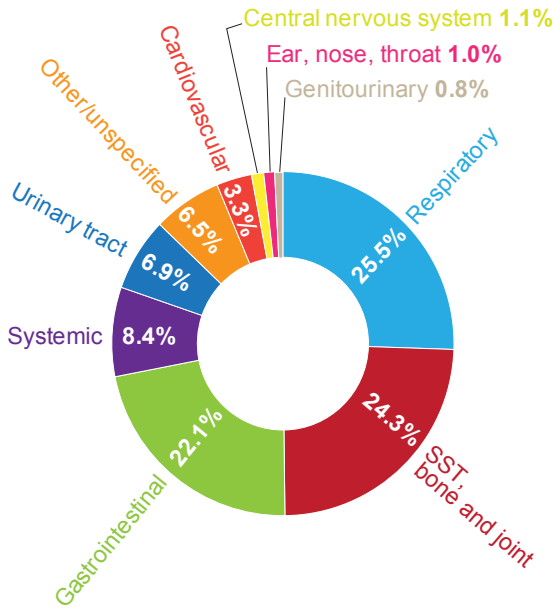
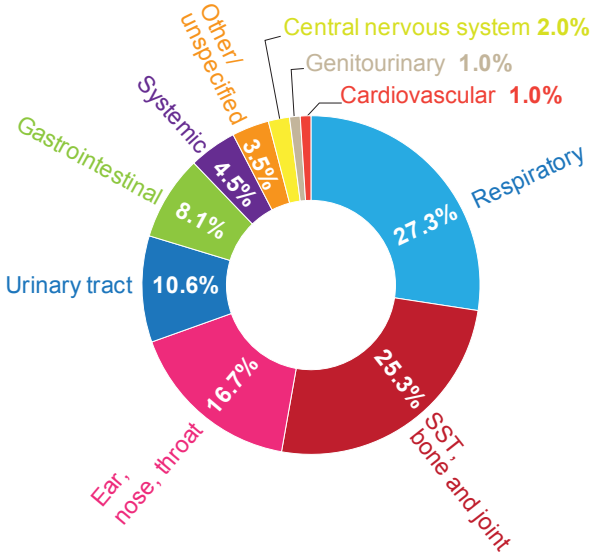


Figure 27: Diagnosis groups for oral antimicrobials prescribed for over 7 days in acute adult inpatients (including independent hospital inpatients) in 2016



The reason for prescribing was recorded in the notes at the time of prescribing for 94.8% of the antimicrobials prescribed for treatment of infection (n=4640) in 2016. This was significantly higher than was reported in 2011 (94.8% versus 89.0%, p<0.001).

Figure 28: Reason recorded in notes for antimicrobials prescribed for treatment of infection in acute adult inpatients (including independent hospitals) in 2016

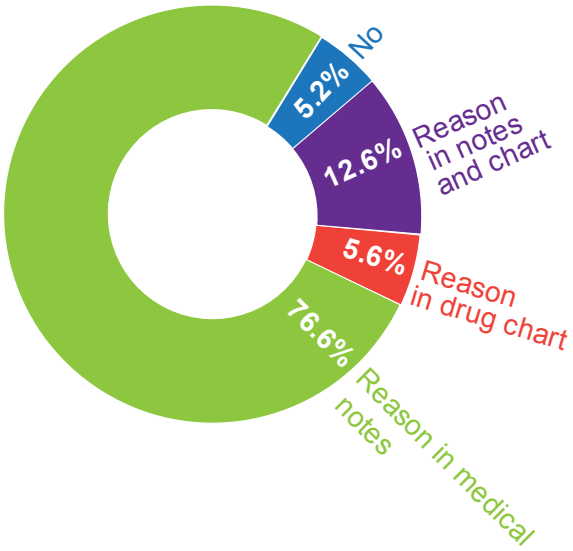
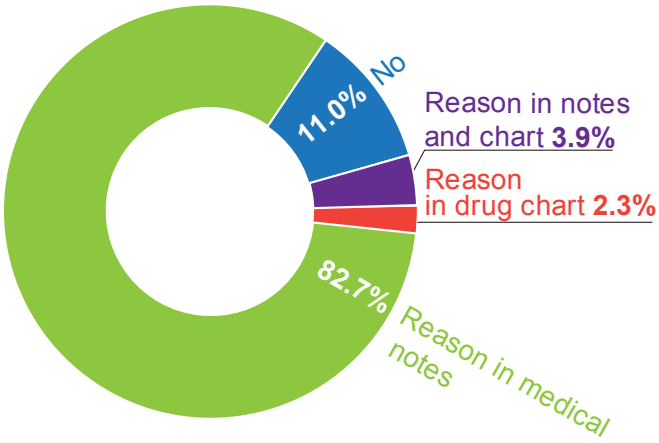
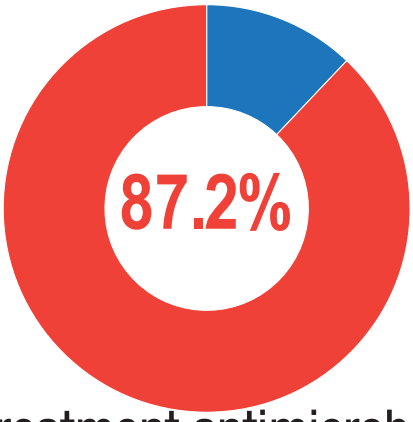


Figure 29: Reason recorded in notes for antimicrobials prescribed for treatment of infection in acute adult inpatients (including independent hospitals) in 2011



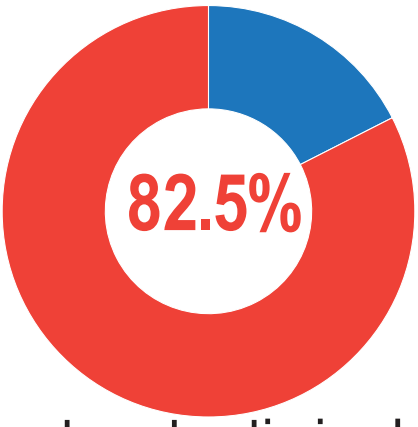
Antimicrobial prescribing was compliant with local policy for 87.2% of antimicrobials (n=3140) where the reason was recorded in the notes and where there was an appropriate local policy for treatment of the infection which could be assessed against (n=3599). This was significantly higher in 2016 compared with 2011 when 82.5% of antimicrobials prescribed were compliant with local prescribing policy (p<0.001).

Figure 30: Compliance with local policy in antimicrobials prescribed for treatment of infection in acute adult inpatients (including independent hospitals) in 2016



of treatment antimicrobials were compliant with local policy in 2016

Figure 31: Compliance with local policy in antimicrobials prescribed for treatment of infection in acute adult inpatients (including independent hospitals) in 2011



of treatment antimicrobials were compliant with local policy in 2011

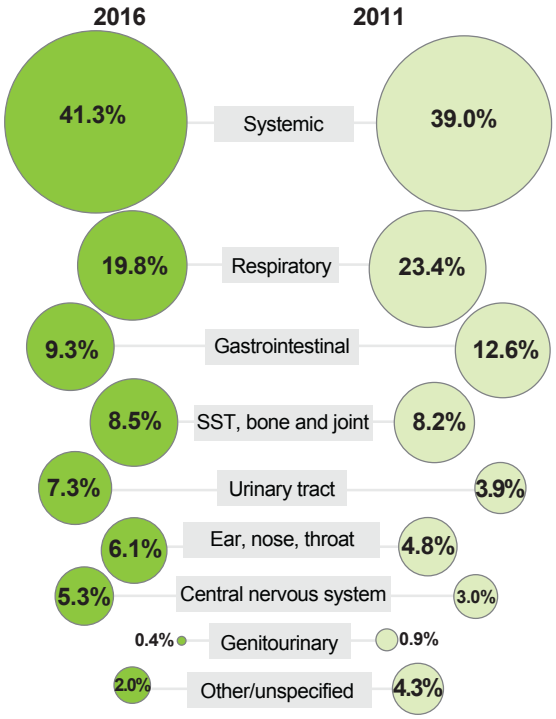
Paediatric inpatients

A total of 247 antimicrobials were prescribed for treatment of infection in paediatric patients, accounting for 62.1% of all antimicrobials prescribed in this patient group. Two thirds of these antimicrobials were prescribed for community acquired infection (n=172) and almost a third were prescribed for treatment of hospital acquired infection (n=74).

The distribution of the types of infection being treated with antimicrobials in this patient group in 2016 and 2011 is described in Figure 32. In addition, a more detailed description of diagnoses in 2016 is provided in Appendix Table A43. The most common reason for prescribing in the paediatric patients was for treatment of systemic infections (n=102) including clinical sepsis (n=54) and febrile neutropenia (n=22); and treatment of respiratory tract infections (n=49) including lower respiratory tract infections other than pneumonia (n=17), cystic fibrosis (n=17) and pneumonia (n=15).

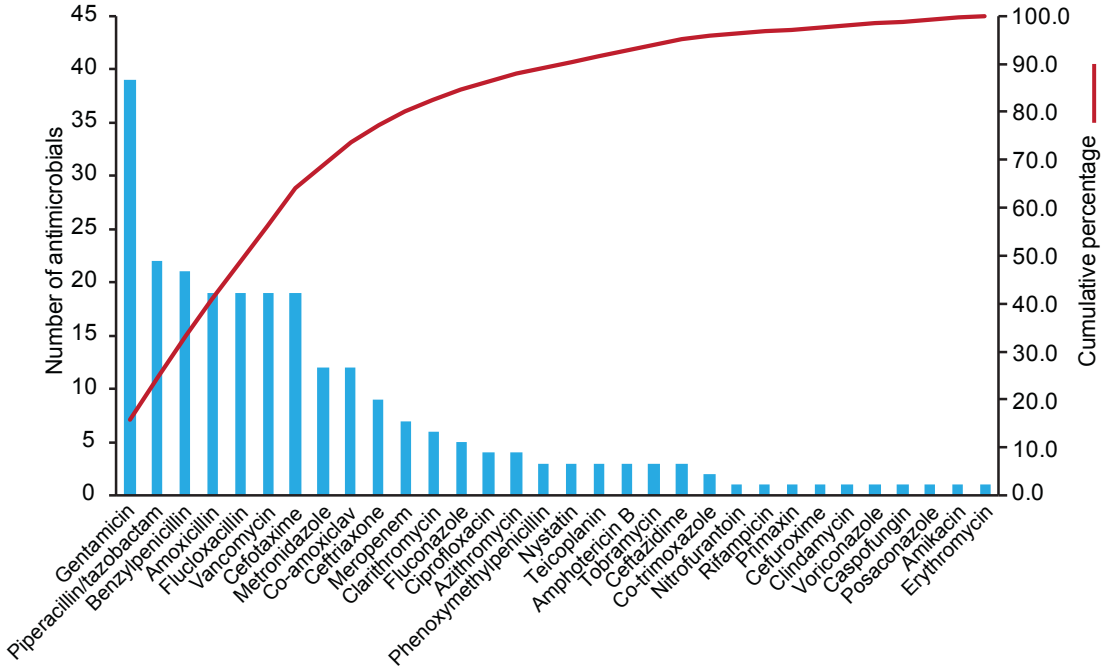
There was no difference between 2016 and 2011 in the prevalence of antimicrobials prescribed for the treatment of systemic infections (41.3% versus 39.0%, p=0.67), respiratory infections (19.8% versus 23.4%, p=0.41), gastrointestinal infections (9.3% versus 12.6%, p=0.32), or SST and bone/joint infections (8.5% versus 8.2%, p=1). The most common diagnoses for the treatment of hospital acquired infection were clinical sepsis (27.0%, n=20) and BSI (14.9%, n=11). Clinical sepsis (19.8%, n=34) and febrile neutropenia (9.9%, n=17) were the most common community acquired infection diagnoses.

Figure 32: Distribution of diagnoses for prescribing for treatment of infection in 2016 versus 2011 in paediatric inpatients



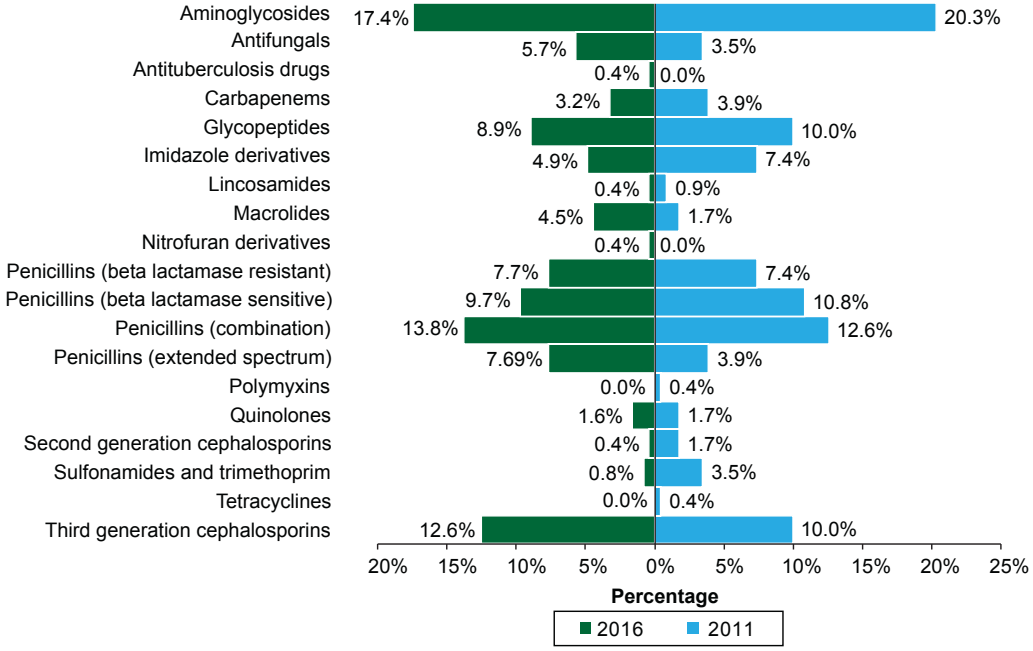
A pareto chart describing the antimicrobials prescribed for treatment of infection in paediatric patients is presented in Figure 33. The most commonly prescribed antimicrobial was gentamicin (15.8%, n=39) and along with piperacillin/tazobactam (8.9%, n=22) and benzylpenicillin (n=21, 8.5%) accounted for a third of all antimicrobials prescribed for treatment of infection in this patient group.

Figure 33: Number and cumulative percentage of antimicrobials prescribed for the treatment of infection in paediatric inpatients in 2016



The antimicrobial groups prescribed for treatment of infection paediatric inpatients in 2016 and 2011 are described in Figure 34. The most commonly prescribed antimicrobial group in paediatric inpatients in 2016 were aminoglycosides (17.4%, n=43). This was also the most common antimicrobial group in 2011 (20.3%, n=47). Combination penicillins (n=34) and third generation cephalosporins (n=31) accounted for 13.8% and 12.6% of antimicrobials prescribed for treatment of infection in 2016, respectively.

Figure 34: Distribution of antimicrobial groups prescribed for treatment of infection in 2016 and 2011 in paediatric inpatients



The majority of antimicrobials prescribed for treatment of infection in paediatric patients were administered parenterally (83.0%, n=205). One antimicrobial was inhaled and the remaining were administered orally (15.4%, n=38). Route of administration was not recorded for three antimicrobials.

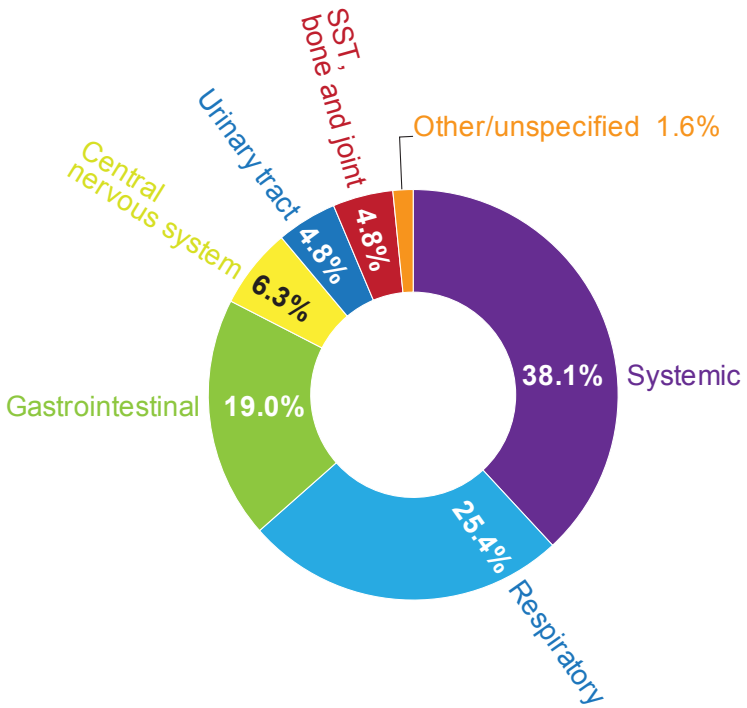
The duration of treatment at time of survey for parenteral and oral antimicrobials is described in Table 17. These analyses were restricted to antimicrobials where there had been no change in the

antimicrobial given or a change in route during the course of treatment of the infection episode. Approximately 40% of antimicrobials administered parenterally where there had been no change had been given for more than three days at the time of survey (n=63). The infection types where parenteral treatment duration was more than three days are described in Figure 35. The most common infection type that were being treated for more than three days were systemic infection (38.1%, n=24) and respiratory tract infection (25.4%, n=16). Eight oral antimicrobials had been given for more than seven days (29.6%). These were given for seven respiratory infections and one ENT infection.

Table 17: Duration of treatment of infection at time of survey in paediatric inpatients in 2016, by route of administration

Duration at time of survey (days)	Parenteral		Oral	
	Number of antimicrobials	%	Number of antimicrobials	%
0	24	14.9	2	7.4
1	37	23.0	5	18.5
2	36	22.4	5	18.5
3	12	7.5	1	3.7
4	11	6.8	3	11.1
5	13	8.1	1	3.7
6	7	4.3	2	7.4
7 or more	20	12.4	8	29.6
Not recorded	1	0.6	0	0.0
Total	**161**	**100.0**	**27**	**100.0**

Figure 35: Diagnosis groups for parenteral (IV) antimicrobials prescribed for over 3 days, in paediatric inpatients in 2016



The reason for prescribing was recorded at the time of prescribing for 91.8% of the antimicrobials prescribed for treatment of infection (n=223) in 2016. This was not significantly different from that reported in 2011 (91.8% versus 91.2%, p=0.9).

Figure 36: Reason recorded in notes for antimicrobials prescribed for treatment of infection in paediatric inpatients in 2016

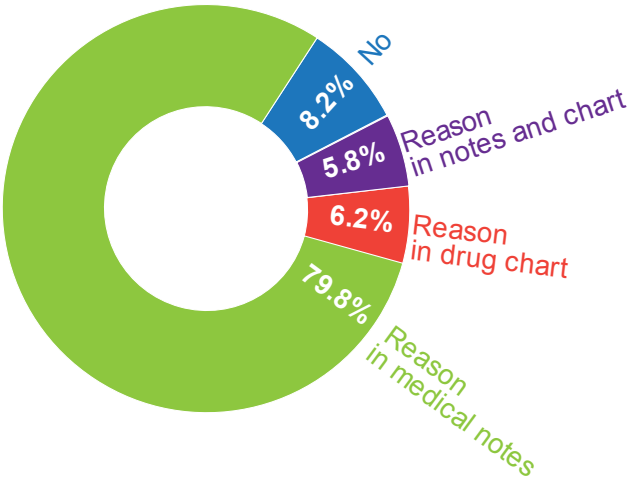
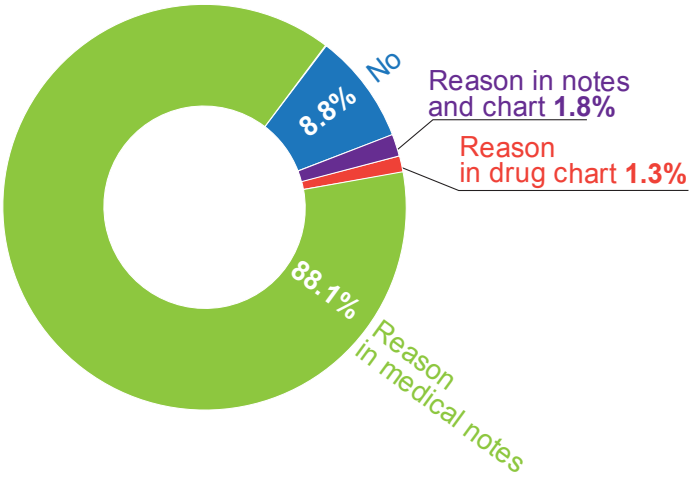
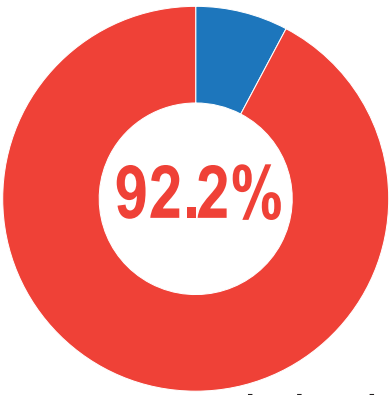


Figure 37: Reason recorded in notes for antimicrobials prescribed for treatment of infection in paediatric inpatients in 2011



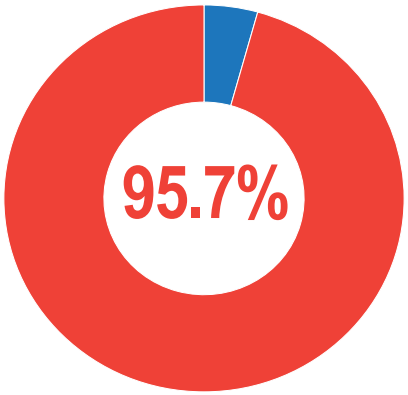
Antimicrobial prescribing was compliant with local policy for 92.2% of antimicrobials (n=154) where the reason was recorded in the notes and where an appropriate local policy for treatment of the infection could be assessed against (n=167). This was not significantly different in 2016 compared with 2011 when 95.7% of antimicrobials prescribed were compliant with local prescribing policy (p=0.36).

Figure 38: Compliance with local policy in antimicrobials prescribed for treatment of infection in paediatric inpatients in 2016



of treatment antimicrobials were compliant with local policy in 2016

Figure 39: Compliance with local policy in antimicrobials prescribed for treatment of infection in paediatric inpatients in 2011



of treatment antimicrobials were compliant with local policy in 2011

Non-acute inpatients

A total of 115 antimicrobials were prescribed for treatment of infection in non-acute adult patients. Three quarters of the antimicrobials prescribed for the treatment of infection were prescribed for infections considered to be hospital acquired (75.7%, n=87). One was prescribed to treat an infection associated with long term care (0.9%) and the remaining to treat community acquired infection (23.5%, n=27).

The distribution of the infection types being treated at the time of survey in 2016 are described in Table 18. In addition, further details of the diagnoses are described in Appendix Table A45. The most common reason for prescribing to treat infection were UTI (36.5%, n=42); respiratory tract infections (28.7%, n=33); and SST, bone and joint infections (26.1%, n=30). A comparison of the distributions in 2016 and 2011 were not made due to the different sampling strategies adopted in the surveys.

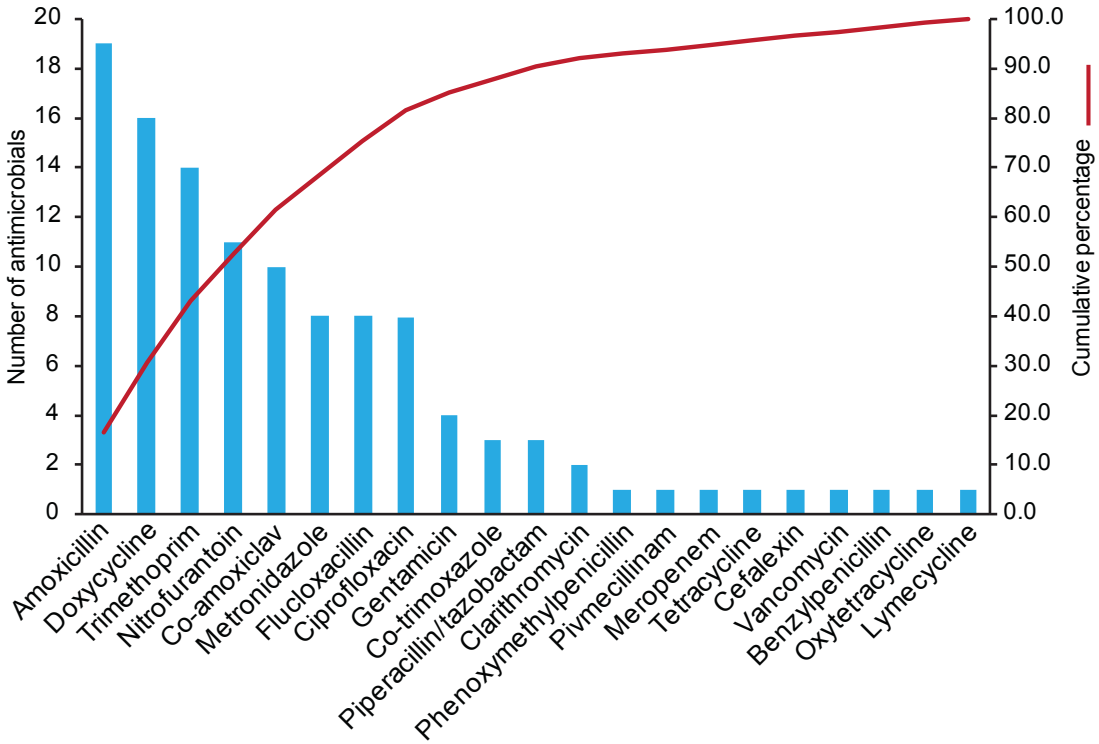
Table 18: Distribution of diagnoses for prescribing for treatment of infection in non-acute inpatients in 2016

Diagnosis	N	%
Urinary tract	42	36.5
Respiratory	33	28.7
Skin and soft tissue	30	26.1
Systemic	3	2.6
Ear, nose, throat	2	1.7
Gastrointestinal	1	0.9
Genitourinary/OBGYN	1	0.9
Other/unspecified	3	2.6
Total	**115**	**100.0**

The most common diagnoses for the treatment of hospital acquired infection were UTI (39.1%, n=34); respiratory tract infection (33.3%, n=29); and SST, bone and joint infections (21.8%, n=19). SST, bone and joint infections (37.0%, n=10) and UTI (29.6%, n=8) were the most common diagnoses for community acquired infection prescribing.

A pareto chart describing the antimicrobials prescribed for treatment of infection is presented in Figure 40. The distribution of antimicrobials is also provided in Appendix Table A46. The most commonly prescribed antimicrobials were amoxicillin (16.5%, n=19), doxycycline (13.9%, n=16) and trimethoprim (12.2%, n=14).

Figure 40: Number and cumulative percentage of antimicrobials prescribed for the treatment of infection in non-acute inpatients in 2016



The majority of antimicrobials prescribed for the treatment of infection in non-acute patients were administered orally (85.2%, n=98). Parenteral antimicrobials accounted for 14.8% of antimicrobials (n=17). The duration of treatment for parenteral and oral antimicrobials where the antimicrobial or route of administration had not changed during the treatment regimen is described in Table 19. Five parenteral antimicrobials had been administered for more than three days at the time of survey (45.5%). These were antimicrobials were being given for: UTI (n=2); respiratory tract infection (n=1); SST, bone

and joint infection (n=1); and systemic infection (n=1). Twelve oral antimicrobials had been given for more than or equal to at the time of survey (17.9%). The diagnoses for these antimicrobials were UTI (n=5); SST, bone and joint infection (n=4) and respiratory tract infection (n=3).

Table 19: Duration of treatment of infection at time of survey in non-acute inpatients in 2016, by route of administration

Duration at time of survey (days)	Parenteral		Oral	
	Number of antimicrobials	%	Number of antimicrobials	%
0	2	18.2	3	4.5
1	2	18.2	11	16.4
2	2	18.2	9	13.4
3	3	27.3	10	14.9
4	1	9.1	13	19.4
5	1	9.1	7	10.4
6	0	0.0	1	1.5
7 or more	0	0.0	12	17.9
Not recorded	0	0.0	1	1.5
Total	**11**	**100.0**	**67**	**100.0**

The reason for prescribing was recorded in the notes for 93.8% of antimicrobials prescribed for treatment of infection (n=106) (Figure 41). Antimicrobial prescribing was compliant with local policy for 87.0% of antimicrobials (n=80) where the reason was recorded in the notes and where an appropriate local policy for treatment of the infection could be assessed against (n=92) (Figure 42).

Figure 41: Reason recorded in notes for antimicrobials prescribed for treatment of infection in non-acute inpatients in 2016

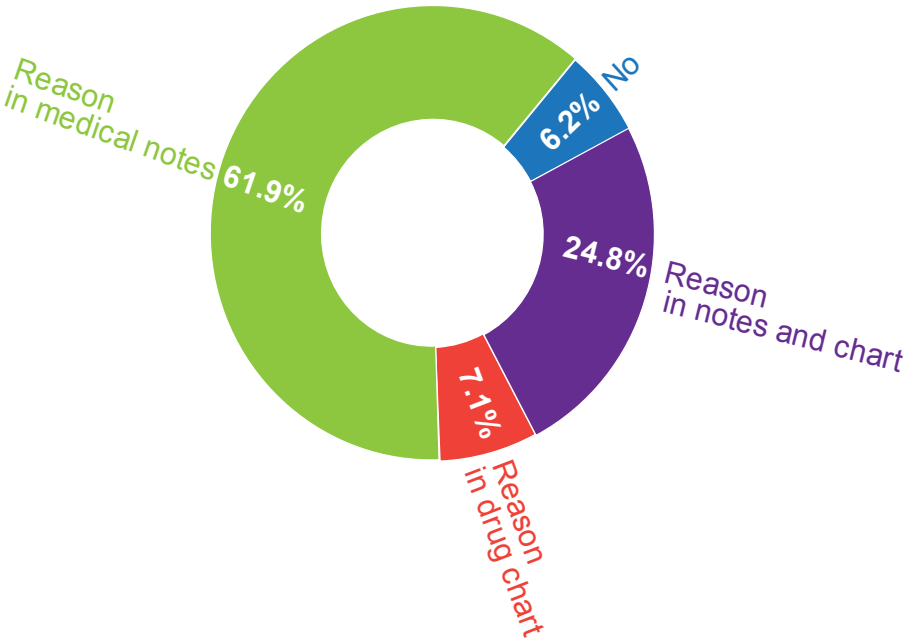
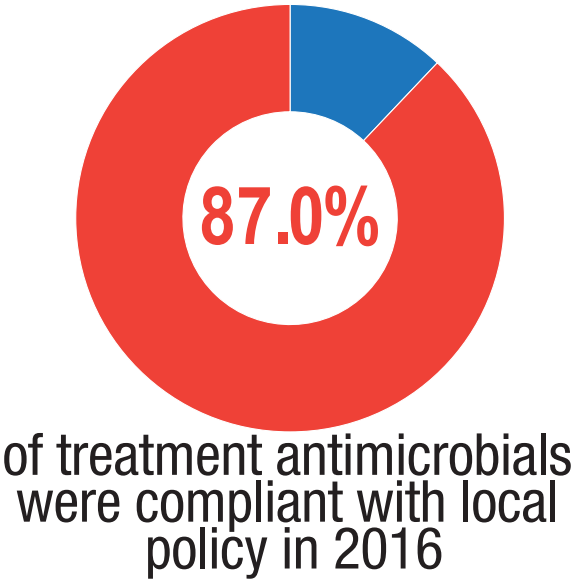


Figure 42: Compliance with local policy in antimicrobials prescribed for treatment of infection in non-acute inpatients in 2016



Prevention of infection: surgical prophylaxis

A total of 339 antimicrobials were prescribed as surgical prophylaxis including four antimicrobials that were prescribed in the paediatric patient group. Surgical prophylaxis prescribing accounted for 5.8% of all prescribing in acute adult patients (n=335) and 1.0% in paediatric patients (n=4). There were no antimicrobials prescribed for surgical prophylaxis in non-acute patients.

The distribution of the surgical procedures for which prophylaxis was given in 2016 and 2011 are described in Figure 43 and in more detail in Appendix Appendix Tables A47 and A48. Orthopaedic surgery prophylaxis was the most commonly prescribed surgical prophylaxis (36.9%, n=125) accounting for more than a third of all surgical prophylaxis antimicrobials. Gastrointestinal tract surgery (22.1%, n=75) and obstetric/gynaecological surgery (16.5%, n=56) accounted for a further third of surgical prophylaxis prescribing.

Figure 43: Distribution of surgery types in antimicrobials prescribed as surgical prophylaxis in 2016 and 2011, in all patients surveyed

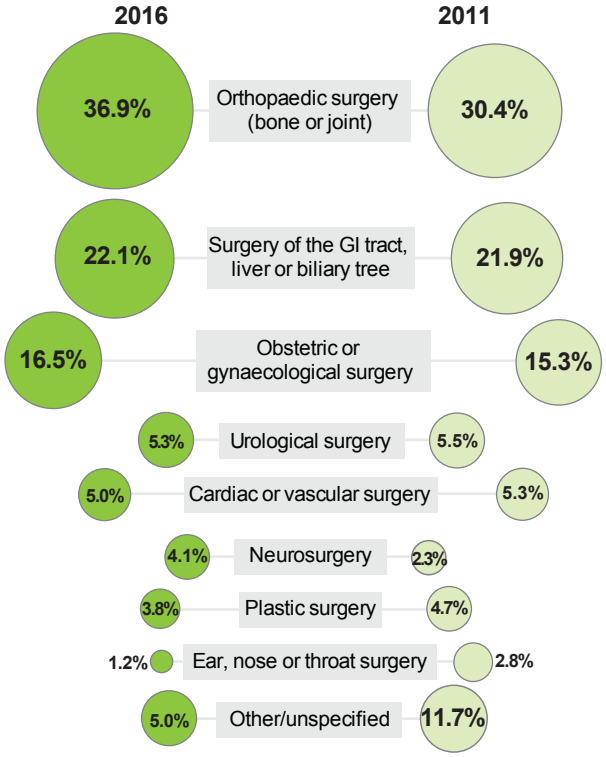
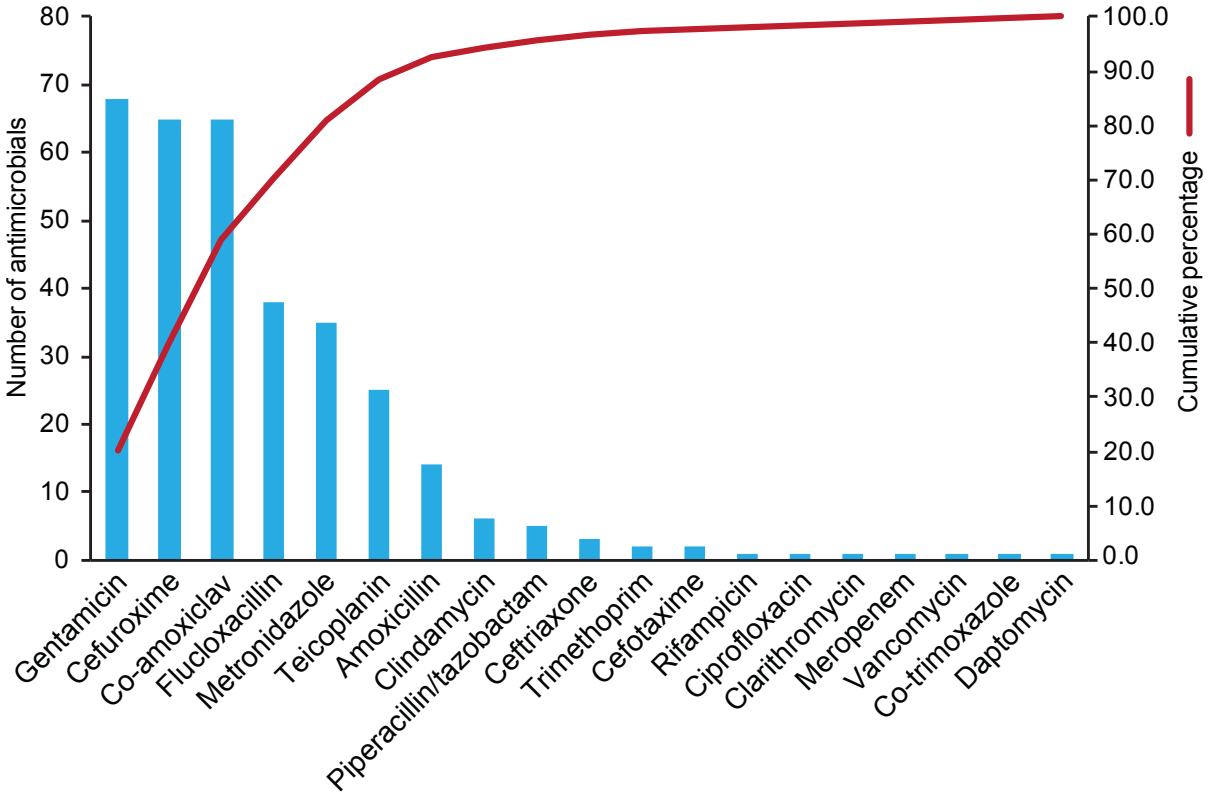


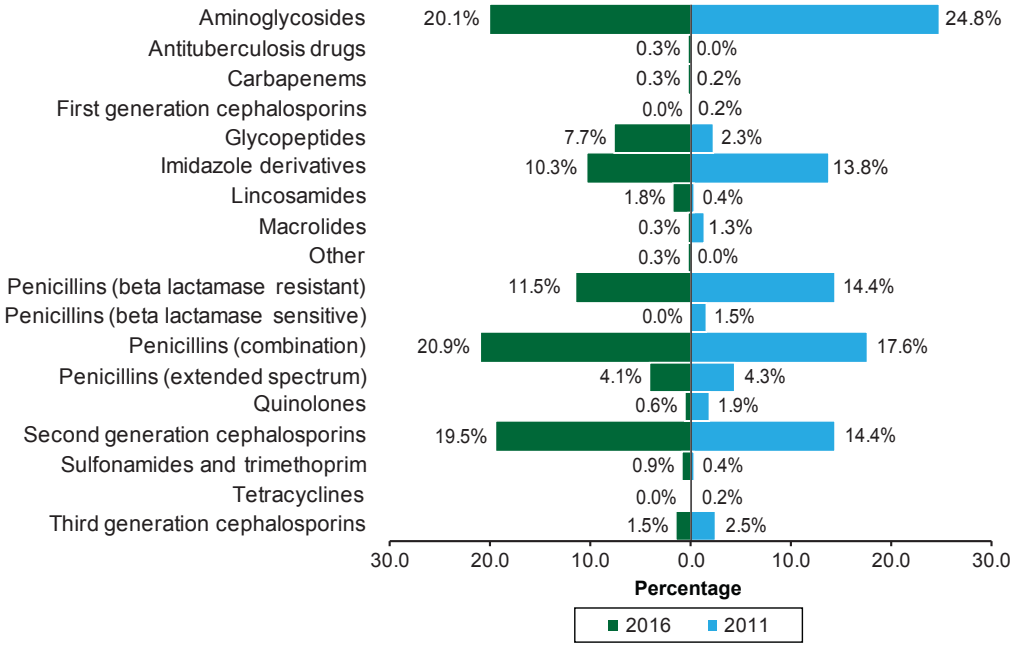
Figure 44 describes the number of antimicrobials prescribed as surgical prophylaxis. The most commonly prescribed antimicrobials were gentamicin (20.1%, n=68), cefuroxime (19.5%, n=66) and co-amoxiclav (19.5%, n=66). These antimicrobials accounted for 59.0% of all antimicrobials prescribed as surgical prophylaxis. The distributions of antimicrobials prescribed as surgical prophylaxis in acute adult inpatients and paediatric inpatients are provided in Appendix Tables A49 and A50, respectively. Pareto charts that describe surgical prophylaxis prescribing for orthopaedic, intra-abdominal, obstetric/gynaecological, urological and vascular surgeries are provided in Appendix Figures A5 to A9.

Figure 44: Number and cumulative percentage of antimicrobials prescribed as surgical prophylaxis in acute inpatients (including independent and paediatric inpatients) in 2016



The distribution of antimicrobial groups prescribed in 2016 and 2011 are described in Figure 45. Combination penicillins were the most commonly prescribed antimicrobial for surgical prophylaxis (20.9%, n=71) followed by aminoglycosides (20.1%, n=68) and second generation cephalosporins (19.5%, n=66).

Figure 45: Distribution of antimicrobial groups prescribed for surgical prophylaxis, in acute inpatients (including independent and paediatric inpatients) in 2016 and 2011



The number of doses and duration over which the surgical prophylaxis antimicrobials were given in 2016 and 2011 are described in Figures 46 and 47, respectively. Two thirds of surgical prophylaxis antimicrobials were given as a single dose (64.9%, n=220). The remainder were given as more than one dose administered within a 24 hour period (15.3%, n=52) or over more than 24 hours (19.8%, n=67). The most common procedures where more than one dose of surgical prophylaxis was administered were orthopaedic surgery (40.3%, n=48), gastrointestinal tract surgery (14.3%, n=17) and obstetric/ gynaecological surgery (11.8%, n=14). The duration of surgical prophylaxis by patient specialty in acute adult and paediatric inpatients is provided in Appendix Tables A51 and A52, respectively.

The percentage of surgical prophylaxis antimicrobials that were given more than once was not significantly different in 2016 compared with 2011 (35.1% versus 41.8%, p=0.06).

Figure 46: Duration of surgical prophylaxis prescribing in acute inpatients (including independent and paediatric inpatients) in 2016

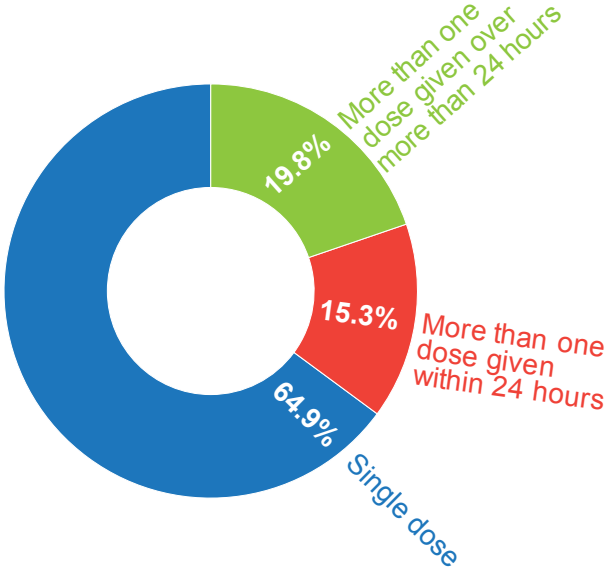
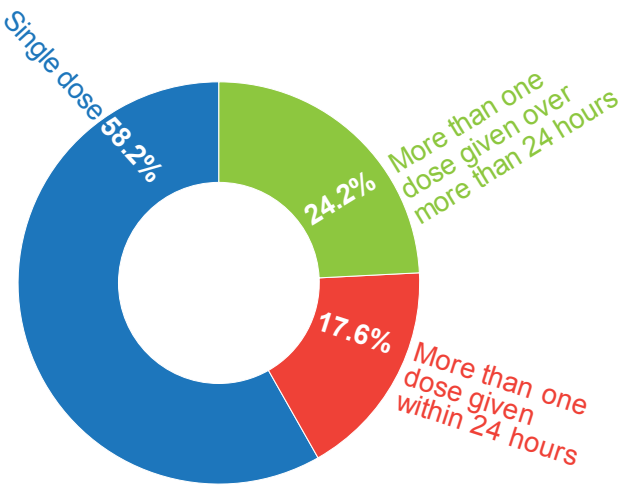


Figure 47: Duration of surgical prophylaxis prescribing in acute inpatients (including independent and paediatric inpatients) in 2011



The reason for prescribing was recorded in the notes for 83.6% of all of the antimicrobials prescribed for surgical prophylaxis (n=276). This was not significantly different in 2016 compared with 2011 (83.6% versus 82.3%, p=0.68).

Figure 48: Reason recorded in notes for antimicrobials prescribed as surgical prophylaxis in acute adult inpatients (including independent and paediatric inpatients) in 2016

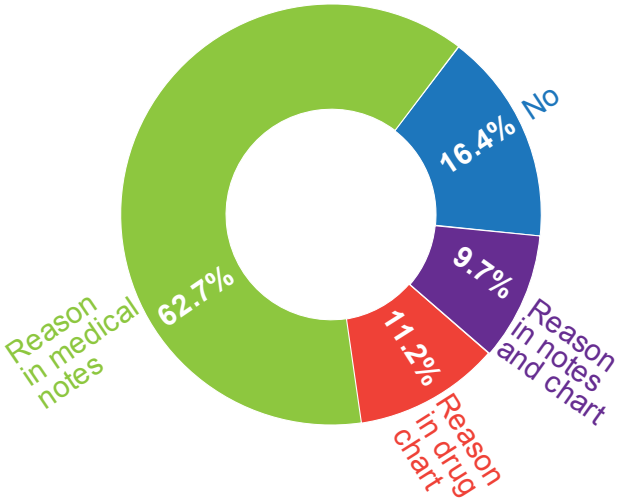
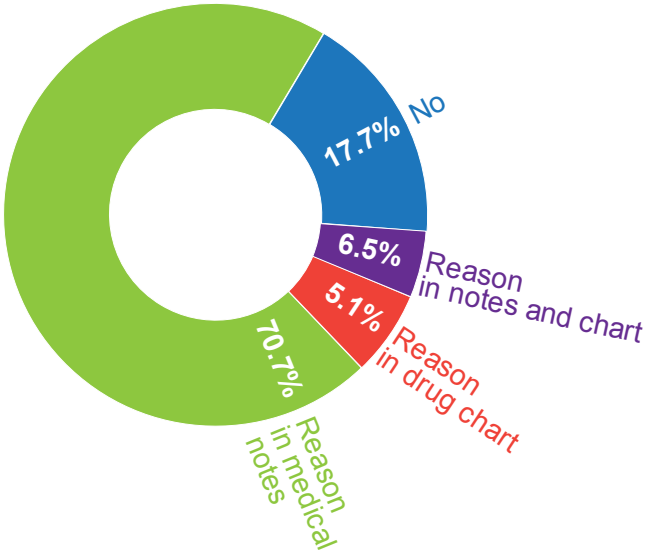
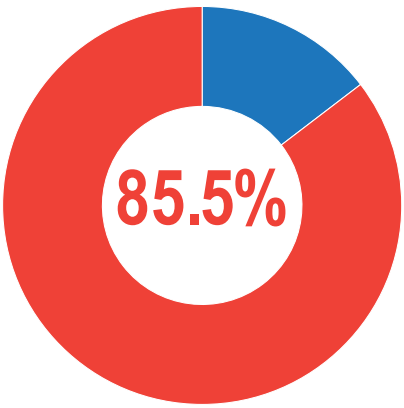


Figure 49: Reason recorded in notes for antimicrobials prescribed as surgical prophylaxis in acute inpatients (including independent and paediatric inpatients) in 2011



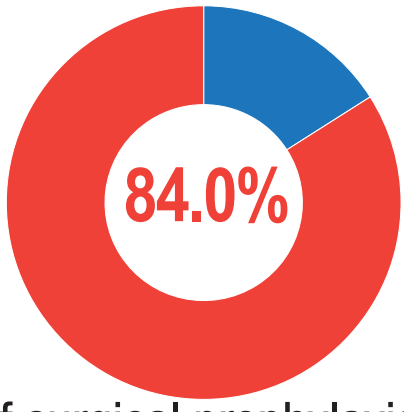
A total of 248 antimicrobials were assessable against local surgical prophylaxis prescribing policy. The antimicrobial was assessed if the reason for prescribing was recorded in the notes and there was a local surgical prophylaxis policy to assess against. Of these, 85.5% were compliant with local policy (n=212) (see Figure 50). This was not significantly different from the compliance reported in 2011 (85.5% versus 84.0%, p=0.71) (see Figure 51).

Figure 50: Compliance with local policy for antimicrobials prescribed as surgical prophylaxis in acute inpatients (including independent and paediatric hospital inpatients) in 2016



of surgical prophylaxis antimicrobials were compliant with policy in 2016

Figure 51: Compliance with local policy for antimicrobials prescribed as surgical prophylaxis in acute inpatients (including independent and paediatric hospital inpatients) in 2011



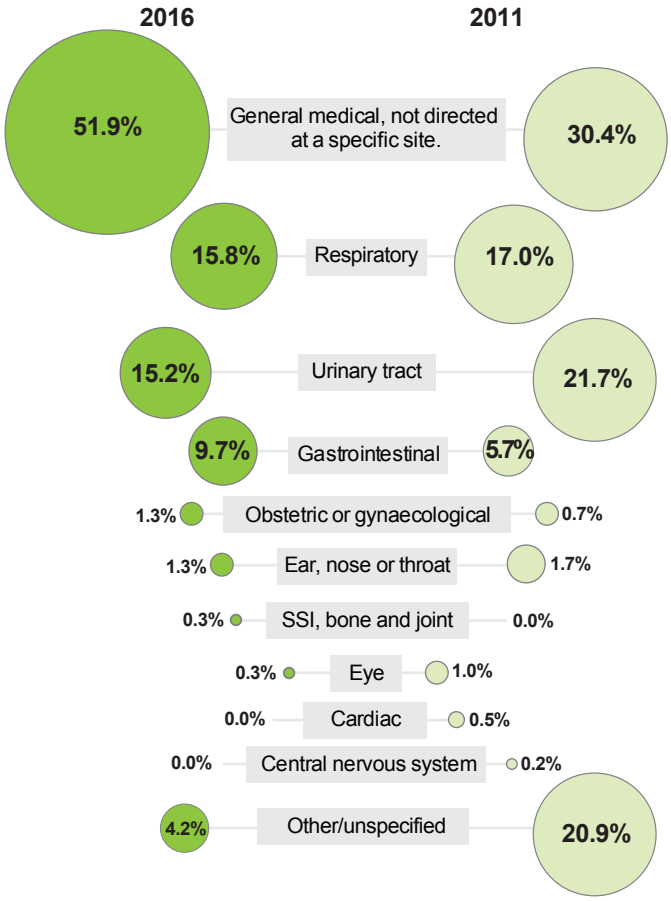
of surgical prophylaxis antimicrobials were compliant with policy in 2011

Prevention of infection: medical prophylaxis

Acute adult inpatients

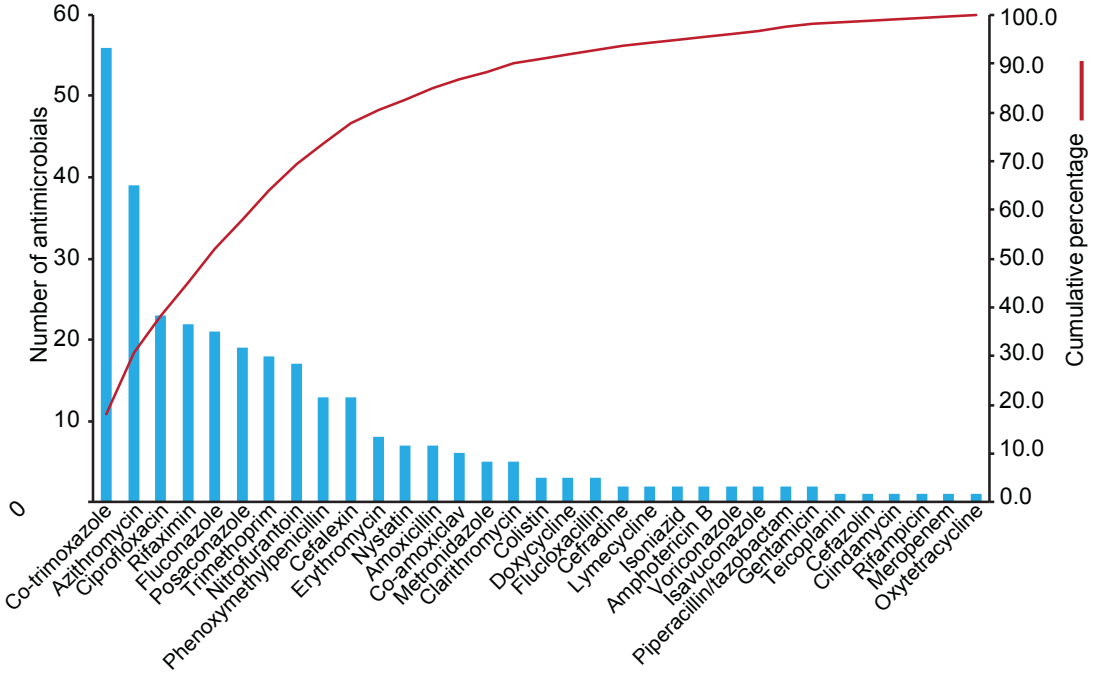
A total of 310 antimicrobials were prescribed as medical prophylaxis in the acute adult inpatient group. This accounted for 5.3% of all prescribing in this patient group. The types of infection where the prophylaxis was being directed in 2016 and 2011 is described in Figure 52. The infection types for the antimicrobials prescribed in the 2016 survey are also described in more detail in Appendix Table A53. The most common reason for medical prophylaxis prescribing was as general medical prophylaxis, for example in haematology patients or splenectomy patients (n=161). The percentage of medical prophylaxis antimicrobials given for this reason was significantly higher in 2016 compared with 2011 (51.9% versus 30.4%, p<0.001). Approximately one in six antimicrobials were given as prophylaxis for respiratory infection (15.8%, n=49). Prophylaxis for UTI accounted for 15.2% of all medical prophylaxis prescribing (n=47) and this was significantly lower in 2016 compared with 2011 (15.2% versus 21.7%, p=0.04).

Figure 52: Distribution of infection types in antimicrobials prescribed as medical prophylaxis in acute adult inpatients (including independent hospitals) in 2016 and 2011



A pareto chart describing the antimicrobials prescribed as medical prophylaxis is provided in Figure 53, and the distribution of antimicrobials is described in Appendix Table A54. Co-trimoxazole (n=56) and azithromycin (n=39) accounted for 30.6% of all antimicrobials prescribed as medical prophylaxis.

Figure 53: Number and cumulative percentage of antimicrobials prescribed as medical prophylaxis in acute adult inpatients (including independent hospital inpatients) in 2016



The reason for prescribing was recorded in the notes for 66.6% of all of the antimicrobials prescribed for medical prophylaxis in acute adult inpatients (n=191). This was not significantly different compared with 2011 (66.6% versus 62.1%, p=0.27).

Figure 54: Reason recorded in notes for antimicrobials prescribed as medical prophylaxis in acute adult inpatients (including independent hospital inpatients) in 2016

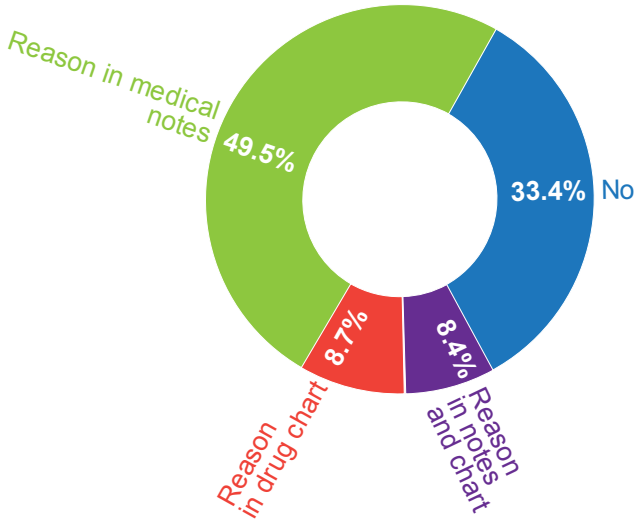
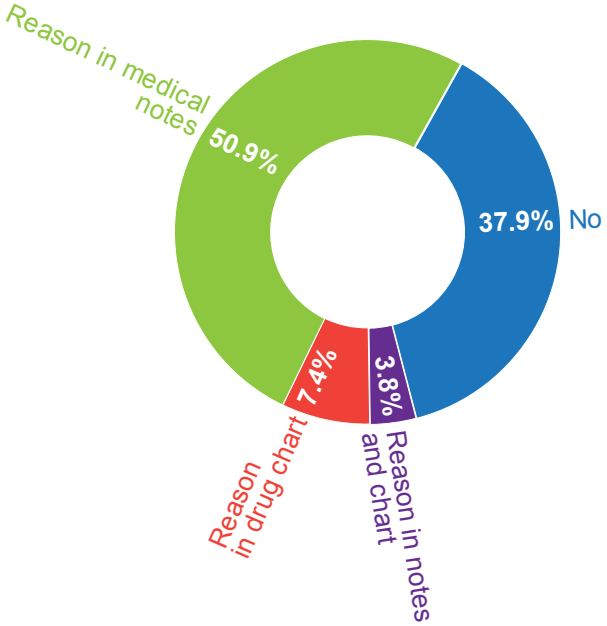


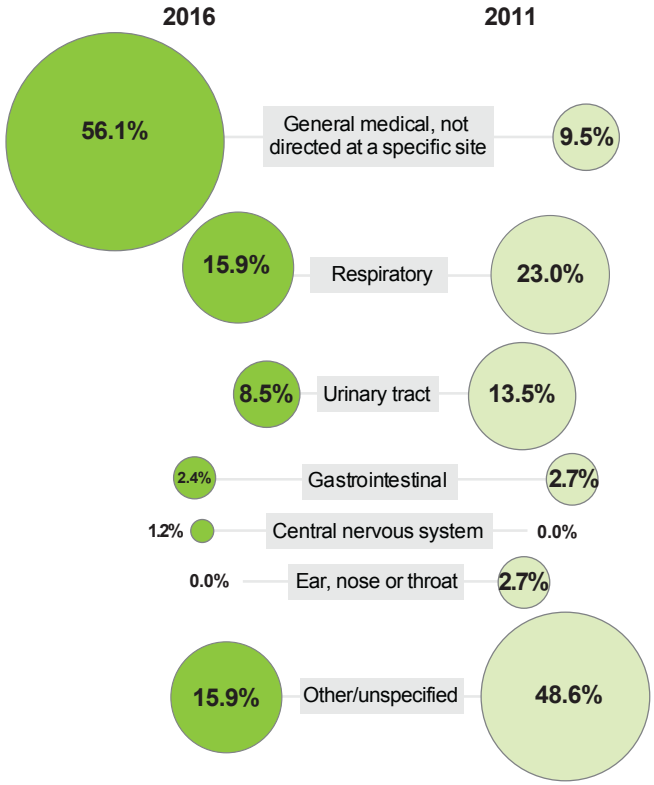
Figure 55: Reason recorded in notes for antimicrobials prescribed as medical prophylaxis in acute adult inpatients (including independent hospital inpatients) in 2011



Paediatric inpatients

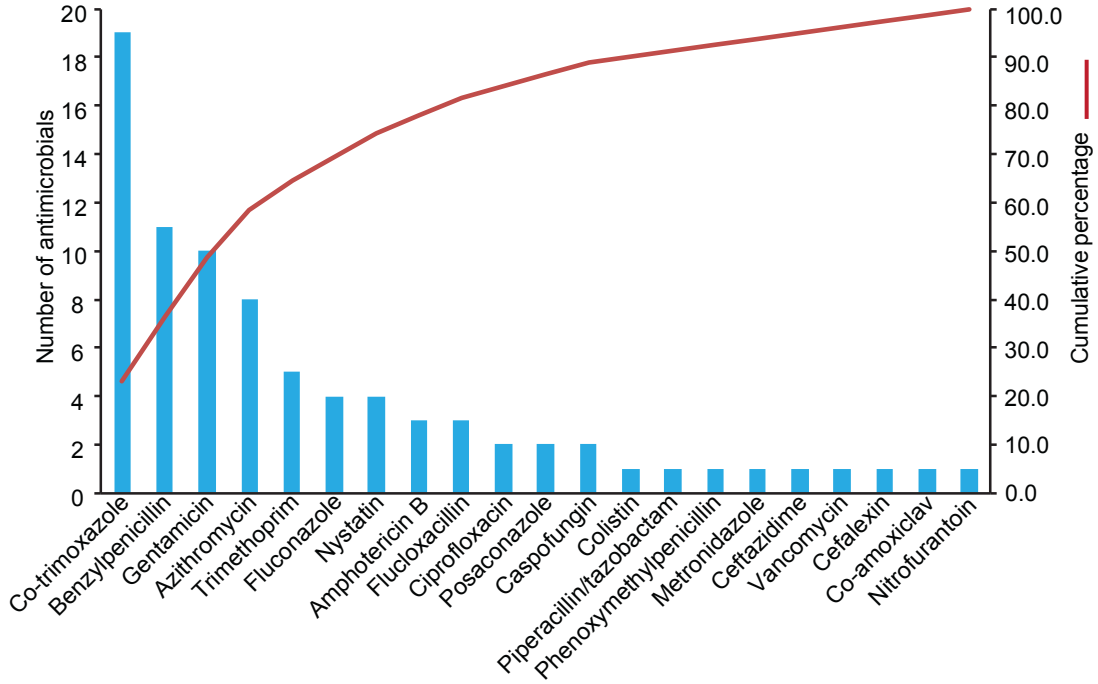
A total of 82 antimicrobials were prescribed as medical prophylaxis in the paediatric inpatient group. This accounted for 20.6% of all prescribing in this patient group. The types of infection where the prophylaxis was being directed in 2016 and 2011 is described in Figure 56. The infection types for the antimicrobials prescribed in the 2016 survey are also described in more detail in Appendix Table A55. The majority of medical prophylaxis prescribing was as general medical prophylaxis, for example in haematology patients or splenectomy patients (56.1%, n=46).

Figure 56: Distribution of infection types in antimicrobials prescribed as medical prophylaxis in paediatric inpatients in 2016 and 2011



A pareto chart describing the antimicrobials prescribed as medical prophylaxis in paediatric inpatients is provided in Figure 57, and the distribution is described in Appendix Table 56. Co-trimoxazole (n=19), benzylpenicillin (n=11) and gentamicin (n=10) were the most commonly prescribed antimicrobials given as medical prophylaxis.

Figure 57: Number and cumulative percentage of antimicrobials prescribed as medical prophylaxis in paediatric inpatients in 2016



The reason for prescribing was recorded in the notes for 72.5% of all of the antimicrobials prescribed for medical prophylaxis in paediatric inpatients (n=58). This was not significantly different in 2016 compared with 2011 (72.5% versus 72.2%, p=1).

Figure 58: Reason recorded in notes for antimicrobials prescribed as medical prophylaxis in paediatric inpatients in 2016

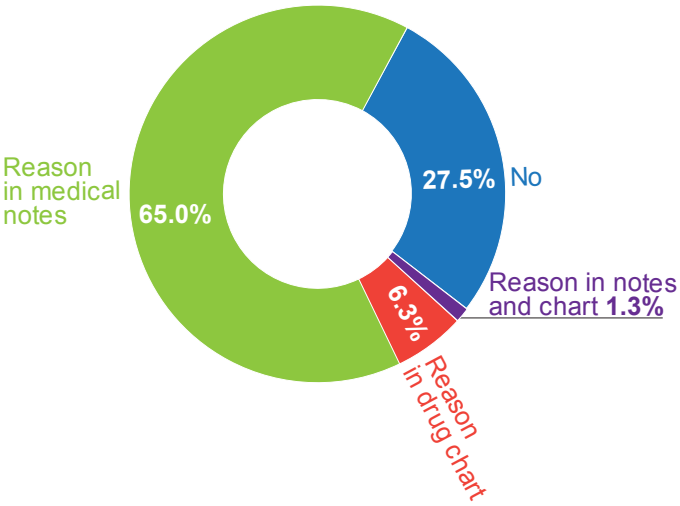
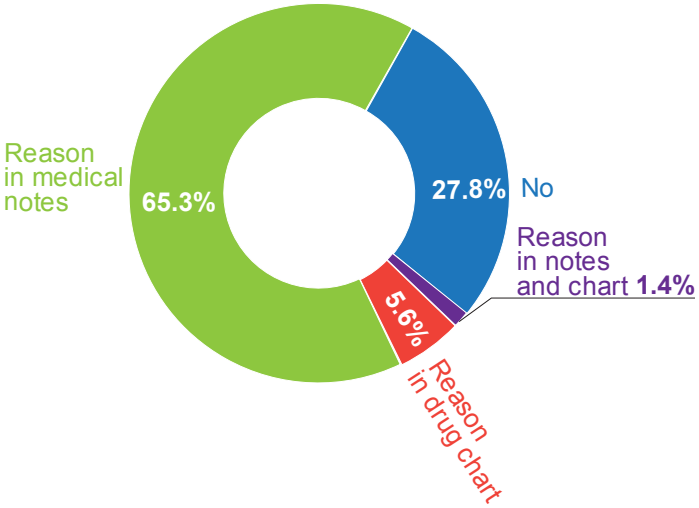


Figure 59: Reason recorded in notes for antimicrobials prescribed as medical prophylaxis in paediatric inpatients in 2011



Non-acute inpatients

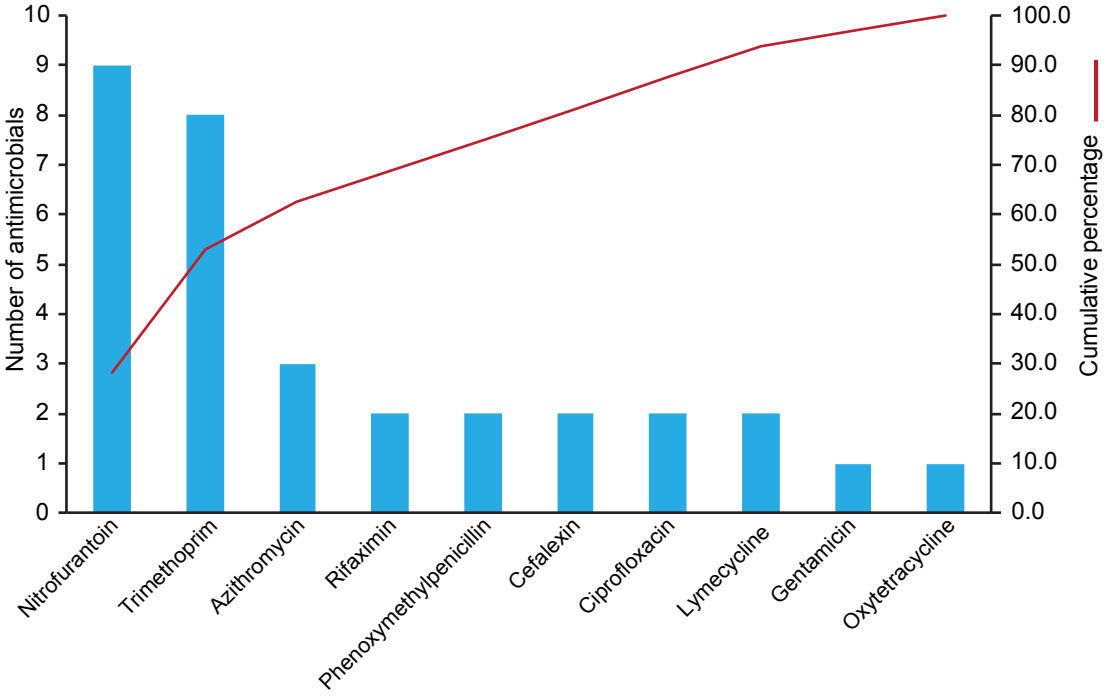
A total of 32 antimicrobials were prescribed as medical prophylaxis in the non-acute adult inpatient group; accounting for 19.0% of all prescribing in this patient group. The types of infection where the prophylaxis was being directed in 2016 is described in Table 20. The infection types for the antimicrobials prescribed in the 2016 survey are also described in more detail in Appendix Table A57. Half of medical prophylaxis antimicrobials were prescribed to prevent UTI (n=16).

Table 20: Distribution of infection types in antimicrobials prescribed as medical prophylaxis in non-acute inpatients in 2016

Infection type	N	%
Urinary tract	16	50.0%
General medical, not directed at a specific site	6	18.8%
Respiratory	4	12.5%
Gastrointestinal	3	9.4%
Other/Unspecified	3	9.4%
Total	**32**	**100.0%**

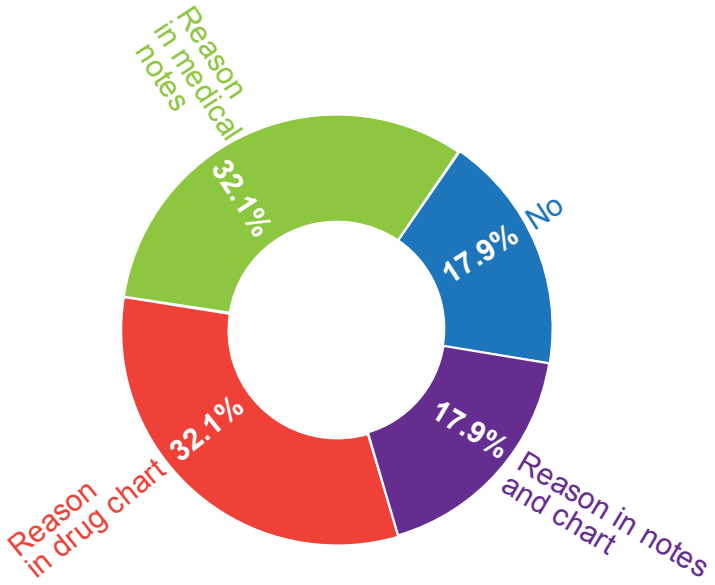
A pareto chart describing the antimicrobials prescribed as medical prophylaxis in non-acute inpatients is provided in Figure 60, and the distribution is described in Appendix table A58. Nitrofurantoin (n=9) and trimethoprim (n=8) were the most commonly prescribed antimicrobials given as medical prophylaxis in non-acute inpatients.

Figure 60: Number and cumulative percentage of antimicrobials prescribed as medical prophylaxis in non-acute inpatients in 2016



The reason for prescribing was recorded in the notes for 82.1% of all of the antimicrobials prescribed for medical prophylaxis in non-acute inpatients (n=23).

Figure 61: Reason recorded in notes for antimicrobials prescribed as medical prophylaxis in non-acute inpatients in 2016



Use of antimicrobials associated with an increased risk of *Clostridium difficile* infection in Scotland

A total of 1242 broad spectrum antimicrobials associated with an increased risk of *Clostridium difficile* (*C. difficile*) infection were prescribed to 1205 patients included in the 2016 survey.

The prevalence of antimicrobial prescribing of these antimicrobials in acute adult patients and paediatric patients was 10.3% (95% CI: 9.7 to 10.9, n=1116) and 8.8% (95% CI: 7.0 to 11.1 n= 65), respectively. After controlling for difference in the case mix between the 2016 and 2011 surveys, the prevalence was significantly higher in acute adult patients compared with the prevalence in 2011 (10.3% versus 9.4%, p=0.04). There was no difference in the prevalence of prescribing in paediatric patients between 2016 and 2011 (8.8% versus 9.1%, p=0.92), though differences in case mix were not controlled for due to small numbers.

In addition to the antimicrobials prescribed in acute care, there were 24 patients in the non-acute sample that were receiving antimicrobials associated with a increased risk of CDI. The antimicrobials prescribed in the 2016 and 2011 surveys are described in Table 21.

Table 21: Distribution of broad spectrum antimicrobials associated with an increased risk of CDI in all patients in 2016 and 2011

Antimicrobial Group	Antimicrobial	2016		2011	
		N	%	N	%
Penicillin (combinations)	Co-amoxiclav	651	52.4	602	50.3
Quinolones	Ciprofloxacin	229	18.4	273	22.8
	Levofloxacin	66	5.3	22	1.8
	Ofloxacin	9	0.7	3	0.3
	Norfloxacin	0	0.0	5	0.4
	Moxifloxacin	3	0.2	0	0.0
Second generation cephalosporins	Cefuroxime	75	6.0	92	7.7
First generation cephalosporins	Cefalexin	41	3.3	38	3.2
	Cefradine	2	0.2	1	0.1
	Cefadroxil	0	0.0	1	0.1
	Cefazolin	1	0.1	0	0.0
Third generation cephalosporins	Cefotaxime	25	2.0	22	1.8
	Ceftazidime	18	1.4	22	1.8
	Ceftriaxone	46	3.7	50	4.2
Other cephalosporins	Ceftolozane and enzyme inhibitor	1	0.1	0	0.0
Lincosamides	Clindamycin	75	6.0	65	5.4
Total		1242	100.0	1196	100.0

The majority of these antimicrobials were prescribed for the treatment of infection (75.1%, n=933); more than half for the treatment of community acquired infection (52.6%, n= 653) and 21.4% for treatment of hospital acquired infection (n=266). Surgical prophylaxis prescribing accounted for 11.7% of these antimicrobials (n=145) and one in twenty were prescribed as medical prophylaxis (4.4%, n=55). The indication for prescribing was not recorded for 38 antimicrobials. The infection types that were treated with these antimicrobials and the surgical procedures where these antimicrobials were given to prevent infection are described in Tables 22 and 23. More than a third of the antimicrobials prescribed for treatment of infection were being given to treat respiratory tract infections (38.3%, n=357) and a further third to treat UTI (17.7%, n=165) and SST, bone and joint infections (15.9%, n=148). Two thirds of antimicrobials prescribed as surgical prophylaxis were given to prevent infections following orthopaedic (37.9%, n=55) and obstetric/gynaecological surgeries (27.6%, n=40).

Table 22: Distribution of infection types treated with antimicrobials associated with an increased risk of CDI in all patients in 2016

Diagnosis	Antimicrobials	
	N	%
Respiratory	357	38.3
Urinary tract	165	17.7
Skin, soft tissue, bone and joint	148	15.9
Systemic	95	10.2
Gastrointestinal	89	9.5
Genitourinary	21	2.3
Central nervous system	19	2.0
Ear, nose, throat	14	1.5
Eye	2	0.2
Cardiovascular	1	0.1
Other/unspecified	22	2.4
Total	**933**	**100.0**

Table 23: Distribution of surgery types where antimicrobials associated with an increased risk of CDI were prescribed as surgical prophylaxis in all patients in 2016

Surgical procedure	Antimicrobials	
	N	%
Orthopaedic surgery (bone or joint)	55	37.9
Obstetric or gynaecological surgery	40	27.6
Neurosurgery	9	6.2
Surgery of the GI tract	9	6.2
Plastic surgery	8	5.5
Urological surgery	5	3.4
Ear, nose or throat surgery	4	2.8
Cardiac or vascular surgery	1	0.7
Other/unspecified	14	9.7
Total	**145**	**100.0**

Nearly a quarter of antimicrobials prescribed as surgical prophylaxis (23.7%, n=23) and approximately a third prescribed for treatment of infection (29.4%, n=202) were not compliant with local prescribing policy. Only antimicrobials where there was a policy that could be assessed against and where the reason for prescribing was recorded in the notes were assessed against policy.

Use of carbapenems and piperacillin/tazobactam in Scotland

A total of 442 very broad spectrum antimicrobials, namely antimicrobials from the carbapenem group (n=109) and piperacillin/tazobactam (n=333), were prescribed to 435 patients included in the 2016 survey.

The prevalence of carbapenem prescribing in acute adult patients and paediatric patients was 0.9% (95% CI: 0.7 to 1.1, n=97) and 1.4% (95% CI: 0.7 to 2.5, n=10), respectively. The prevalence between 2016 and 2011 was not significantly different for acute adults (0.9% versus 1.1%, p=0.17) or paediatric patients (1.4% versus 1.2%, p=1).

The prevalence of piperacillin/tazobactam prescribing in acute adult patients and paediatric patients was 2.8% (95% CI: 2.5 to 3.1, n=301) and 3.1% (95% CI: 2.1 to 4.7, n=23), respectively. The prevalence between 2016 and 2011 was not significantly different in acute adults (2.8% versus 3.1%, p=0.20) but was significantly higher in paediatric patients in 2016 (3.1% versus 1.4%, p=0.03).

Differences in the case mix between the two surveys were controlled for in the comparison prevalence of carbapenems and piperacillin/tazobactam prescribing in acute adults but were not in the paediatric comparison due to small numbers.

The antimicrobials prescribed in 2016 and in the 2011 surveys are described in Table 24.

Table 24: Distribution of piperacillin/tazobactam and carbapenem antimicrobials in all patients in 2016 and 2011

Antimicrobial	2016		2011	
	N	%	N	%
Carbapenems:				
Meropenem	99	22.4	127	25.7
Ertapenem	6	1.4	2	0.4
Imipenem	3	0.7	2	0.4
Doripenem	1	0.2	0	0.0
Piperacillin/tazobactam	333	75.3	364	73.5
Total	**442**	**100**	**495**	**100**

The majority of the antimicrobials were prescribed to treat infection (88.9%, n=393); half were prescribed for the treatment of community acquired infection (50.9%, n=225) and more than a third were prescribed to treat hospital acquired infection (36.9%, n=163). Six of these antimicrobials were given as surgical prophylaxis (1.4%) and four as medical prophylaxis (0.9%). The types of infection that were being treated with the carbapenem group of antimicrobials and piperacillin/tazobactam are described in Table 25. The most common infection type being treated with carbapenem antimicrobials were systemic infections (35.7%, n=35). Two fifths of piperacillin/tazobactam antimicrobials were prescribed for respiratory tract infections (43.4%, n=128) and a quarter for treatment of systemic infections (25.8%, n=76).

Table 25: Distribution of infection types treated with carbapenems and piperacillin/tazobactam in all patients in 2016

Diagnosis	Carbapenems		Piperacillin/tazobactam	
	N	%	N	%
Systemic	35	35.7	76	25.8
Respiratory	22	22.4	128	43.4
Gastrointestinal	16	16.3	51	17.3
Skin, soft tissue	14	14.3	20	6.8
Urinary tract	6	6.1	15	5.1
Central nervous system	2	2.0	0	0.0
Unspecified	2	2.0	4	1.4
Ear, nose, throat	1	1.0	0	0.0
Genitourinary	0	0.0	1	0.3
Total	**98**	**100.0**	**295**	**100.00**

Approximately a fifth of carbapenems (18.2%, n=10) and more than a quarter of piperacillin/tazobactam (26.7%, n=58) prescriptions for treatment of infection were not compliant with local policy. Only antimicrobials where there was a policy that could be assessed against and where the reason for prescribing was recorded in the notes were assessed against policy.

Three quarters of carbapenem antimicrobials prescribed for treatment of infection had been prescribed for more than three days at the time of survey (76.3%, n=74). More than a third of these had been prescribed to treat systemic infections including febrile neutropenia (n=12), BSI (n=9), clinical sepsis (n=5); and a fifth for treatment of respiratory tract infections (n=15).

Over half of piperacillin/tazobactam antimicrobials given to treatment infection had been prescribed for more than three days at the time of survey (53.1%, n=153). Two fifths of these were prescribed for respiratory tract infections (n=64) and a fifth for systemic infections including clinical sepsis (n=14), systemic inflammatory response syndrome (SIRS) (n=9), febrile neutropenia (n=7) and BSI (n=5). In addition, a fifth of piperacillin/tazobactam prescribed for the treatment of infection were for intra-abdominal infections (n=30).

Infection prevention and control and antimicrobial stewardship structure and process indicators

A summary of the IPC and antmicrobial stewardship structure and process indicator data are provided in Table 26. Further description of Scottish hospitals including indicator data and patient demographics are provided as separate infographics for acute and non-acute.

The average LOS in Scottish acute and non-acute hospitals was 3.8 days and 37.4 days, respectively and bed occupancy was approximately 85% in both acute and non-acute hospitals.

All of the hospitals had annual IPC plans and produced an annual IPC report. There were approximately 1.4 IPCNs and 0.12 ICDs per 250 beds and 80-85% of hospitals had access to a seven day microbiology service.

Approximately a third of beds in acute hospitals were single rooms and 85% of these had en-suite facilities. Approximately a quarter of beds did not have ABHR at point of care. The percentage of HCWs carrying pocket ABHR was higher in areas where the percentage of beds with ABHR at point of care was lower.

There was approximately 0.3 WTE staff with an antimicrobial stewardship role and two thirds of hospitals reported having a formal process to review antimicrobials within 72 hours of order in at least selected wards.

Table 26: IPC and antimicrobial stewardship programme structure and process indicators in Scottish NHS hospitals in 2016

Indicator		Hospital Type	
		Acute (including paediatric hospitals)	Non-acute
Activity and bed occupancy	Number of discharges in year	1 156 473	12 079
	Number of patient days in year	4 352 927.0	451 763.4
	Average length of stay in survey hospital¤	3.8	37.4
	Bed occupancy (00:01 data)*	86.5% (data for 694 wards)	84.4% (data for 76 wards)
Staffing	WTE nurses/100 beds	151.6	95.4
	WTE nursing assistants/100 beds	54.4	59.6
	WTE nurses in ICU/100 ICU beds	512.5	N/A
	WTE nursing assistants in ICU/100 ICU beds	49.4	N/A
Characteristics of IPC programmes	Annual IPC plan, approved by the board CEO, HAI Executive Lead or Infection Control Committee	100% hospitals	100% hospitals
	Annual IPC report, approved the board CEO, HAI Executive Lead or Infection Control Committee	100% hospitals	100% hospitals
	Number of WTE IPCNs/250 beds$#	1.4 (data for 39/40 hospitals)	1.4 (data for 19/24 hospitals)
	Number of WTE ICDs/250 beds¥	0.12 (data for 39/40 hospitals)	0.11 (data for 23/24 hospitals)
	Availability of microbiology service on Saturdays, clinical samples	85.0% (data for 40/40 hospitals)	83.3% (data for 24/24 hospitals)
	Availability of microbiology service on Saturdays, screening samples	85.0% (data for 40/40 hospitals)	83.3% (data for 24/24 hospitals)
	Availability of microbiology service on Sundays, clinical samples	82.5% (data for 40/40 hospitals)	79.2% (data for 24/24 hospitals)
	Availability of microbiology service on Sundays, screening samples	82.5% (data for 40/40 hospitals)	79.2% (data for 24/24 hospitals)
	Number of blood culture sets received and incubated per 1000 patient days	45.7	1.7
	Number of inpatient stool tests performed for *Clostridium difficile* infection per 1000 patient days	17.1 (data for 27/40 hospitals)	1.6 (data for 13/24 hospitals)

¤ Does not include length of stay in other hospitals where the patient was transferred to or from the survey hospital
* Reported for wards included in the survey hospital only
$ Likely to be an overstimate as ICNs also cover services outside of hospital care e.g. hospices, dental services, care homes
# Likely to be an overestimate as IPCNs often have other job roles outside of direct IPC activities e.g. surveillance activities
¥ WTE is for doctors with infection control remit specifically within their job description and does not include IPC work undetaken by consultant microbiologists

	Indicator	Hospital Type	
		Acute (including paediatric hospitals)	Non-acute
Isolation capacity	Total number of single rooms in surveyed wards	5357 (data for 702 wards)	546 (data for 77 wards)
	Percentage of all beds in surveyed wards that were single rooms	36.6% (data for 700 wards)	41.8% (data from 77 wards)
	Percentage of single rooms with en-suite	84.6% (data for 698 wards)	80.2% (data for 74 wards)
	Number of airborne isolation rooms	148 (for 40/40 hospitals)	2 (for 24/24 hospitals)
Hand hygiene and availability of ABHR	Alcohol hand rub consumption per 1000 patient days	38.6 (data for 33/40 hospitals)	6.2 (data for 16/24 hospitals)
	Total number of observed hand hygiene opportunities in year	125 509 (data for 645/700 wards)	10 037 (data for 53/77 wards)
	Average number of observed hand hygiene opportunities per ward in a year	195 (data for 645/700 wards)	190 (data for 53/77 wards)
	% of beds with ABHR dispensers at point of care§	75.4% (data for 685 wards)	41.8% (data for 72 wards)
	Percentage HCWs carrying ABHR dispensers at the time of survey	11.3% (data for 689 wards: 3168 HCW)	16.7% (data for 64 wards: 257 HCW)
	% of HCWs carrying ABHR when <50% beds have ABHR at point of care§	35.2% (129 wards)	18.9% (35 wards)
	% of HCWs carrying ABHR when <30% beds have ABHR at point of care§	37.9% (106 wards)	19.0% (34 wards)
	% of HCWs carrying ABHR when 0% beds have ABHR at point of care§	41.6% (91 wards)	20.3% (32 wards)
Characteristics of antimicrobial stewardship programmes	Number of WTE antimicrobial stewardship rolesß/250 beds	0.30 (38/40 hospitals)	0.29 (21/24 hospitals)
	Formal process to review the appropriateness of an antimicrobial within 72 hours of initial order	(38/40 hospitals)	(18/24 hospitals)
	Yes at least in selected wards	65.0%	54.2%
	No	35.0%	45.8%

§ There may be some settings or situations where it is appropriate for there to be no ABHR at point of care. This measure does not account for such situations

ß WTE is for antimicrobials pharmacists and other experts with antimicrobial stewardship activities in their job description

Multimodal strategies

Tables 27 to 29 describe the percentage of hospitals with each of the components of multimodal strategies designed to prevent key HAI and promote antimicrobial stewardship in acute hospitals, ICU wards in acute hospitals and non-acute hospitals.

Table 27: Hospital-wide (excluding ICU) multimodal strategies in Scottish acute hospitals in 2016

	Hospital-wide strategy (excluding ICU)						
	Component						
	Guideline	Bundle	Checklist	Audit	Surveillance	Feedback	Training
Pneumonia	62.5% (n=25)	5.4% (n=2)	12.8% (n=5)	19.4% (n=7)	32.5% (n=13)	27.0% (n=10)	35.0% (n=14)
Bloodstream infection	75.0% (n=30)	64.9% (n=24)	19.4% (n=7)	54.1% (n=20)	92.5% (n=37)	78.4% (n=29)	52.5% (n=21)
Surgical site infection	84.6% (n=33)	58.3% (n=21)	48.6% (n=17)	33.3% (n=12)	100% (n=39)	100% (n=39)	64.1% (n=25)
Urinary tract infection	82.5% (n=33)	91.9% (n=34)	50.0% (n=17)	62.5% (n=25)	40.0% (n=16)	67.5% (n=27)	75.0% (n=30)
Antimicrobial use	97.5% (n=39)	3.1% (n=1)	19.4% (n=6)	97.5% (n=39)	80.0% (n=32)	82.5% (n=33)	94.9% (n=37)

Hospitals with missing information were excluded from the denominator. All data are as reported by NHS board staff.

Table 28: Multimodal strategies in ICU wards in Scottish acute hospitals in 2016

	ICU-wide strategy						
	Component						
	Guideline	Bundle	Checklist	Audit	Surveillance	Feedback	Training
Pneumonia	58.3% (n=14)	100% (n=21)	54.2% (n=13)	65.0% (n=13)	91.7% (n=22)	66.7 (n=14)	62.5% (n=15)
Bloodstream infection	87.5% (n=21)	95.2% (n=20)	28.6% (n=6)	65.0% (n=13)	95.8% (n=23)	71.4% (n=15)	66.7% (n=16)
Surgical site infection	72.2% (n=13)	46.7% (n=7)	33.3% (n=5)	42.9% (n=6)	72.2% (n=13)	72.2% (n=13)	61.1% (n=11)
Urinary tract infection	83.3% (n=20)	85.7% (n=18)	66.7% (n=16)	73.9% (n=17)	29.2% (n=7)	54.2% (n=13)	50.0% (n=12)
Antimicrobial use	100% (n=24)	5.6% (n=1)	5.6% (n=1)	87.5% (n=21)	87.5% (n=21)	91.7% (n=22)	91.3% (n=21)

Hospitals with missing information were excluded from the denominator. All data are as reported by NHS board staff.

Table 29: Hospital-wide (excluding ICU) multimodal strategies in Scottish non-acute hospitals in 2016

	Hospital-wide strategy (excluding ICU)						
	Component						
	Guideline	Bundle	Checklist	Audit	Surveillance	Feedback	Training
Pneumonia	77.3% (n=17)	0.0% (n=0)	9.5% (n=2)	15.8% (n=3)	40.9% (n=9)	40.0% (n=8)	45.5% (n=10)
Bloodstream infection	68.2% (n=15)	45.0% (n=9)	15.8% (n=3)	60.0% (n=12)	86.4% (n=19)	95.0% (n=19)	54.5% (n=12)
Surgical site infection	85.0% (n=17)	33.3 (n=6)	29.4% (n=5)	33.3% (n=6)	85.0% (n=17)	90.0% (n=18)	60.0% (n=12)
Urinary tract infection	81.8% (n=18)	85.0% (n=17)	22.2% (n=4)	36.4% (n=8)	45.5% (n=10)	59.1% (n=13)	72.7% (n=16)
Antimicrobial use	100% (n=22)	0.0% (n=0)	15.0% (n=3)	85.7% (n=18)	66.7% (n=14)	66.7% (n=14)	95.2% (n=20)

Hospitals with missing information were excluded from the denominator. All data are as reported by NHS board staff.

Validation of the 2016 PPS dataset

Training validation results

The results from the validation exercise undertaken following each training session are presented in Table 30. The sensitivity of whether a patient had a HAI was 90.7% indicating that nine out of ten of the data collectors correctly identified that the patient had a prevalent HAI. The specificity was 88.9% which indicated that nine out of ten data collectors correctly identified when a patient didn't have a HAI. The kappa statistic of 0.63 indicates a good level of agreement between data collectors.

The sensitivity of the collection of data relating to whether a patient was receiving antimicrobials was 91.0% and 96.3% of the data collectors correctly identified the McCabe score of the patient in the training exercises.

Table 30: Sensitivity, specificity and kappa statistic for validation exercise undertaken post-training session

Data item	Sensitivity	Specificity	Kappa
Patient has HAI (yes/no)	90.7%	88.9%	0.63
Patient is receiving antimicrobials (yes/no)	91.0%	N/A	N/A
McCabe score	96.3%	N/A	N/A

On-site gold standard validation results and prevalence adjustment

A total of 258 patients in nine hospitals were included in the gold validation exercise. The results are presented in Table 31. Ten of the included patients had a HAI and 109 patients were receiving antimicrobials at the time of survey. The sensitivity of the HAI data item was 60% (95% CI: 31.3 to 83.2) and of the antimicrobial data was 89.0% (95% CI: 81.7 to 93.6). The very small number of HAI identified and the resulting random variation introduced in this validation study mean the results should be interpreted with caution.

Table 31: Sensitivity and specificity for on-site gold standard validation exercise

Data item	Sensitivity	Specificity
Patient had HAI (yes/no)	60% (95% CI:31.3 to 83.2)	100% (95% CI: 98.5 to 100)
Patient is receiving antimicrobials (yes/no)	89.0% (95% CI: 81.7 to 93.6)	97.8% (95% CI: 93.8 to 99.6)

The 60% sensitivity and 100% specificity of the HAI data collection were used to adjust the reported prevalence of HAI in acute adult patients. The prevalence before adjustment was 4.6% and after adjustment for the estimated under-reporting was 7.7% (95% CI: 5.1 to 15.8).

Estimation of the number of HAI per year in Scotland

The incidence of HAI was calculated using the mean and median duration between date of onset and date of survey; 7.6 days and 5 days, respectively. The estimated length of stay in acute adult inpatients was 6.7 days. The estimated prevalence used was the prevalence estimate adjusted using the results from the gold standard validation study (7.7%). The incidence of HAI that was calculated using the mean and median duration between date of onset and date of survey were 6.7% and 10.2%, respectively and the average incidence was 8.4%. Application of the incidence to the number of hospital stays in Scotland (n= 655 061), resulted in an estimate that there are 55 307 HAI in acute adult inpatients each year in Scotland.

Discussion

This is the third PPS of HAI and AMR in Scotland. The findings indicate a significantly lower prevalence of HAI in acute hospitals, however a substantial burden remains, with one in 22 patients (4.5%) at any one time with a HAI. This is equivalent to one patient on every ward, every day, in every acute hospital in Scotland, with an infection associated with the care they have received. The report also points to a large burden of antimicrobials being used in acute care and the risk of AMR therein. More than a third of patients at any one time were on one or more antimicrobials and this was significantly higher than 5 years ago. There also remains an important burden of HAI and antimicrobial prescribing in non-acute care. These findings point to the importance of managing and preventing infection risk in all areas of care delivery, given the changes to health and social care services underway.[22] HAI are thus recognised as a public health threat beyond the doors of acute care hospitals.

The burden of healthcare associated infection

One in 22 acute adult inpatients had a HAI at the time of survey (4.5%). A gold standard validation study, undertaken for the first time in the 2016 survey, identified under-reporting of HAI. The estimated prevalence after controlling for the under-reporting was 7.7% (95% CI: 5.1 and 15.8); one in 13 patients with HAI rather than one in 22. Using this adjusted prevalence figure, it was estimated that there are approximately 55 500 HAI per year in acute adult patients in Scotland.

The purposive sampling of non-acute hospitals resulted in an under-representation of psychiatric hospitals. This method was chosen to reduce data collection in low prevalence areas and maximise the usefulness of the local reports for quality improvement. The weighted prevalence, which accounts for this sampling, was 2.3%, indicating that one in fifty patients in non-acute care in Scotland had a HAI at the time of survey. A further one in thirty paediatric patients had a HAI (3.4%) indicating the burden of HAI across hospital settings in Scotland. Collectively, these data indicate a large burden of HAI in all hospital settings in Scotland.

The burden of six common HAI in Europe, the same as those found in this PPS report (pneumonia, UTI, SSI, CDI, BSI and neonatal sepsis), measured in disability-adjusted life years (DALYs), are estimated to be higher than all of the other communicable disease conditions under surveillance by ECDC.[23] Prevention and control of HAI alongside antimicrobial stewardship are key components of programmes to contain the spread of antimicrobial resistant organisms; the threat of which is recognised as an international public health crisis.[1;24]

The changing hospital population

The demographics of the hospital population have changed in the five years since the 2011 survey and this has important implications for the risk of HAI and for the interpretation of the results from this survey. The median age of patients in acute hospitals was higher and a larger proportion of patients had severe co-morbidities that were expected to be ultimately or rapidly fatal. Differences in the acute adult patient case mix between 2016 and 2011 were adjusted for using statistical modelling techniques. The comparisons of acute adult patients take these differences, including age and co-morbidity status, into account. These differences likely reflect the continuing change in the demographics of the Scottish population. The number of people aged 65-74 years and 75 years and older in Scotland has increased by 24% and 31%, respectively between 1996 and 2016.[26] The number of people aged 75 years and over is projected to increase by approximately 29% between 2014 and 2024.[27] The changing demographics of the population has important implications for infection risk, including the risk of healthcare associated infection, with older patients at an increased risk of developing infection, both in hospital and in the community.[28-30]

Risk factors for HAI

A number of risk factors were associated with a higher prevalence of HAI in this 2016 survey: higher co-morbidity score, having undergone surgery since admission to hospital, being cared for in a

surgical specialty and being cared for in a high dependency unit (HDU) or ICU. Patients cared for in surgical specialties or in ICU and HDU are particularly vulnerable to infection due to extrinsic risk factors such as surgical procedures and invasive devices.[31] The prevalence of PVC use was highest in intensive care (62.8%) and surgical specialties (48.6%) and half of all patients in ICU had a CVC. Urinary catheterisation and intubation were also highest in ICU patients where two thirds had a urinary catheter and a third were intubated. These devices increase the risk of vulnerable patients developing device associated infection[31] and infections related to extrinsic risk factors, such as devices, are often considered to be the most preventable.[5] A similar profile of risk factors that were associated with HAI prevalence was reported in acute adults in 2011 where underlying medical condition and extrinsic risk factors associated with invasive procedures were also important in the survey population.

The only risk factor reported to be associated with a higher HAI prevalence in the non-acute patients was increased age. The different risk factors associated with HAI prevalence in the acute and non-acute populations likely reflects the patient population and differences in the care delivered in these hospitals. A similar modelling analysis of the paediatric patient population could not be undertaken due to the small sample size, though there were two risk factors identified as associated with an increased prevalence of HAI in the univariate analyses: having undergone surgery since admission and an increased length of stay in hospital.

Characteristics of HAI

The most common type of HAI were UTI (one in four) and pneumonia (more than a fifth). A similar distribution of UTI and pneumonia as the frequent HAI was reported in the European PPS of 2011 where UTI and pneumonia accounted for 19.0% and 19.4%, respectively. The prevalence of UTI and pneumonia and the overall proportion of HAI that were UTI and pneumonia were not significantly different from the 2011 survey indicating a continuing need for focused action to tackle the burden of these infections. The prevalence of UTI and pneumonia reported in 2016 is similar to those reported in European hospitals in the 2011 survey; 1.2% and 1.3%, respectively.[2]

Urinary tract infections accounted for a quarter of all HAI in acute adult patients and more than half in the non-acute patients included in the survey. They were also the most common secondary source of infection in patients with healthcare associated BSI. Patients with UTI tended to be older with approximately a fifth having the most severe McCabe co-morbidity score.

Approximately half of the patients with UTI had been catheterised prior to onset; a similar proportion to that reported in 2011 (45.4%). Ensuring consistent application of standard infection control precautions (SICPs)[32] and use of extant catheter associated UTI (CAUTI) bundles[33;34] are essential in the prevention of these infections. The key intervention to minimise the risk of CAUTI is not to catheterise in the first place and consideration should always be given to alternatives where possible and safe.[35] After adjusting for differences in patient case mix between the 2011 and 2016 surveys, the prevalence of catheterisation was not significantly different with one in five patients catheterised. Whilst there may be differences in the population that have not been adjusted for, these data indicate that continued quality improvement work is required to optimise the use of the bundles; particularly consideration for whether there is an alternative to catheterisation. For patients where catheterisation is necessary, the introduction of the national catheter passport[36] aims to ensure the appropriate management and continuity of catheter care across care settings including the management of catheters both in and out of hospital settings. All care settings should consider implementing the passport.

This survey reports that half of all UTI were reported in patients who had not been catheterised and consideration for other interventions to reduce the risk of UTI in older patients and the population at large is required. Reducing the risk of developing UTI in the older population both before and during hospital admissions would reduce the burden these infections place on the healthcare system as a whole and prevent the unnecessary use of antimicrobials.

Healthcare associated pneumonia accounted for one in four of all HAI in acute adult patients and one in nine in non-acute patients in 2016. Patients with pneumonia also tended to be older and a quarter had the most severe co-morbidity score and were considered to be approaching the end of their life. A third of the patients, however, had the lowest McCabe co-morbidity score indicating that they did not

have ultimately or rapidly fatal co-morbidities and were expected to live more than five years.[37] Patients in this group should be a target population for interventions to reduce preventable pneumonia.

Many IPC interventions for the prevention of healthcare associated pneumonia focus on ventilator associated pneumonia[38;39]; three quarters of the pneumonia identified in this survey developed in patients who had not been intubated in the 48 hours prior to onset. The burden of pneumonia in non-ventilated patients across a range of specialties highlights the need for the development of interventions to reduce infection across the hospital population. A recent review of guidance and literature relating to pneumonia in non-ventilated patients reported that there was a lack of evidence for preventative measures and no specific national guidance had been issued by professional societies or professional medical associations for the prevention of these infections.[39] There was some evidence that good oral care; prevention, early diagnosis and treatment of aspiration and dysphagia; and early mobilisation of patients to improve clearance of respiratory secretions were associated with a reduced risk of pneumonia in non-ventilated patients.[39] There are currently no comprehensive national guidelines for the prevention and management of pneumonia in non-ventilated patients. The current National Institute for Health and Care Excellence (NICE) guidelines for diagnosis and management of pneumonia in adults provides recommendations only for the appropriate antibiotic therapy for hospital-acquired pneumonia; the main focus of the guideline being the management of community acquired pneumonia.[40] Given the low uptake of a multimodal IPC strategy for prevention of pneumonia, development of quality improvement tools to prevent non-ventilator associated pneumonia may assist frontline staff in reducing the risk of pneumonia in hospital patients and patients being cared for in the wider healthcare system. One in five infections reported in a prevalence survey of long term care facilities undertaken in Scotland in 2010 were respiratory tract infections.[41] A second prevalence survey in long term care facilities will be undertaken in 2017 and the intelligence from that survey will inform the wider HAI agenda.

Surgical site infections continue to contribute to the burden of HAI in Scottish hospitals; one in six HAI in acute adults were SSI. More than half of all SSI reported in this survey were deep or organ space. These infections have serious implications for quality of life for the patient and the cost of healthcare both in hospitals and in the community following discharge.[42] SSI developing after colon surgery were the most common SSI though it is important to note that prevalence surveys are biased towards identifying those patients with longer lengths of stay and thus not equivalent to incidence surveillance which will identify all SSI. The introduction of mandatory vascular and large bowel SSI surveillance on 1st April 2017[9] was informed by the results from the 2011 PPS and the results from this 2016 survey confirm that a focus on these procedures in the mandatory surveillance programme remains important. The incidence of SSI following large bowel and vascular surgeries in England between April 2011 and March 2016 were reported to be 9.8% and 2.8%, respectively.[43] This highlights a significant patient safety risk and requirement for focused prevention efforts including implementation of the HPS quality improvement initiatives.[44]

The 2011 PPS indicated that the proportion of HAI that were SST infections was markedly lower than that the previous survey of 2005/6. In 2016, SST infections accounted for approximately one in 14 HAI in acute adult patients and the proportion of all HAI that were SST infections was higher in 2016 compared with 2011. A third of all SST infections were infected pressure ulcers and whilst these HAI do not place the largest burden, there are some indications that they are contributing more to the burden of HAI than in 2011. This reinforces the need for continued quality improvement to prevent pressure ulcers in all settings using the current Healthcare Improvement Scotland (HIS) Standards for the Prevention and Management of Pressure Ulcers[45], reducing the risk to patients and requirement to use antimicrobials to treat pressure ulcers if they become infected.

Bloodstream infections accounted for one in twelve HAI in acute adult patients. BSI are associated with higher rates of morbidity and mortality,[46;47] increased length of stay in hospital and increased treatment costs.[48] A quarter of all BSI were linked, either microbiologically or clinically, to a vascular catheter; a similar proportion to that reported in hospitals in 2011 (26.2%). Vascular catheter related infections can be prevented through optimal insertion techniques and maintenance of the catheter.[49] Implementation of evidence based bundles for the insertion and maintenance of CVCs[50] and PVCs[51] are part of a suite of patient safety essentials that are mandatory in NHSScotland.[52] One of the key steps in both maintenance bundles is the daily review of clinical need for the device. The prevalence of PVC use in acute adult patients was significantly higher in 2016 compared with 2011 (36.3% versus 32.3%). This comparison controlled for known differences in the patient case mix between the two surveys

indicating that changes in age, co-morbidity status and specialty distributions were not responsible for the observed difference. It is possible that there are good clinical reasons for the increased use of the devices that cannot be identified using PPS methodology. Continuing the quality improvement focus on these devices remains an important strategy to reduce the risk of BSI associated with vascular catheterisation.

Infections occurring in neonates were the most common HAI reported in paediatric patients. Whilst the numbers were small and should be interpreted with caution, the epidemiological picture of clinical sepsis and BSI is similar to that reported in Scotland[3] and more widely across Europe during the 2011 PPS.[53] An epidemiological review of all of the European paediatric data collected during the 2011/12 survey recommended that infection prevention and control strategies should focus on prevention of BSI, particularly among neonates and infants.[53] The ICU incidence surveillance programme that is well established in Scotland[54] does not currently include surveillance in neonatal intensive care units. The burden of neonatal infections reported in the 2011 and 2016 Scottish PPS suggests consideration should be given to the development of a neonatal HAI ICU surveillance system. Surveillance systems that have been implemented in other countries report high incidence rates of infection[55;56], increased lengths of stay in neonatal ICU[57] and higher mortality rates.[56] The intelligence from such a surveillance system in Scotland would inform the development of evidence based quality improvement measures to reduce HAI in this high risk population.

Causative organisms of HAI

Only microbiology data available on the day of survey are reported in PPS. The majority of the HAI epidemiological case definitions used in the PPS can be met without a positive microbiology result and are met based on clinical signs and symptoms only. Almost half of all HAI reported met a case definition without a positive microbiology test. The distribution of microorganisms reported is therefore not likely to represent all causative organisms causing HAI and should be interpreted with some degree of caution. In addition, data pertaining to AMR were not comprehensively collected suggesting limited availability of these data at ward level.

E. coli were the most commonly reported causative microorganism in acute adult patients (22.7%) and non-acute patients (61.1%). This is a change from the last two PPS in Scotland wherein *S. aureus* was the most frequently reported causative organism[3]. This finding supports intelligence from the HPS incidence surveillance programme which has identified a year on year increase in *E. coli* in Scotland in recent years.[58;59] *E. coli* and other Gram negative bacteria, more specifically Gram negative bacilli, are a concern for IPC as this is where the current threat of AMR is present.[60] Two fifths of all microorganisms reported in acute adult patients (n=114) and all except one microorganism in the non-acute patients (n=17) were Gram negative bacilli. Preventing the spread of these microorganisms in hospital settings is an essential component of controlling antimicrobial resistance. HPS coordinate a national health protection programme on *E. coli* bacteraemia and intelligence from the enhanced surveillance programme has been used to develop interventions to prevent these infections in both the community and healthcare setting.[33;34;36;61]

The wider Gram negative agenda is also being addressed by HPS given the threat of AMR. HPS adopted the Hospital Infection Society "Prevention and control of multi-drug-resistant Gram negative bacteria: recommendations from a Joint Working Party" guidance as national guidance in 2016.[62] Toolkits for the management of carbapenemase-producing Enterobacteriaceae (CPE) in the acute setting including a mandatory clinical risk assessment (CRA)-based admission screening were introduced in 2009[63] and a policy letter highlighting the importance of ensuring good screening uptake was issued by the Chief Nursing Officer (CNO) in 2017.[64]

Admission screening for multi-drug resistant organisms (MDRO) is an important intervention to identify colonised/infected patients on admission to acute care and to manage these patients appropriately, reducing the risk of cross-transmission and self-infection.[65] The other mandatory admission screening programme in Scotland is Meticillin resistant *Staphylococcus aureus* (MRSA) screening.[66] A fifth of microorganisms reported in acute adult patients were *S. aureus,* indicating the need for continued focus to prevent MRSA and Meticillin sensitive *Staphylococcus aureus* (MSSA) infections in Scottish hospitals.

Antimicrobial prescribing prevalence

National PPS provide an opportunity to describe antimicrobial prescribing, including compliance with prescribing quality indicators, in Scottish hospitals. The national PPS is the only source of comprehensive national patient level prescribing data in hospitals as antimicrobial data is currently limited to usage data at hospital level in Scotland.

In response to the threat posed by AMR, the UK government produced the 'UK Five Year Antimicrobial Resistance Strategy (2013 to 2018)'[67]. One of the key aims of the strategy is to conserve and steward the effectiveness of existing antimicrobial treatments.[67] The results from PPS can be used to inform antimicrobial stewardship interventions and monitor progress towards quality indicator targets.[68] AMTs are required to undertake a programme of point prevalence surveys to complement surveillance of hospital usage data.[69]

More than one in three acute adult patients, a third of paediatric patients and one in seven non-acute patients were receiving at least one antimicrobial at the time of survey. After accounting for differences in patient case mix between the two surveys, the prevalence of antimicrobial prescribing in acute adult patients was significantly higher in 2016 compared with 2011. This is in line with hospital antimicrobial usage data currently available in Scotland.[70] The use of antimicrobials in Scotland, as measured in daily defined doses, was reported to have increased in hospitals between 2012 and 2015.[70] The increased usage and higher prevalence, even after adjustment for the changing case mix, reinforces the ongoing need for effective antimicrobial stewardship and use of prescribing indicators to drive quality improvement.

In acute adult patients, more than eight out of ten antimicrobials were prescribed for the treatment of infection. In European hospitals in 2011, seven out of ten antimicrobials were prescribed to treat infection and surgical prophylaxis accounted for 16.3% of antimicrobials,[2] in contrast to the 5.5% reported in acute adults and paediatric patients in the 2016 Scottish survey. More than half of all antimicrobials were prescribed for the treatment of community acquired infection and approximately a quarter were prescribed for hospital acquired infection. Approximately half of antimicrobials were being given for treatment of community acquired infection in the 2011 European PPS and less than a fifth for hospital acquired infection[2] (clinician defined/symptoms started 48 hours or more after admission). A similar distribution of indication for treatment prescribing was reported in paediatric patients though one in five antimicrobials in paediatric patients were given as medical prophylaxis. In non-acute care, more than half of all antimicrobials were prescribed for the treatment of hospital acquired infection.

More than a third of all antimicrobials prescribed for the treatment of infection were prescribed for treatment of respiratory tract infections and a quarter specifically for the treatment of pneumonia. Pneumonia was the most common reason for community acquired and hospital acquired infection prescribing and the proportion of antimicrobials prescribed for respiratory tract infections was significantly higher in 2016 compared with 2011 (35.2% versus 31.3%). Preventing pneumonia in hospitals, other care settings including care at home and in the community would reduce the need for antimicrobials. Respiratory tract infections were the most common diagnoses for piperacillin/tazobactam prescribing and more than a fifth of carbapenem antimicrobials were prescribed for respiratory tract infections. It is essential to protect these critically important antimicrobials and prevention of pneumonia would contribute to their preservation for the future.

There was also significant prescribing associated with the treatment of UTI, accounting for approximately one in seven antimicrobials prescribed for treatment of infection. The treatment of community acquired UTI contributed to the overall burden of prescribing in this survey; accounting for 9.2% of all antimicrobials prescribed as treatment and approximately one in twenty antimicrobials were prescribed for the treatment of UTI considered by the clinician to be hospital acquired, or where the symptoms started 48 hours or more after admission. UTI were a common diagnosis for prescribing broad spectrum antimicrobials associated with an increased risk of CDI and preventing UTI may reduce the use of these higher risk antimicrobials in an at risk older population.[71]

Prescribing quality indicators

The use of quality indicators feature as a component of antimicrobial stewardship programmes.[72] Collection of prescribing quality indicator data has been mandatory in Scotland since 2009.[73] Quality indicators developed by SAPG are routinely measured by AMTs to inform local and national quality improvement and stewardship programmes.[74]

Two measures included in the hospital prescribing quality indicator were included in both the 2011 and 2016 PPS: the documentation of reason for prescribing an antimicrobial, and compliance with the local prescribing policy. The reason for prescribing was recorded in the notes for almost 95% of antimicrobials prescribed as treatment in acute adult patients. Local quality improvement work has been undertaken in targeted areas in acute care since 2011 and this is reflected in the significantly higher compliance in 2016. Compliance with this measure meets the 95% target for these prescribing indicators.[75] Whilst the national quality improvement programme has focused on acute adult care, the high reported compliance in paediatric (91.8%) and non-acute patients (93.8%) suggests that, alongside other local improvement initiatives, the national programme is having a broader effect in other areas. Since 2014, the national improvement work has focused on treatment of infection and this may be reflected in the lower levels of compliance with documentation of indication for surgical and medical prophylaxis. Documentation of reason for prophylactic use of antimicrobials should be considered as an area for quality improvement in acute hospitals in Scotland.

The success of national quality improvement work is also reflected in the levels of compliance with local prescribing policy for treatment of infection in acute adult patients. Whilst compliance remains below the 95% target, the compliance was significantly higher in 2016 compared with 2011 (87.2% versus 82.5%). Compliance with surgical prophylaxis prescribing was not significantly different in 2016 compared with 2011 and 14.5% of antimicrobials prescribed as surgical prophylaxis were not compliant with local policy. Ensuring prescribers follow local prescribing policy, or provide justification for the deviation, continues to be an area of focus for improvement.

The duration of antimicrobial surgical prophylaxis also provides an indication of prescribing quality as for the majority of procedures a single dose is recommended.[76] More than a third of patients received more than one dose of antimicrobials as surgical prophylaxis. The main focus of the SAPG national surgical prophylaxis duration quality improvement measure up until 2014 was colorectal surgery[75] but since then boards have focused on local areas for improvement. Whilst it is not possible to determine the appropriateness of the prophylaxis being given as multiple doses, there may be scope to reduce unnecessary additional dosing in some patients. Two of the most common antimicrobials prescribed as surgical prophylaxis are co-amoxiclav and cefuroxime which are associated with an increased risk of CDI, therefore reducing exposure to these antimicrobials is recommended where possible.[77]

A new measure was added to the hospital quality indicator in 2014/15 to support the reduction in unnecessary antimicrobial use by ensuring documentation of duration of treatment and timely switch from intravenous to oral therapy.[74] Whilst this measure was not included in this survey, the duration of treatment was assessed to inform the further development of improvement work. Almost half of all parenteral antimicrobials prescribed in acute adults had been prescribed for more than three days; the recommended review for intravenous treatment is within 72 hours of starting.[78] One in seven oral antimicrobials had been prescribed for more than seven days. The appropriateness of the longer duration of these antimicrobials was not assessed in this survey and it is possible that there were good clinical reasons for the extended duration. These results indicate, nonetheless, that review of whether a patient is clinically stable for an intravenous to oral switch (IVOST) and duration of antimicrobial therapy are areas with improvement potential; reducing unnecessary antimicrobial use and minimising the risk of AMR.

Broad spectrum antimicrobials

Approximately one in ten patients in acute hospitals were receiving broad spectrum antimicrobials (cephalosporins, co-amoxiclav, quinolones, clindamycin) that are associated with a higher risk of CDI.[71] After controlling for differences in the patient case mix, the prevalence was significantly higher in acute adult patients in 2016 compared with the same population in 2011. The latest HPS report on

antimicrobial use and resistance in humans reported that whilst there had been an increase in the use of broad spectrum antimicrobials between 2012 and 2015, usage had decreased between 2014 and 2015.[70] Similar reductions in the use of cephalosporins and quinolones were reported in England between 2010 and 2015.[79] The interpretation of these two snapshots of the prevalence of broad spectrum antimicrobial use five years apart is limited as trends in the intervening period cannot be determined. Nonetheless a substantial burden of prescribing of these antimicrobials exists and there is room for improvement.

Respiratory tract infections and UTI were the most common indications for prescribing, accounting for more than two thirds of the broad spectrum antimicrobials prescribed for the treatment of infection. These antimicrobials were also commonly used as surgical prophylaxis in orthopaedic and obstetric/ gynaecological surgeries.

Since 2008, SAPG have recommended that the use of these antimicrobials be restricted for both treatment and prophylaxis of infection in order to reduce the risk of CDI.[72] The latest epidemiological report for the incidence surveillance of CDI reports that the rates in 15-64 years and 65 years and older age groups was significantly lower in 2016 compared with 2015.[58] Whilst reducing the inappropriate use of these antimicrobials continues to be a priority to reduce the risk of CDI, it is important to consider their use in the broader context of ensuring diversity in antimicrobial use. Utilising a range of antimicrobials is an important step in reducing selection pressure and antimicrobial resistance.[70] Evidence based local guidelines are essential to reduce the risk of CDI and prevent further development of AMR. This survey reports that more than a quarter of these antimicrobials were not prescribed in line with local prescribing policy. This reinforces the need for clear guidelines around the controlled re-introduction of some of these antimicrobials based on specialist advice to ensure the continued delivery of safe care.

Very broad spectrum antimicrobials

Infections caused by multidrug resistant Gram negative bacteria are increasing.[70] This PPS identified that the most common cause of HAI was a Gram negative organism (*E. coli*) and where these infections are multi-drug resistant (MDR) there are very limited treatment options available.[62] The carbapenems (meropenem, imipenem, ertapenem) and piperacillin/tazobactam (a penicillin/enzyme inhibitor combination) are considered 'critically important' and should be protected and preserved to ensure that patients can be successfully treated in the future.[80]

Approximately one in a hundred patients were receiving a carbapenem at the time of the 2016 survey and the prevalence was not significantly different in acute adult or paediatric patients from that reported in 2011. Approximately three in a hundred patients were receiving piperacillin/tazobactam. The prevalence was not significantly different in acute adult patients but was higher in paediatric patients compared with 2011. There have been no major changes in paediatric piperacillin/tazobactam prescribing policy in the intervening period. The comparison in acute adults accounted for changes in patient case mix though this was not possible in the paediatric group. Therefore, the difference observed may reflect any changes in patient case mix and care delivery in the paediatric population since 2011.

In 2016, SAPG updated national consensus based recommendations first published in 2013 to assist local AMTs produce their own local guidelines to restrict the use of these antimicrobials.[81] The SAPG recommendations include carbapenem-sparing approaches and advice on alternative options for treatment of suspected or proven Gram negative infections including alternatives to carbapenems.[62] The implementation of these recommendations via local guidelines is expected to have improved carbapenem and piperacillin/tazobactam prescribing since their introduction in 2013. The latest report on antimicrobial use and resistance in Scotland reported an increase in carbapenem use between 2012 and 2015.[70] Piperacillin/tazobactam use in Scotland has historically been increasing though a decrease in use was reported in 2015.[70] Further usage data is required to determine the impact of the guidelines on carbapenem and piperacillin/tazobactam use since implementation, nonetheless the PPS points to this being an important area of focus for AM stewardship given the burden of prescribing has remained unchanged.

More than a third of carbapenem and a quarter of piperacillin/tazobactam antimicrobials were prescribed for the treatment of systemic infection. The introduction of the Sepsis Six campaign[82]

between 2011 and 2012 in NHSScotland is likely to have contributed to patients being commenced on (or escalated to) very broad spectrum antimicrobials. The Surviving Sepsis Campaign International Guidelines recommend empiric broad-spectrum therapy with one or more antimicrobials to cover all likely pathogens, increasing the likelihood of a very broad spectrum choice of antimicrobial such as a carbapenem or piperacillin/tazobactam.[82]

One in five carbapenem prescriptions and a quarter of piperacillin/tazobactam prescriptions were considered by the local teams not to be compliant with local policy. Continued improvement in prescribing of these broad spectrum antimicrobials is essential to ensure they are preserved and that inappropriate use does not drive antimicrobial resistance.

Organisation of hospital infection prevention and control and antimicrobial stewardship programmes in Scotland

This PPS survey for the first time collected data on IPC indicators. ECDC have proposed these indicators for use by all EU member states based on systematic reviews of evidence in the published literature[83] and the expert advice of the European HAI-net PPS working group. These indicators recognised that the organisation of IPC programmes, along with other structures and processes within hospitals, play an important role in preventing the spread of infection.[83] In 2016, the World Health Organisation (WHO) built on this work and published Guidelines for the Core Components of Infection Prevention and Control Programmes at the National and Acute Healthcare Facility Level.[84] These guidelines, developed using systematic reviews of the literature and considerations of a WHO expert group, describe the core components of IPC programmes associated with preventing HAI. A suite of measurable structure and process indicators based on the core components were incorporated into the EU PPS protocol[85] for the first time in the 2016 survey and these indicators provide an opportunity to review the way the IPC and stewardship programmes are organised in Scotland and to benchmark with other European countries following completion of the 2016/17 Europe-wide PPS.

The indicators are divided into eight key areas: the use of multimodal strategies; activity and bed occupancy; staffing levels; characteristics of IPC programmes; microbiology service capacity; isolation capacity and single room provision; hand hygiene and ABHR; and characteristics of antimicrobial stewardship programmes.

Multimodal strategies

There is evidence from the literature that hospitals which organise multimodal IPC programmes have significant reductions in HAI.[83] Multimodal is described as a cultural approach to IPC taking account of local context and conditions, surveillance, training/education, bundles and guidance developed and owned by local interdisciplinary teams.[83] It is a quality improvement approach at an organisational level. The elements of the multimodal approach need to all be in place for it to be considered as such. In this PPS, these approaches were identified in ICU for ventilator associated pneumonia and BSI. This is in large part due to the national Scottish Patient Safety Programme in Scotland.[86]

Elements of the multimodal approach were used but not as a formal multimodal programme for other HAI. The use of SSI and UTI bundles and guidelines were common across all settings. The use of bundles and checklists for pneumonia prevention outside of the ICU setting were not common nor was surveillance of pneumonia. The bundles and guidelines with the largest proportion of hospitals reporting their use were available as national resources[87] highlighting the benefits of developing evidence-based guidelines that can be consistently applied across NHSScotland. Evidence-based national bundles to assist in the prevention of pneumonia in non-ventilated patients and UTI in non-catheterised patients have the potential to impact on infection and the prescribing associated with treating these HAI. Almost all hospitals reported having an antimicrobial use guideline however bundles and checklists for prescribing were not as common. Training in prudent use of antimicrobials tended to be more common than training in prevention of the specific infection types.

Activity and bed occupancy

High occupancy in hospitals is recognised as a public health issue and can lead to disease transmission.[84] Bed occupancy and high workload have been associated with low adherence to hand hygiene and increased infection rates.[83] The WHO recommends that bed occupancy should not exceed the standard capacity of the hospital. The bed occupancy in the wards included in the PPS was 86.5% in acute hospitals and 84.4% in non-acute, which is in line with bed occupancy reported for NHSScotland in all wards (83% in 2015/16).[88] The average length of stay in the survey hospitals was 3.8 days in acute hospitals and 37.4 days in non-acute hospitals. This measure differs from the average length of stay of 6.3 days in 2015/16 for acute hospitals published by ISD, as this is the average length of a continuous inpatient stay (hospital stays before and after transfer are counted as a single hospital stay). This length of stay excludes obstetric and psychiatric hospitals, and geriatric long stay specialty, and includes accident and emergency admissions.[89] Monitoring bed occupancy at midnight is recommended as a structure and process indicator for IPC[83] and these data are available nationally in Scotland albeit for more select patient population.[88]

Staffing levels

Increased workload and low nurse-to-patient ratios have been demonstrated to be associated with an increased risk of infection transmission.[83] The average WTE nurses and WTE nursing assistants per 100 beds in acute hospitals were 151.6 and 54.4, respectively. In non-acute hospitals, there were 95.4 WTE nurses per 100 beds and 59.6 nursing assistants per 100 beds. The number of WTE ICU nurses and nursing assistant were 512.5 and 49.4, respectively. The staffing levels in Scotland will be reviewed in the context of other European countries following publication of the 2016/17 European PPS. The average number of frontline staff is recommended as an indicator and these data are also available from existing national datasets.[90]

Characteristics of IPC

Evidence from published literature indicates that IPC programmes should have one IPCN per 250 beds.[83] NHSScotland has no policy on the required number of IPCNs per hospital as this is an NHS board matter for workforce planning based on service need. The number of WTE IPCNs per 250 beds in Scotland was in line with the WHO recommended average of 1 nurse per 250 beds.[84] There was variation across hospitals and the average of 1.4 IPCNs per 250 beds is likely an overestimate as the IPCN role often covers care settings outside of hospitals. This varies by board but includes dental services, hospice care and care homes. This is not accounted for in the average WTE. In addition, some IPCNs have other job roles outside of direct IPC activities, for example surveillance activities, which other boards have defined post holders for and these were included in the WTE. The average number of IPCN per 250 beds in Europe as reported in the 2011/12 Europe-wide survey was 1.31 per 250 beds. Comparisons are challenging as in other countries IPCTs include hospital epidemiologists, whereas in the UK, epidemiology is a functional part of the IPCN role.[91]

The WTE ICD per 250 beds is based on the WTE of a medical doctor's job description dedicated to infection control. This PPS reported this to be an average of 0.12 per 250 beds. The last ECDC PPS reported an average of 0.56 per 250 beds; again these comparisons are difficult given the differences in roles between countries. For example in Scotland, we have dedicated antimicrobial stewardship roles and consultants in Public Health Medicine who have a role in chairing outbreak management teams[92] whereas in other European countries this would be part of the ICD role.

All of the hospitals included in the survey reported that there was an annual IPC plan in place and that an IPC report was compiled annually, and that both of these were approved by the NHS board Chief Executive Officer, HAI executive lead or the Infection Control Committee. This is in line with Healthcare Improvement Scotland's HAI Standards.[93]

Microbiology service capacity

There is evidence that good quality microbiological support is a critical factor for an effective IPC programme[84] and a seven day microbiology service is an indicator of microbiological support.[85] This

includes being able to process screening specimens at the weekend in the same timeframe as weekdays. In many countries microbiology out of hours services only cover emergency specimen processing.

The majority of acute hospitals (82.5%) and non-acute hospitals (79.2%) in Scotland have weekend access (Saturday and Sunday) to a microbiology service that tests screening and/or clinical samples.

Isolation capacity and single room provision

Single room provision is associated with reduced HAI in hospitals.[94] In addition, isolation room capacity within a hospital is an indicator of preparedness for IPC effectiveness. In the 2016 survey, 36.6% of acute hospital beds and 41.8% of non-acute hospital beds were single rooms. More than 80% of these single rooms had en-suite facilities. The average number of acute beds that were single rooms in the European PPS of 2011/12 was 17.6%. In Scotland, 26.1% of acute hospital beds and 33.1% of non-acute hospital beds were single rooms. This reflects policy in Scotland where the government has been committed to providing single room accommodation. All new-build hospitals are required to be equipped to provide single room accommodation for all patients and refurbishments should have a minimum of 50% single room provision.[95]

Hand hygiene and availability of ABHR

Hand hygiene is one of the most important interventions for the the prevention of HAI. The mean ABHR consumption per 1000 patient days in the 2011 European PPS was 23.9 litres.[2] In Scotland in 2016, it was 38.6 and 6.2 litres per patient days in acute and non-acute hospitals, respectively. These data should be interpreted with caution as a number of hospitals could not supply data on ABHR consumption. Availability of ABHR at the point of care is an enabler of good hand hygiene uptake and practice.[95] Three quarters of acute beds included in the survey had ABHR at the point of care. The appropriateness of there not being ABHR at point of care was not assessed in this survey and it is possible that there were good clinical reasons for the ABHR not being present e.g. removal to promote hand washing practice in the context of CDI outbreaks, and local clinical areas risk assessments in the context of health and safety. Nonetheless, a quarter of beds in acute hospitals did not have ABHR at the point of care. Nearly one in ten HCW in acute hospitals were carrying personal ABHR and the percentage was higher in wards where the percentage of beds with ABHR was lower. This suggests that on some wards, the ABHR was not at point of care but that the staff carried it themselves. More than half of beds in non-acute care did not have ABHR available at point of care and only one in six HCW were carrying personal ABHR. Whilst this is a crude indicator to measure availability, rather than ABHR use, it does point to further work being required to enable hand hygiene ergonomics.

Characteristics of antimicrobial stewardship programmes

The indicators for antimicrobial stewardship were based on a consensus process carried out by a working group of the Transatlantic Taskforce on Antimicrobial Resistance (TATFAR).[97] These indicators are designed to characterise the infrastructure and activities of hospital antimicrobial stewardship programmes. The availability of staff with dedicated time for antimicrobial stewardship activities and having procedures in place to review antimicrobial prescribing are considered indicators for effective stewardship programmes. In recognition of the key role of the antimicrobial pharmacist, the Scottish Government has provided funding for these dedicated posts since 2008.[98] There are currently approximately 0.30 WTE antimicrobial stewardship roles per 250 beds in Scotland. The WTE include antimicrobials pharmacists and other experts with antimicrobial stewardship activities in their job description. Two thirds of hospitals reported having a formal process to review the appropriateness of an antimicrobial within 72 hours of initial order. These data should be interpreted with some caution as the question was subject to a degree of interpretation and further work is required to determine the proportion of hospitals that currently have a formal review process in place.

These IPC and antimicrobial stewardship indicators require further development to ensure they are meaningful and useful in the Scottish context and to undertake secondary analyses in the context of patient outcome. HPS will work over the coming year to progress this.

Limitations

Methodological limitations

In prevalence surveys a cross sectional approach is adopted which is biased towards identifying HAI of longer duration. Furthermore, patients with a longer length of stay are overrepresented in prevalence surveys. Prevalence surveys report the prevalence at the time of survey and may not represent the prevalence at all times within the hospital.

From a methodological aspect, the main limitation in measuring prevalence lies in the accurate application of specified definitions by a large number of data collectors. Standardised training and assessment of sensitivity, specificity and IRR were employed to minimise the risk of invalid or unreliable data. Notwithstanding this, data collection is limited to a certain extent by the availability and quality of information recorded in the data sources e.g. medical notes, drug charts.

The extent of microbiological investigation, as well as the availability of reports of these and other investigations at the time of the survey, will also have affected the completeness and accuracy of a HAI diagnosis. It should be noted that the interpretation of the microbiology data has limitations as only reports available at the time of survey were included and pending results were not followed up after completion of the survey. This resulted in small numbers and may be biased towards results from tests with faster turnaround times from the laboratory.

This survey focused on infections originating in acute and non-acute hospitals and did not consider the prevalence or impact of infections associated with long term care facilities or care at home, or those arising post-discharge that did not result in readmission.

Gold standard validation

The number of HAI cases identified for validation during the validation study was small leading to wide confidence intervals around the sensitivity estimate. This limits the interpretation of the results.

Comparing surveys

There were a number of limitations associated with comparing the 2016 and 2011 surveys. Prevalence surveys do not provide intelligence regarding trends nor allow the true impact of interventions to be assessed between the two surveys, therefore the comparison results should be interpreted with some degree of caution. The low sensitivity reported in the gold standard validation study also limits the interpretation of any comparison between the two surveys and may result in a truly lower prevalence being masked by the low sensitivity.

The comparison of acute adult patients was adjusted for changes in patient mix. This adjustment only controlled for changes in case mix that were known and could be measured. It is possible that other changes in patient case mix that were not controlled for are responsible for the results of comparison analyses. Differences in paediatric patient case mix could not be controlled for due to small numbers. No comparisons were made between the non-acute patients in 2016 and 2011 since the included populations were sampled using different methods in the two surveys. In the 2016 survey, a pragmatic decision was made to exclude wholly psychiatric hospitals where HAI and antimicrobial prescribing prevalence is lower; maximising the usefulness of the local reports.

In addition to changes in patient case mix and sampling strategies, two of the HAI case definitions had changed since the 2011 survey: the SSI case definition (onset of SSI occurring with one year for patients undergoing implant surgery was reduced to 90 days) and the pneumonia case definition (option added for patients with cardiac or pulmonary disease to be diagnosed with one chest x-ray when compared with a previous chest x-ray that was not indicative of pneumonia; previously two definitive chest x-rays were required for these patients). This may have led to decreased ascertainment of SSI and increased case ascertainment of pneumonia in comparison to 2011.

Hospital indicators

The hospital indicator data and analyses were subject to a number of limitations important to consider when interpreting the results. Some of the data were provided at board level and required to be apportioned to hospitals based on the number of beds e.g. WTE staffing. This may not accurately reflect the way these resources are divided across the board. Missing data was an issue for the majority of data items and in some instances, data collected at ward level did not match with data provided at hospital level e.g. number of ICU beds. Where possible, the most consistent measure was selected for the analyses.

Summary

HAI remains a significant burden in Scotland; a greater burden than any other communicable disease. On average there is one patient in every ward in every hospital at all times with HAI and there are an estimated 55 500 HAI each year in acute adult patients in Scottish hospitals.

The population has changed and the risks in healthcare have too. The patient population is older and sicker in comparison to five years ago and the most common HAI (UTI and pneumonia) reflect this population at risk. There is a continuing risk of infection associated with the high prevalence of invasive devices. A quarter of BSI were associated with a vascular cathether and half of UTI occurred in patients who had been catheterised. Despite focused quality improvement work, the use of PVCs was higher in 2016 and there had been no change in the prevalence of urinary catheterisation since 2011. The most common HAI were often not associated with device use and occurred in patients that, whilst older, were not considered to be at the end of their life. These infection types were also common in the community as indicated by the types of community acquired infections being treated in hospital.

AMR remains a threat; antimicrobial prescribing was high and the types of HAI reported are commonly associated with Gram negative organisms where the greatest threat of AMR currently lies. *E. coli*, for the first time, was the most commonly reported causative organism. Whilst the use of very broad spectrum antimicrobials, which should be preserved for future use, was unchanged from 2011, with the exception of piperacillin/tazobactam use in paediatric patients, there was potentially inappropriate prescribing of these antimicrobials as highlighted by those that were not in line with local policy. Based on duration of treatment, there were also some indications of unnecessary prescribing, although the appropriateness of duration was not assessed in the survey.

The IPC and antimicrobial stewardship indicators, measured for the first time in this survey, allow the organisation of IPC and antimicrobial stewardship to be discussed in the context of the WHO core components of IPC programmes and will, following the completion of the 2016/2017 European survey, allow the Scottish indicators to be reviewed in the context of other European countries. Based on current evidence and intelligence from the 2011 European PPS, the following areas for future improvement were identified: improving the availability of ABHR and data on ABHR; improving single room provision and isolation capacity; development of multimodal strategies for UTI and pneumonia that are not associated with devices; improving coverage of a seven day microbiology service; and the role of ICNs, ICDs and resources dedicated to antimicrobial stewardship.

Importantly, this survey highlights that the types of HAI occurring in Scottish hospitals are also associated with a large burden of prescribing to treat community acquired infections in hospital. Measures to reduce the risk of infection that can be applied to both community and hospital settings would reduce the risk of all infections in all care settings.

The Health and Social Care Integration agenda and the 2020 vision for healthcare delivery in Scotland aims to have integrated health and social care with a focus on prevention and supported self management. Given the changes to the way care is delivered and will be delivered in the future, it is appropriate that a broader public health approach which focuses on reducing the risk of infection upstream before admission to hospital is developed. This may have implications for the specialised workforce therein. Such an approach would reduce community acquired infections and the associated prescribing and risk of AMR; reduce the need for hospital admission for infections and reduce the risk of patients developing a HAI should they require to be admitted to hospital.

Future Priorities

Priority areas for infection prevention and control quality improvement

Based on the results from this PPS, the following priority areas for IPC quality improvement were identified:

- Development of a multimodal national programme for prevention of pneumonia in non-ventilated patients
- Development of a multimodal national programme for prevention of UTI in non-catheterised patients
- Focus on prevention of sepsis and bloodstream infections in neonatal patients
- Focus on Gram negative infections, including BSI, across health and social care using an integrated public health approach to prevention[99]
- Develop interventions to reduce risk of UTI and other infections across all settings particularly in older people e.g. promotion of HIS standard for food, fluid and nutritional care[100]
- Further focus on:
    - implementation of CAUTI prevention bundles for insertion and maintenance of urinary catheters in acute and community care
    - implementation of PVC and CVC insertion and maintenance bundles, with a focus on reviewing the requirement for continued use, to reduce the risk of BSI associated with vascular catheters
- Improve availability of ABHR at point of care in acute and non-acute care and the availability of data pertaining to ABHR
- Local IPCTs to ensure multimodal quality improvement strategies are in place for prevention of pneumonia (including pneumonia in non-ventilated patients), UTI (including UTI in non-catheterised patients), SSI and BSI care that are aligned with the WHO Core Components guidance[84]
- Improve the availability of a seven day microbiology service in all boards
- Continue to increase single room and isolation capacity
- Review the role of the IPC and antimicrobial stewardship workforce in Scotland

Priority areas for health protection surveillance activities

The following surveillance activity priorities were informed by the results of the PPS:

- Development of neonatal ICU surveillance system
- Development of Gram negative bacteraemia surveillance system
- Further develop and promote informatics based approaches to surveillance including prevalence surveys to maximise intelligence whilst reducing data collection burden
- Scope the development of surveillance systems to monitor infections across the whole care collective with a wider public health focus
- Further assessment and development of the IPC indicator data in the context of outcomes

Priority areas for antimicrobial stewardship

- Continue and sustain the improvements in documentation of indication and compliance with local policy for antimicrobials given as treatment in acute adults

- Promote documentation of indication and compliance with local policy in all clinical settings, (including paediatric and non-acute settings) and in prescribing of prophylactic antimicrobials through staff education and training
- Continue work to improve carbapenem and piperacillin/tazobactam prescribing ensuring compliance with local policies
- Continue work to improve prescribing of broad-spectrum antimicrobials associated with an increased risk of CDI ensuring compliance with local policies
- Continue work to reduce unnecessary prescribing by undertaking timely reviews, promoting IVOST and improving the documentation of duration
- Continue improvement work to reduce unnecessary prolongation of surgical prophylaxis beyond a once only dose

Recommendations

- These PPS data should be considered by the Scottish AMR and HAI Strategy Group (SARHAI) in order to inform future policy priorities using intelligence on the current epidemiology of HAI, antimicrobial prescribing and IPC indicators
- These data should be used for benchmarking locally and nationally to drive improvement
- A formal economic evaluation of the priorities is required in order that financial impact is considered prior to investment
- Evaluation studies of future investment in HAI interventions are required in order that impact on outcome can be formally assessed
- The experience from delivering this PPS should be used to inform future options for PPS in NHSScotland. This should include consideration of the availability of key data items.

Appendix

Table A1: Prevalence of HAI in Scottish acute inpatients in 2016, by hospital

Board	2016						
	Hospital	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI	Adjusted prevalence (%)
NHS Ayrshire and Arran	Arran War Memorial Hospital*	4	1	25.0	4.6	69.9	-
	University Hospital Ayr	315	8	2.5	1.3	4.9	2.2
	University Hospital Crosshouse	517	13	2.5	1.5	4.3	2.6
NHS Borders	Borders General Hospital	239	16	6.7	4.2	10.6	7.8
NHS Dumfries & Galloway	Dumfries and Galloway Royal Infirmary	253	4	1.6	0.6	4.0	1.9
	Galloway Community Hospital	35	0	0.0	0.0	9.9	0.0
NHS Fife	Victoria Hospital	433	33	7.6	5.5	10.5	7.3
NHS Forth Valley	Forth Valley Royal Hospital	608	20	3.3	2.1	5.0	3.8
NHS Greater Glasgow & Clyde	Gartnavel General	318	8	2.5	1.3	4.9	2.3
	Glasgow Royal Infirmary	713	18	2.5	1.6	4.0	2.5
	Inverclyde Royal Hospital	314	9	2.9	1.5	5.4	3.2
	Princess Royal Maternity Unit	117	2	1.7	0.5	6.0	4.3
	Queen Elizabeth University Hospital	1336	46	3.4	2.6	4.6	3.2
	Royal Alexandra Hospital	572	22	3.8	2.6	5.8	4.2
	Royal Hospital for Children	166	6	3.6	1.7	7.7	3.6
	Vale of Leven General Hospital	81	1	1.2	0.2	6.7	1.7
NHS Grampian	Aberdeen Maternity Hospital	70	1	1.4	0.3	7.7	4.8
	Aberdeen Royal Infirmary	538	49	9.1	7.0	11.8	7.3
	Dr Gray's Hospital	102	8	7.8	4.0	14.7	9.6
	Royal Aberdeen Children's Hospital	19	0	0.0	0.0	16.8	0.0
	Woodend General Hospital	183	14	7.7	4.6	12.4	7.8
NHS Highland	Belford Hospital	14	1	7.1	1.3	31.5	5.3
	Caithness General Hospital	44	0	0.0	0.0	8.0	0.0
	Lorn & Islands Hospital	33	2	6.1	1.7	19.6	7.0
	Raigmore Hospital	344	23	6.7	4.5	9.8	6.8
NHS Lanarkshire	Hairmyres Hospital	421	5	1.2	0.5	2.7	1.3
	Monklands District General Hospital	370	12	3.2	1.9	5.6	3.6
	Wishaw General Hospital	496	16	3.2	2.0	5.2	3.9

Board	2016						
	Hospital	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI	Adjusted prevalence (%)
NHS Lothian	Edinburgh Royal Infirmary	783	50	6.4	4.9	8.3	4.9
	Princess Alexandra Eye Pavilion*	4	1	25.0	4.6	69.9	-
	Royal Hospital for Sick Children	64	5	7.8	3.4	17.0	7.7
	St John's Hospital	309	23	7.4	5.0	10.9	10.2
	Western General Hospital	599	49	8.2	6.2	10.7	6.8
NHS National Waiting Times Centre	Golden Jubilee National Hospital	110	6	5.5	2.5	11.4	3.9
NHS Orkney	Balfour Hospital	30	2	6.7	1.8	21.3	7.4
NHS Shetland	Gilbert Bain Hospital	30	0	0.0	0.0	11.4	0
NHS Tayside	Ninewells Hospital	589	29	4.9	3.4	7.0	4.5
	Perth Royal Infirmary	195	11	5.6	3.2	9.8	5.9
	Stracathro Hospital	62	0	0.0	0.0	5.8	0.0
NHS Western Isles	Western Isles Hospital	76	3	3.9	1.4	11.0	5.0
Independent hospitals	BMI Albyn Hospital	7	0	0.0	0.0	35.4	0.0
	BMI Fernbrae Hospital	4	0	0.0	0.0	49.0	0.0
	BMI King's Park Hospital	2	0	0.0	0.0	65.8	0.0
	BMI Ross Hall Hospital	11	0	0.0	0.0	25.9	0.0
	Glasgow Nuffield Hospital	4	0	0.0	0.0	49.0	0.0
	Spire Edinburgh Hospitals	13	0	0.0	0.0	22.8	0.0

* Adjusted prevalence was not calculated due to small numbers

Table A2: Prevalence of HAI in Scottish non-acute inpatients, in 2016 by hospital

Board	Hospital	2016					
		Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI	Adjusted prevalence (%)
AA	Biggart Hospital	92	1	1.1	0.2	5.9	1.0
	East Ayrshire Community Hospital	37	0	0.0	0.0	9.4	0.0
BR	Kelso Hospital	23	1	4.3	0.8	21.0	4.0
D&G	Midpark Hospital	42	0	0.0	0.0	8.4	0.0
	Newton Stewart Hospital	15	0	0.0	0.0	20.4	0.0
FF	Glenrothes Hospital	56	1	1.8	0.3	9.4	1.8
FV	Stirling Community Hospital	71	1	1.4	0.2	7.6	1.1
GG&C	Gartnavel Royal Hospital	148	0	0.0	0.0	2.5	0.0
	Mearnskirk House	69	1	1.4	0.3	7.8	1.3
GR	Chalmers Hospital	15	3	20.0	7.0	45.2	9.5
	Fraserburgh Hospital	33	4	12.1	4.8	27.3	14.7
	Peterhead Community Hospital	16	0	0.0	0.0	19.4	0.0
	Turner Memorial Hospital	15	1	6.7	1.2	29.8	3.1
HG	County Community Hospital Invergordon	26	1	3.8	0.7	18.9	3.6
	Mid Argyll Community Hospital	21	0	0.0	0.0	15.5	0.0
	Nairn Town & County Hospital	16	0	0.0	0.0	19.4	0.0
	RNI Community Hospital	29	0	0.0	0.0	11.7	0.0
LN	Kello Hospital	15	0	0.0	0.0	20.4	0.0
	Lady Home Hospital	17	2	11.8	3.3	34.3	10.6
LO	Astley Ainslie Hospital	87	4	4.6	1.8	11.2	5.0
	Belhaven Hospital	7	0	0.0	0.0	35.4	0.0
	Liberton Hospital	109	6	5.5	2.5	11.5	5.0
TY	Royal Victoria Hospital	111	7	6.3	3.1	12.4	5.7
	St Margaret's Community Hospital	9	1	11.1	2.0	43.5	4.7

Table A3: Prevalence of HAI in 2016 and 2011, by patient group

Patient group	2016					2011					Adjusted odds ratio	95% Lower CI	95% Upper CI	p-value
	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI				
Acute adult inpatients (including independent hospital inpatients)	10 813	497	4.6	4.1	5.1	11 015	548	5.0	4.5	5.5	0.8	0.72	0.98	0.03
Paediatric inpatients	734	20	2.7	1.8	4.2	806	25	3.1	2.1	4.5	Adjusted odds ratios were not calculated for these patient groups.			
Total acute inpatients	**11 547**	**517**	**4.5**	**4.0**	**5.0**	**11 821**	**573**	**4.8**	**4.4**	**5.3**				
Non-acute inpatients	1079	34	3.2	2.3	4.4	1647	41	2.5	1.8	3.4				

Table A4: Prevalence of HAI in acute adult inpatients (including independent hospital inpatients) by specialty in 2016

Specialty	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI
Burns Care	13	0	0.0	0.0	22.8
Cardiac Surgery	39	1	2.6	0.5	13.2
Cardiology	496	20	4.0	2.6	6.1
Clinical Oncology	112	5	4.5	1.9	10.0
Dermatology	20	0	0.0	0.0	16.1
Digestive Tract	66	6	9.1	4.2	18.4
Ear, Nose and Throat	92	7	7.6	3.7	14.9
Endocrinology	125	3	2.4	0.8	6.8
Gastroenterology	407	11	2.7	1.5	4.8
General Medicine	2021	72	3.6	2.8	4.5
General Surgery (exc. vascular)	1042	66	6.3	5.0	8.0
Geriatric Medicine	1424	58	4.1	3.2	5.2
Geriatric Rehabilitation	555	26	4.7	3.2	6.8
Gynaecology	128	8	6.3	3.2	11.8
Haematology	124	15	12.1	7.5	19.0
ICU - not known	12	2	16.7	4.7	44.8
ICU Medical	27	2	7.4	2.1	23.4
ICU Mixed	67	6	9.0	4.2	18.2
ICU Other	2	0	0.0	0.0	65.8
ICU Specialised	13	1	7.7	1.4	33.3
ICU Surgical	28	6	21.4	10.2	39.5
Infectious Diseases	135	9	6.7	3.5	12.2
Long Term Care	31	0	0.0	0.0	11.0
Maxillo-Facial Surgery	24	2	8.3	2.3	25.8
Medical - not known	30	1	3.3	0.6	16.7
Medical Oncology	106	5	4.7	2.0	10.6
Neurology	56	1	1.8	0.3	9.4
Neurosurgery	125	10	8.0	4.4	14.1
Obstetrics	324	3	0.9	0.3	2.7
Ophthalmology	29	1	3.4	0.6	17.2
Palliative Medicine	37	1	2.7	0.5	13.8
Plastic Surgery	53	1	1.9	0.3	9.9
Psychiatry	435	9	2.1	1.1	3.9
Rehabilitation Medicine	304	15	4.9	3.0	8.0
Renal Medicine	167	7	4.2	2.0	8.4
Respiratory Medicine	587	22	3.7	2.5	5.6
Rheumatology	27	1	3.7	0.7	18.3
Specialty not known	16	0	0.0	0.0	19.4
Surgical - not known	43	7	16.3	8.1	30.0
Thoracic Surgery	22	2	9.1	2.5	27.8
Transplant Surgery	15	2	13.3	3.7	37.9
Trauma and Orthopaedic Surgery	901	49	5.4	4.1	7.1
Urology	190	16	8.4	5.2	13.2
Vascular Surgery	188	14	7.4	4.5	12.1
Other (not listed)	154	4	2.6	1.0	6.5
Not recorded	1	0	0.0	0.0	79.3
Total	**10 813**	**497**	**4.6**	**4.2**	**5.0**

Table A5: Prevalence of HAI in acute adult inpatients (including independent hospitals) in 2016 and univariate logistic regression analysis

Risk factor	Category	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
Sex	Female*	5740	257	4.5	4.0	5.0	1				0.08
	Male	4576	239	5.2	4.6	5.9	1.19	0.98	1.45	0.08	
Age group	16-29	592	24	4.1	2.7	6.0	0.88	0.55	1.42	0.60	0.33
	30-49	1324	50	3.8	2.9	4.9	0.82	0.59	1.15	0.25	
	50-64	1897	104	5.5	4.5	6.6	1.18	0.90	1.53	0.23	
	65-79	3410	153	4.5	3.8	5.2	0.97	0.77	1.23	0.82	
	80+*	3586	166	4.6	4.0	5.4	1				
McCabe score	None/non-fatal*	6250	207	3.3	2.9	3.8	1				<0.001
	Ultimately fatal	3232	195	6.0	5.3	6.9	1.90	1.55	2.32	<0.001	
	Rapidly fatal	1269	89	7.0	5.7	8.6	2.22	1.72	2.86	<0.001	
	Not recorded	62	6	9.7	4.5	19.5	3.18	1.32	7.66	0.01	
Hospital type	General*	5966	252	4.2	3.7	4.8	1				0.048
	Obstetrics	102	1	1.0	0.2	5.3	0.23	0.04	1.51	0.13	
	Teaching	4745	244	5.1	4.5	5.8	1.24	0.99	1.56	0.07	
Ward type	General*	10157	439	4.3	3.9	4.7	1				<0.001
	General/HDU	205	8	3.9	2.0	7.5	0.92	0.54	1.57	0.76	
	HDU	264	27	10.2	7.1	14.5	2.56	1.58	4.14	<0.001	
	HDU/ICU Mixed	97	10	10.3	5.7	17.9	2.57	1.37	4.84	0.003	
	ICU	90	13	14.4	8.6	23.2	3.78	1.96	7.28	<0.001	
Specialty	Geriatric medicine*	1979	84	4.2	3.4	5.2	1				<0.001
	Intensive care	149	17	11.4	7.2	17.5	2.94	1.56	5.53	0.001	
	Medicine	4753	188	4.0	3.4	4.5	0.93	0.69	1.26	0.65	
	Obstetrics and gynaecology	452	11	2.4	1.4	4.3	0.57	0.28	1.17	0.13	
	Other	203	4	2.0	0.8	5.0	0.46	0.16	1.33	0.15	
	Psychiatry	435	9	2.1	1.1	3.9	0.48	0.20	1.16	0.10	
	Surgery	2842	184	6.5	5.6	7.4	1.56	1.13	2.15	0.007	
Surgery since admission to hospital	No *	8542	317	3.7	3.3	4.1	1				<0.001
	Yes	2175	172	7.9	6.8	9.1	2.24	1.78	2.83	<0.001	
	Not recorded	96	8	8.3	4.3	15.6	2.09	0.93	4.68	0.08	
Length of stay	<8d*	5585	195	3.5	3.0	4.0	1				<0.001
	8-14d	1822	111	6.1	5.1	7.3	1.79	1.40	2.29	<0.001	
	15-21d	912	55	6.0	4.7	7.8	1.77	1.30	2.41	<0.001	
	22-28d	549	28	5.1	3.6	7.3	1.48	0.95	2.33	0.09	
	29-35d	425	21	4.9	3.3	7.4	1.44	0.91	2.27	0.12	
	>35d	1492	81	5.4	4.4	6.7	1.59	1.20	2.10	0.001	

*reference category

Modelling excludes records with unknown HAI status, sex, age, surgery and length of stay leaving n=10781 records for modelling. Specialty category 'Other Specialty' includes specialties 'long term care', 'Obstetrics and gynaecology', 'Surgery', and those recorded as 'Other'.

Table A6: Factors associated with HAI prevalence in acute adult inpatients (including independent patients) in 2016 - multivariate analysis results

Risk factor	Category	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
McCabe score	None/Non-fatal*	1				<0.001
	Ultimately fatal	1.93	1.58	2.36	<0.001	
	Rapidly fatal	2.39	1.81	3.16	<0.001	
	Not recorded	2.73	1.05	7.10	0.040	
Ward type	General*	1				<0.001
	General/HDU	0.96	0.53	1.73	0.89	
	HDU	2.15	1.34	3.45	0.002	
	HDU/ICU Mixed	3.15	1.65	5.99	0.001	
	ICU	3.51	1.56	7.91	0.003	
Specialty	Geriatric medicine*	1				0.02
	Intensive care	0.96	0.43	2.16	0.93	
	Medicine	1.10	0.81	1.50	0.55	
	Obstetrics and gynaecology	0.97	0.46	2.04	0.94	
	Psychiatry	0.63	0.27	1.43	0.27	
	Surgery	1.56	1.10	2.21	0.01	
	Other	0.45	0.16	1.25	0.13	
Surgery since admission to hospital	No*	1				<0.001
	Yes	1.84	1.42	2.38	<0.001	
	Not recorded	1.51	0.70	3.26	0.29	
Length of stay	<8d*	1				0.001
	8-14d	1.66	1.28	2.14	<0.001	
	15-21d	1.62	1.17	2.25	0.004	
	22-28d	1.40	0.89	2.22	0.15	
	29-35d	1.30	0.81	2.07	0.28	
	>35d	1.68	1.25	2.26	0.001	

*reference category

Modelling excludes records with unknown HAI status, sex, age, surgery and length of stay leaving n=10781 records for modelling. Specialty category 'Other Specialty' includes specialties 'long term care', 'Obstetrics and gynaecology', 'Surgery', and those recorded as 'Other'.

Table A7: Prevalence of HAI in Scottish paediatric inpatients in 2016, by specialty

Specialty	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI
Cardiology	5	0	0.0	0.0	43.4
Dermatology	1	0	0.0	0.0	79.3
Digestive Tract	2	0	0.0	0.0	65.8
Ear, Nose and Throat	8	0	0.0	0.0	32.4
Endocrinology	1	0	0.0	0.0	79.3
Gastroenterology	9	1	11.1	2.0	43.5
General Medicine	81	2	2.5	0.7	8.6
General Paediatrics (in adult ward)	18	1	5.6	1.0	25.8
General Surgery (exc vascular)	27	1	3.7	0.7	18.3
Haematology	20	1	5.0	0.9	23.6
Healthy neonates (maternity ward)	163	0	0.0	0.0	2.3
Healthy neonates (paediatric ward)	3	1	33.3	6.1	79.2
ICU Mixed	2	0	0.0	0.0	65.8
ICU Neonatal	111	9	8.1	4.3	14.7
ICU Paediatrics	27	1	3.7	0.7	18.3
Infectious Diseases	2	0	0.0	0.0	65.8
Medical - not known	1	0	0.0	0.0	79.3
Medical Oncology	4	0	0.0	0.0	49.0
Neonate - not known	9	0	0.0	0.0	29.9
Neurology	9	0	0.0	0.0	29.9
Neurosurgery	4	0	0.0	0.0	49.0
Oral Surgery and Dentistry	1	0	0.0	0.0	79.3
Paediatric Neonatology (other than healthy babies and NICU)	129	3	2.3	0.8	6.6
Paediatrics - not known	43	0	0.0	0.0	8.2
Plastic Surgery	2	0	0.0	0.0	65.8
Psychiatry	4	0	0.0	0.0	49.0
Renal Medicine	6	0	0.0	0.0	39.0
Respiratory Medicine	23	0	0.0	0.0	14.3
Trauma and Orthopaedic Surgery	19	0	0.0	0.0	16.8
Total	**734**	**20**	**2.7**	**1.8**	**4.2**

Table A8: Prevalence of HAI in paediatric inpatients in 2016 and univariate logistic regression analysis

Risk factor	Category	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
Sex	Female*	335	11	3.3	1.8	5.8	1				0.52
	Male	399	9	2.3	1.2	4.2	0.68	0.22	2.14	0.52	
Age group	<1m*	329	7	2.1	1.0	4.3	1				0.22
	1-23m	193	9	4.7	2.5	8.6	2.26	0.74	6.86	0.16	
	2-4y	61	2	3.3	0.9	11.2	1.58	0.29	8.52	0.59	
	5-18y	151	2	1.3	0.4	4.7	0.64	0.11	3.54	0.61	
McCabe score	None/non-fatal*	635	15	2.4	1.4	3.9	1				0.14
	Ultimately fatal	75	4	5.3	2.1	12.9	2.30	0.73	7.25	0.16	
	Not recorded	23	1	4.3	0.8	21.0	2.02	0.99	4.11	0.06	
Ward type	General*	438	6	1.4	0.6	3.0	1				0.1
	General/HDU	50	1	2.0	0.4	10.5	1.47	0.23	9.24	0.68	
	HDU/ICU Mixed	175	9	5.1	2.7	9.5	3.85	1.22	12.09	0.02	
	ICU	63	4	6.3	2.5	15.2	4.78	0.81	28.26	0.09	
Specialty	Medicine*	162	4	2.5	1.0	6.2	1				0.22
	Healthy newborns	173	1	0.6	0.1	3.2	0.23	0.02	2.30	0.21	
	Neonates (excluding NICU)	128	3	2.3	0.8	6.6	0.94	0.24	3.63	0.92	
	General paediatrics	61	1	1.6	0.3	8.7	0.67	0.07	6.76	0.74	
	Intensive Care	140	10	7.1	3.9	12.6	3.15	0.82	12.06	0.10	
	Surgery	63	1	1.6	0.3	8.5	0.65	0.14	3.04	0.59	
Surgery since admission to hospital	No*	651	13	2.0	1.2	3.4	1				0.003
	Yes	80	7	8.8	4.3	17.0	4.81	1.73	13.35	0.00	
Length of stay	<8d*	485	6	1.2	0.6	2.7	1				0.002
	8-35d	158	7	4.4	2.2	8.9	3.69	1.24	11.01	0.02	
	>35d	88	7	8.0	3.9	15.5	7.33	2.58	20.81	<0.001	

*reference category

Modelling excludes records with unknown HAI status, sex, age, surgery, and length of stay, and McCabe score category rapidly fatal, ward type category 'HDU' and specialty 'psychiatry' due to small numbers leaving n=715 records for modelling. The specialty category 'Neonates (excluding NICU)' includes neonates other than healthy newborns and other than NICU.

Table A9: Prevalence of HAI in non-acute inpatients by specialty, in 2016

Specialty	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI
Gastroenterology	1	0	0.0	0.0	79.3
General Medicine	57	1	1.8	0.3	9.3
Geriatric General Practice (GP)	74	3	4.1	1.4	11.3
Geriatric Medicine	237	5	2.1	0.9	4.8
Geriatric Rehabilitation	327	14	4.3	2.6	7.1
Long Term Care	16	0	0.0	0.0	19.4
Neurology	13	0	0.0	0.0	22.8
Obstetrics	1	0	0.0	0.0	79.3
Palliative Medicine	13	0	0.0	0.0	22.8
Psychiatry	214	2	0.9	0.3	3.3
Rehabilitation Medicine	122	8	6.6	3.4	12.4
Renal Medicine	2	1	50.0	9.5	90.5
Trauma and Orthopaedic Surgery	1	0	0.0	0.0	79.3
Other (not listed)	1	0	0.0	0.0	79.3
Total	**1079**	**34**	**3.2**	**2.3**	**4.4**

Table A10: Prevalence of HAI in non-acute inpatients in 2016 and univariate logistic regression analysis

Risk factor	Category	Number of patients surveyed	Number of patients with HAI	Prevalence (%)	95% Lower CI	95% Upper CI	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
Sex	Female*	631	16	2.5	1.6	4.1	1				0.30
	Male	448	18	4.0	2.6	6.3	1.44	0.74	2.81	0.30	
Age group	17-64	231	3	1.3	0.4	3.7	0.17	0.04	0.84	0.03	0.03
	65-79	302	7	2.3	1.1	4.7	0.45	0.19	1.06	0.07	
	80+*	564	24	4.3	2.9	6.3	1				
McCabe Score	None/non-fatal*	363	11	3.0	1.7	5.3	1				0.14
	Ultimately fatal	449	17	3.8	2.4	6.0	1.77	0.79	3.97	0.18	
	Rapidly fatal	245	4	1.6	0.6	4.1	0.87	0.22	3.40	0.86	
	Not recorded	22	2	9.1	2.5	27.8	4.52	1.05	19.42	0.047	
Specialty	Geriatric medicine*	638	22	3.4	2.3	5.2	1				0.048
	Medicine	208	10	4.8	2.6	8.6	1.42	0.61	3.28	0.43	
	Psychiatry	214	2	0.9	0.3	3.3	0.09	0.01	0.71	0.03	
Surgery since admission to hospital	No *	1041	33	3.2	2.3	4.4	1				0.76
	Yes	30	1	3.3	0.6	16.7	1.39	0.17	11.14	0.76	
Length of stay	<14d*	226	12	5.3	3.1	9.1	1				0.23
	14-35	230	5	2.2	0.9	5.0	0.42	0.12	1.44	0.17	
	>35	618	17	2.8	1.7	4.4	0.48	0.18	1.25	0.14	

*reference category

Modelling excludes records with unknown HAI status, sex, age, surgery and length of stay, and excludes specialty categories 'Long term care', 'Obstetrics and gynaecology', 'Surgery', and those recorded as 'Other', leaving n=1047 records for modelling.

Table A11: Number and percentage distribution of HAI in acute adult inpatients (including independent hospital inpatients) in 2016, by HAI type

HAI type	HAI	
	N	%
Pneumonia (without positive microbiology)	92	17.5
Symptomatic urinary tract infection, microbiologically confirmed	73	13.9
Symptomatic urinary tract infection, not microbiologically confirmed	56	10.6
Bloodstream infection (laboratory-confirmed)	46	8.7
Surgical site infection (superficial incisional)	40	7.6
Surgical site infection (deep incisional)	28	5.3
Oral cavity (mouth, tongue, or gums)	22	4.2
Soft tissue infection	21	4.0
Surgical site infection (organ/space)	19	3.6
Treated unidentified severe infection	17	3.2
Clostridium difficile infection	15	2.8
Pneumonia, clinical + positive sputum culture or non-quantitative culture from lower respiratory tract specimen	11	2.1
Pneumonia, clinical + positive quantitative culture from minimally contaminated lower respiratory tract specimen	8	1.5
Intraabdominal infection	8	1.5
Decubitus ulcer (not microbiologically confirmed)	6	1.1
Bronchitis, tracheobronchitis, bronchiolitis, tracheitis, without evidence of pneumonia	6	1.1
Decubitus ulcer, including both superficial and deep infections (microbiologically confirmed)	6	1.1
Pneumonia, clinical + microbiological diagnosis by alternative microbiology methods	5	0.9
Microbiologically confirmed CVC-related bloodstream infection	5	0.9
Local PVC-related infection (no positive blood culture)	4	0.8
Eye, other than conjunctivitis	4	0.8
Skin infection	4	0.8
PVC-related bloodstream infection (microbiologically confirmed)	4	0.8
Gastrointestinal tract infection	2	0.4
Endocarditis	2	0.4
Pneumonia, clinical + positive quantitative culture from possibly contaminated lower respiratory tract specimen	2	0.4
Other infections of the lower respiratory tract	2	0.4
Arterial or venous infection	2	0.4
Gastroenteritis (excluding CDI)	2	0.4
Osteomyelitis	2	0.4
CVC/PVC-related bloodstream infection (microbiologically confirmed)	1	0.2
Upper respiratory tract infection	1	0.2
Other infections of the male or female reproductive tract	1	0.2
Sinusitis	1	0.2
Ear mastoid	1	0.2
Vaginal cuff	1	0.2
General CVC/PVC-related infection (no positive blood culture)	1	0.2
Joint or bursa infection	1	0.2
Breast abscess or mastitis	1	0.2
Spinal abscess without meningitis	1	0.2
Disc space infection	1	0.2
Local CVC-related infection (no positive blood culture)	1	0.2
Intracranial infection	1	0.2
Grand Total	**527**	**100.0**

Table A12: Number and percentage of SSI in acute adult inpatients (including independent hospital inpatients), by surgical procedure category and type of SSI in 2016

Surgical procedure category	Superficial SSI		Deep SSI		Organ space SSI		All SSI	
	N	%	N	%	N	%	N	%
Abdominal hysterectomy	2	5.0	2	7.1	0	0.0	4	4.6
Appendix surgery	2	5.0	2	7.1	0	0.0	4	4.6
Bile duct, liver or pancreatic surgery	0	0.0	1	3.6	0	0.0	1	1.1
Caesarean section	1	2.5	0	0.0	2	10.5	3	3.4
Colon surgery	5	12.5	3	10.7	8	42.1	16	18.4
Coronary artery bypass graft with both chest and donor site incisions	0	0.0	1	3.6	0	0.0	1	1.1
Exploratory laparotomy	2	5.0	1	3.6	2	10.5	5	5.7
Gallbladder surgery	2	5.0	2	7.1	0	0.0	4	4.6
Gastric surgery	2	5.0	0	0.0	1	5.3	3	3.4
Herniorrhaphy	1	2.5	0	0.0	0	0.0	1	1.1
Hip prosthesis	1	2.5	1	3.6	0	0.0	2	2.3
Kidney surgery	1	2.5	0	0.0	0	0.0	1	1.1
Knee prosthesis	0	0.0	3	10.7	1	5.3	4	4.6
Laminectomy	1	2.5	1	3.6	0	0.0	2	2.3
Limb amputation	4	10.0	0	0.0	0	0.0	4	4.6
Neck Surgery	3	7.5	1	3.6	0	0.0	4	4.6
Open reduction of fracture	2	5.0	1	3.6	0	0.0	3	3.4
Other arthroplasty	1	2.5	0	0.0	0	0.0	1	1.1
Pacemaker surgery	0	0.0	0	0.0	1	5.3	1	1.1
Peripheral vascular bypass surgery	2	5.0	0	0.0	1	5.3	3	3.4
Rectal surgery	1	2.5	0	0.0	0	0.0	1	1.1
Ventricular shunt	2	5.0	0	0.0	0	0.0	2	2.3
Not recorded	5	12.5	9	32.1	3	15.8	17	19.5
Total	**40**	**100.0**	**28**	**100.0**	**19**	**100.0**	**87**	**100.0**

Table A13: Number and percentage distribution of microbiology reports in acute adult inpatients (including independent hospital inpatients) in 2016, by microorganism

Microorganism	Reports	
	N	%
Escherichia coli	64	22.7
Staphylococcus aureus	57	20.2
Clostridium difficile	15	5.3
Enterococcus faecalis	10	3.5
Klebsiella pneumoniae	10	3.5
Klebsiella oxytoca	9	3.2
Aspergillus niger	8	2.8
Enterococcus faecium	8	2.8
Anaerobes, not specified	7	2.5
Candida species, not specified	7	2.5
Staphylococcus epidermidis	7	2.5
Haemophilus influenzae	6	2.1
Proteus mirabilis	6	2.1
Pseudomonas aeruginosa	6	2.1
Enterococcus species, not specified	4	1.4
Streptococcus agalactiae (Group B)	4	1.4
Streptococcus species, other	4	1.4
Bacillus species	3	1.1
Candida albicans	3	1.1
Candida glabrata	3	1.1
Enterobacter cloacae	3	1.1
Morganella species	3	1.1
Other coagulase-negative staphylococci (CNS)	3	1.1
Gram negative bacteria (non Enterobacteriaceae)	3	1.1
Bacteroides species, other	2	0.7
Coagulase-negative staphylococci (CNS)	2	0.7
Corynebacterium species	2	0.7
Enterobacter aerogenes	2	0.7
Enterococcus species, other	2	0.7
Other haemolytic streptococci (Group C,G)	2	0.7
Other yeasts	2	0.7
Staphylococcus haemolyticus	2	0.7
Acinetobacter species, other	1	0.4
Citrobacter freundii	1	0.4
Citrobacter koseri (exc. diversus)	1	0.4
Enterobacter species, other	1	0.4
Gram negative cocci, other	1	0.4
Gram positive bacilli, not specified	1	0.4
Gram positive cocci, not specified	1	0.4
Haemophilus parainfluenzae	1	0.4
Klebsiella species, not specified	1	0.4
Other Enterobacteriaceae	1	0.4
Prevotella species	1	0.4
Proteus species, not specified	1	0.4
Serratia marcescens	1	0.4
Total	**282**	**100.0**

Table A14: Number and percentage distribution of HAI in adult acute inpatients (including independent hospital inpatients) in 2016, by time of onset and HAI group

HAI group	HAI present on admission		HAI developed during stay in survey hospital		Not recorded		All HAI	
	N	%	N	%	N	%	N	%
Bone/joint infection	0	0.0	4	0.9	0	0.0	4	0.8
Cardiovascular system infection	0	0.0	4	0.9	0	0.0	4	0.8
Central nervous system infection	1	1.1	1	0.2	0	0.0	2	0.4
CVC/PVC related infection	2	2.2	14	3.3	0	0.0	16	3.0
Eye, ear, nose, throat and mouth infection	0	0.0	29	6.8	0	0.0	29	5.5
Gastrointestinal tract infection	4	4.3	23	5.4	0	0.0	27	5.1
Laboratory-confirmed BSI	7	7.6	39	9.1	0	0.0	46	8.7
Lower respiratory tract infection, other than pneumonia	1	1.1	7	1.6	0	0.0	8	1.5
Pneumonia	12	13.0	103	24.1	3	42.9	118	22.4
Reproductive tract infection	0	0.0	2	0.5	0	0.0	2	0.4
Skin and soft tissue infection	10	10.9	28	6.5	0	0.0	38	7.2
Surgical site infection	42	45.7	44	10.3	1	14.3	87	16.5
Systemic infection	2	2.2	15	3.5	0	0.0	17	3.2
Urinary tract infection	11	12.0	115	26.9	3	42.9	129	24.5
Total	**92**	**100.0**	**428**	**100.0**	**7**	**100.0**	**527**	**100.0**

Table A15: Number and percentage distribution of HAI in paediatric inpatients in 2016, by HAI type

HAI type	HAI	
	N	%
Clinical sepsis in neonates	7	35.0
Bloodstream infection (laboratory-confirmed)	4	20.0
Surgical site infection (superficial incisional)	2	10.0
Treated unidentified severe infection	2	10.0
Gastroenteritis (excluding CDI)	1	5.0
Soft tissue infection	1	5.0
Pneumonia in neonates	1	5.0
Necrotising enterocolitis	1	5.0
Pneumonia (clinical signs without positive microbiology)	1	5.0
Total	**20**	**100.0**

Table A16: Number and percentage distribution of microbiology reports in paediatric inpatients in 2016, by microorganism

Microorganism	Reports	
	N	%
Enterococcus faecalis	2	25.0
Escherichia coli	2	25.0
Staphylococcus aureus	2	25.0
Staphylococcus epidermidis	1	12.5
Staphylococcus haemolyticus	1	12.5
Total	**8**	**100.0**

Table A17: Number and percentage distribution of HAI in paediatric inpatients (including independent hospital inpatients) in 2016, by time of onset and HAI group

HAI group	HAI present on admission		HAI developed during stay in survey hospital		All HAI	
	N	%	N	%	N	%
Gastrointestinal tract infection	0	0.0	1	5.6	1	5.0
Laboratory-confirmed BSI	0	0.0	4	22.2	4	20.0
Neonatal infection	0	0.0	9	50.0	9	45.0
Pneumonia	0	0.0	1	5.6	1	5.0
Skin and soft tissue infection	0	0.0	1	5.6	1	5.0
Surgical site infection	0	0.0	2	11.1	2	10.0
Systemic infection	2	100.0	0	0.0	2	10.0
Total	**2**	**100.0**	**18**	**100.0**	**20**	**100.0**

Table A18: Number and percentage distribution of HAI in non-acute inpatients in 2016, by HAI type

HAI type	HAI	
	N	%
Symptomatic urinary tract infection (not microbiologically confirmed)	10	29.4
Symptomatic urinary tract infection (microbiologically confirmed)	10	29.4
Pneumonia (clinical signs without positive microbiology)	4	11.8
Surgical site infection (deep incisional)	2	5.9
Soft tissue infection	2	5.9
Other infections of the lower respiratory tract	1	2.9
Treated unidentified severe infection	1	2.9
Clostridium difficile infection	1	2.9
Gastroenteritis (excluding CDI)	1	2.9
Bloodstream infection (laboratory-confirmed)	1	2.9
Surgical site infection (superficial incisional)	1	2.9
Total	**34**	**100.0**

Table A19: Number and percentage distribution of microbiology reports in non-acute inpatients in 2016, by microorganism

Microorganism	Reports	
	N	%
Escherichia coli	11	61.1
Staphylococcus aureus	2	11.1
Clostridium difficile	1	5.6
Klebsiella pneumoniae	1	5.6
Proteus mirabilis	1	5.6
Proteus vulgaris	1	5.6
Pseudomonas aeruginosa	1	5.6
Total	**18**	**100.0**

Table A20: Number and percentage distribution of HAI in non-acute inpatients in 2016, by time of onset and HAI group

HAI group	HAI present on admission		HAI developed during stay in survey hospital		Not known		All HAI	
	N	%	N	%	N	%	N	%
Gastrointestinal tract infection	0	0.0	2	7.1	0	0.0	2	5.9
Laboratory-confirmed BSI	0	0.0	1	3.6	0	0.0	1	2.9
Lower respiratory tract infection, other than pneumonia	0	0.0	1	3.6	0	0.0	1	2.9
Pneumonia	1	25.0	2	7.1	1	50.0	4	11.8
Skin and soft tissue infection	0	0.0	2	7.1	0	0.0	2	5.9
Surgical site infection	1	25.0	2	7.1	0	0.0	3	8.8
Systemic infection	1	25.0	0	0.0	0	0.0	1	2.9
Urinary tract infection	1	25.0	18	64.3	1	50.0	20	58.8
Total	**4**	**100.0**	**28**	**100.0**	**2**	**100.0**	**34**	**100.0**

Table A21: Prevalence of device use in acute adult inpatients (including independent hospital inpatients) in 2016, by specialty

Device	Specialty	2016				
		Number of patients surveyed	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI
Peripheral vascular catheter	Geriatric Medicine	1978	337	17.0	15.4	18.8
	Intensive Care	148	93	62.8	54.8	70.2
	Long Term Care	31	0	0.0	0.0	11.0
	Medicine	4738	1956	41.3	39.9	42.7
	Obstetrics and Gynaecology	451	114	25.3	21.5	29.5
	Other specialty	154	35	22.7	16.8	30.0
	Psychiatry	437	2	0.5	0.1	1.7
	Surgery	2850	1384	48.6	46.7	50.4
	Not recorded	16	3	18.8	6.6	43.0
Central vascular catheter	Geriatric Medicine	1979	6	0.3	0.1	0.7
	Intensive Care	147	74	50.3	42.4	58.3
	Long Term Care	31	0	0.0	0.0	11.0
	Medicine	4746	247	5.2	4.6	5.9
	Obstetrics and Gynaecology	451	2	0.4	0.1	1.6
	Other specialty	153	4	2.6	1.0	6.5
	Psychiatry	437	0	0.0	0.0	0.9
	Surgery	2864	149	5.2	4.4	6.1
	Not recorded	16	0	0.0	0.0	19.4
Urinary catheter	Geriatric Medicine	1978	483	24.4	22.6	26.4
	Intensive Care	147	113	76.9	69.4	83.0
	Long Term Care	31	11	35.5	21.1	53.1
	Medicine	4721	887	18.8	17.7	19.9
	Obstetrics and Gynaecology	454	47	10.4	7.9	13.5
	Other specialty	153	56	36.6	29.4	44.5
	Psychiatry	435	4	0.9	0.4	2.3
	Surgery	2855	647	22.7	21.2	24.2
	Not recorded	16	1	6.3	1.1	28.3
Intubation	Geriatric Medicine	1976	0	0.0	0.0	0.2
	Intensive Care	146	48	32.9	25.8	40.9
	Long Term Care	30	1	3.3	0.6	16.7
	Medicine	4757	20	0.4	0.3	0.6
	Obstetrics and Gynaecology	453	0	0.0	0.0	0.8
	Other specialty	153	6	3.9	1.8	8.3
	Psychiatry	437	0	0.0	0.0	0.9
	Surgery	2855	17	0.6	0.4	1.0
	Not recorded	16	0	0.0	0.0	19.4

Table A22: Prevalence of device use in acute adult inpatients (including independent hospital inpatients) in 2016 and 2011

Device	2016					2011								
	Number of patients surveyed	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI	Number of patients surveyed	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI	Adjusted odds ratio	95% Lower CI	95% Upper CI	p-value
Peripheral vascular catheter	10 803	3924	36.3	34.3	38.3	11 002	3551	32.3	30.5	34.1	1.25	1.14	1.38	0.001
Central vascular catheter	10 824	482	4.5	3.7	5.2	11 022	439	4.0	3.3	4.7	1.01	0.78	1.29	0.9
Urinary catheter	10 790	2249	20.8	20.0	22.1	11 001	2209	20.1	18.8	21.4	0.98	0.88	1.08	0.57
Intubation	10 823	92	0.9	0.5	1.2	11 003	135	1.2	0.8	1.6	0.55	0.34	0.89	0.02

Table A23: Prevalence of device use in paediatric inpatients in 2016, by specialty

Device	Specialty	2016				
		Number of patients surveyed	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI
Peripheral vascular catheter	Intensive Care	139	65	46.8	38.7	55.0
	Medicine	162	55	34.0	27.1	41.5
	Newborn Babies	304	47	15.5	11.8	20.0
	Paediatrics	59	22	37.3	26.1	50.0
	Psychiatry	4	0	0.0	0.0	49.0
	Surgery	63	30	47.6	35.8	59.7
Central vascular catheter	Intensive Care	139	34	24.5	18.1	32.2
	Medicine	162	34	21.0	15.4	27.9
	Newborn Babies	305	6	2.0	0.9	4.2
	Paediatrics	61	6	9.8	4.6	19.8
	Psychiatry	4	0	0.0	0.0	49.0
	Surgery	63	7	11.1	5.5	21.2
Urinary catheter	Intensive Care	137	9	6.6	3.5	12.0
	Medicine	160	1	0.6	0.1	3.5
	Newborn Babies	303	2	0.7	0.2	2.4
	Paediatrics	59	0	0.0	0.0	6.1
	Psychiatry	4	0	0.0	0.0	49.0
	Surgery	63	3	4.8	1.6	13.1
Intubation	Intensive Care	139	34	24.5	18.1	32.2
	Medicine	161	3	1.9	0.6	5.3
	Newborn Babies	303	3	1.0	0.3	2.9
	Paediatrics	59	1	1.7	0.3	9.0
	Psychiatry	4	0	0.0	0.0	49.0
	Surgery	63	0	0.0	0.0	5.7

Table A24: Prevalence of device use in paediatric inpatients in 2016, and 2011

Device	2016					2011								
	Number of patients surveyed	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI	Number of patients surveyed	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI	Crude OR	95% Lower CI	95% Upper CI	p-value
Peripheral vascular catheter	731	219	30.0	26.8	33.4	811	191	23.6	20.8	26.6	1.4	1.0	2.0	0.09
Central vascular catheter	734	87	11.9	9.7	14.4	811	70	8.6	6.9	10.8	1.4	0.7	3.0	0.4
Urinary catheter	726	15	2.1	1.3	3.4	811	18	2.2	1.4	3.5	0.9	0.3	2.7	0.9
Intubation	729	41	5.6	4.2	7.5	810	40	4.9	3.6	6.7	1.2	0.5	2.8	0.8

Table A25: Prevalence of device use in non-acute inpatients in 2016, by specialty

Device	Specialty	2016				
		Number of patients surveyed	Number of patients with device in situ	Prevalence (%)	95% Lower CI	95% Upper CI
Peripheral vascular catheter	Geriatric Medicine	636	12	1.9	1.1	3.3
	Long Term Care	16	0	0.0	0.0	19.4
	Medicine	211	10	4.7	2.6	8.5
	Obstetrics and Gynaecology	1	0	0.0	0.0	79.3
	Other specialty	1	0	0.0	0.0	79.3
	Psychiatry	214	0	0.0	0.0	1.8
	Surgery	1	0	0.0	0.0	79.3
Central vascular catheter	Geriatric Medicine	636	0	0.0	0.0	0.6
	Long Term Care	16	0	0.0	0.0	19.4
	Medicine	211	0	0.0	0.0	1.8
	Obstetrics and Gynaecology	1	0	0.0	0.0	79.3
	Other specialty	1	0	0.0	0.0	79.3
	Psychiatry	214	0	0.0	0.0	1.8
	Surgery	1	0	0.0	0.0	79.3
Urinary catheter	Geriatric Medicine	632	163	25.8	22.5	29.3
	Long Term Care	16	1	6.3	1.1	28.3
	Medicine	210	55	26.2	20.7	32.5
	Obstetrics and Gynaecology	1	0	0.0	0.0	79.3
	Other specialty	1	0	0.0	0.0	79.3
	Psychiatry	213	7	3.3	1.6	6.6
	Surgery	1	0	0.0	0.0	79.3
Intubation	Geriatric Medicine	634	0	0.0	0.0	0.6
	Long Term Care	16	0	0.0	0.0	19.4
	Medicine	211	0	0.0	0.0	1.8
	Obstetrics and Gynaecology	1	0	0.0	0.0	79.3
	Other specialty	1	0	0.0	0.0	79.3
	Psychiatry	214	0	0.0	0.0	1.8
	Surgery	1	0	0.0	0.0	79.3

Table A26: Prevalence of antimicrobial use in Scottish acute inpatients in 2016, by hospital

Board	Hospital	2016					
		Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI	Adjusted prevalence (%)
AA	Arran War Memorial Hospital*	4	4	100.0	51.0	100.0	-
	University Hospital Ayr	316	152	48.1	42.6	53.6	43.3
	University Hospital Crosshouse	521	201	38.6	34.5	42.8	37.2
BB	Borders General Hospital	240	87	36.3	30.4	42.5	37.3
D&G	Dumfries and Galloway Royal Infirmary	254	103	40.6	34.7	46.7	38.5
	Galloway Community Hospital	35	8	22.9	12.1	39.0	27.0
FF	Victoria Hospital	439	175	39.9	35.4	44.5	34.8
FV	Forth Valley Royal Hospital	608	217	35.7	32.0	39.6	37.1
GG&C	Gartnavel General	318	106	33.3	28.4	38.7	34.9
	Glasgow Royal Infirmary	712	290	40.7	37.2	44.4	38.6
	Inverclyde Royal Hospital	314	110	35.0	30.0	40.5	40.5
	Princess Royal Maternity Unit	117	33	28.2	20.8	37.0	34.5
	Queen Elizabeth University Hospital	1333	489	36.7	34.1	39.3	36.3
	Royal Alexandra Hospital	572	208	36.4	32.5	40.4	36.8
	Royal Hospital for Children	165	61	37.0	30.0	44.6	35.5
	Vale of Leven General Hospital	81	35	43.2	33.0	54.1	53.0
GR	Aberdeen Maternity Hospital	78	13	16.7	10.0	26.5	24.7
	Aberdeen Royal Infirmary	553	229	41.4	37.4	45.6	36.0
	Dr Gray's Hospital	105	38	36.2	27.6	45.7	38.3
	Royal Aberdeen Children's Hospital	19	8	42.1	23.1	63.7	35.2
	Woodend General Hospital	188	29	15.4	11.0	21.3	19.0
HG	Belford Hospital	12	3	25.0	8.9	53.2	23.4
	Caithness General Hospital	44	13	29.5	18.2	44.2	29.6
	Lorn & Islands Hospital	33	7	21.2	10.7	37.8	21.7
	Raigmore Hospital	345	115	33.3	28.6	38.5	31.6
LN	Hairmyres Hospital	420	102	24.3	20.4	28.6	26.7
	Monklands District General Hospital	372	137	36.8	32.1	41.8	35.5
	Wishaw General Hospital	495	170	34.3	30.3	38.6	40.1

Board	Hospital	2016					
		Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI	Adjusted prevalence (%)
LO	Edinburgh Royal Infirmary	784	284	36.2	32.9	39.6	34.2
	Princess Alexandra Eye Pavilion	4	1	25.0	4.6	69.9	24.1
	Royal Hospital for Sick Children	64	32	50.0	38.1	61.9	47.8
	St John's Hospital	311	83	26.7	22.1	31.9	32.2
	Western General Hospital	603	190	31.5	27.9	35.3	33.0
NWTC	Golden Jubilee National Hospital	110	39	35.5	27.1	44.7	27.4
OR	Balfour Hospital	30	15	50.0	33.2	66.8	50.8
SH	Gilbert Bain Hospital	31	9	29.0	16.1	46.6	28.1
TY	Ninewells Hospital	598	215	36.0	32.2	39.9	33.3
	Perth Royal Infirmary	196	50	25.5	19.9	32.0	25.4
	Stracathro Hospital	63	3	4.8	1.6	13.1	11.3
WI	Western Isles Hospital	76	15	19.7	12.3	30.0	26.4
Independent hospitals	BMI Albyn Hospital	7	2	28.6	8.2	64.1	23.5
	BMI Fernbrae Hospital	4	2	50.0	15.0	85.0	44.4
	BMI King's Park Hospital*	2	1	50.0	9.5	90.5	-
	BMI Ross Hall Hospital	11	0	0.0	0.0	25.9	0.0
	Glasgow Nuffield Hospital	5	4	80.0	37.6	96.4	64.2
	Spire Edinburgh Hospitals	13	6	46.2	23.2	70.9	43.6

* Adjusted prevalence was not calculated due to small numbers

Table A27: Prevalence of antimicrobial use in Scottish non-acute inpatients in 2016, by hospital

Board	Hospital	2016					
		Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI	Adjusted prevalence (%)
AA	Biggart Hospital	92	11	12.0	6.8	20.2	14.9
	East Ayrshire Community Hospital	37	14	37.8	24.1	53.9	26.5
BR	Kelso Hospital	23	8	34.8	18.8	55.1	33.3
D&G	Midpark Hospital	42	7	16.7	8.3	30.6	14.3
	Newton Stewart Hospital	15	2	13.3	3.7	37.9	10.6
FF	Glenrothes Hospital	48	10	20.8	11.7	34.3	22.1
FV	Stirling Community Hospital	71	4	5.6	2.2	13.6	4.3
GG&C	Gartnavel Royal Hospital	148	13	8.8	5.2	14.4	13.2
	Mearnskirk House	69	6	8.7	4.0	17.7	13.8
GR	Chalmers Hospital	15	8	53.3	30.1	75.2	20.8
	Fraserburgh Hospital	33	8	24.2	12.8	41.0	21.8
	Peterhead Community Hospital	16	0	0.0	0.0	19.4	0.0
	Turner Memorial Hospital	16	1	6.3	1.1	28.3	3.3
HG	County Community Hospital Invergordon	26	4	15.4	6.1	33.5	20.7
	Mid Argyll Community Hospital	21	3	14.3	5.0	34.6	14.0
	Nairn Town & County Hospital	16	1	6.3	1.1	28.3	6.7
	RNI Community Hospital	29	7	24.1	12.2	42.1	34.9
LN	Kello Hospital	15	2	13.3	3.7	37.9	11.6
	Lady Home Hospital	17	4	23.5	9.6	47.3	18.9
LO	Astley Ainslie Hospital	87	10	11.5	6.4	19.9	12.4
	Belhaven Hospital	7	0	0.0	0.0	35.4	0.0
	Liberton Hospital	109	12	11.0	6.4	18.3	10.5
TY	Royal Victoria Hospital	112	9	8.0	4.3	14.6	7.8
	St Margaret's Community Hospital	10	4	40.0	16.8	68.7	26.7

Table A28: Prevalence of antimicrobial prescribing in 2016 and 2011, by patient group

Patient group	2016					2011								
	Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI	Number of patients surveyed	Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Upper CI	Adjusted OR	95% Lower CI	95% Upper CI	p-value*
Acute adult inpatients (including independent hospital inpatients)	10 869	3878	35.7	34.2	37.2	11 012	3653	33.2	31.8	34.6	1.1	1.02	1.21	0.01
Paediatric inpatients	736	216	29.3	26.2	32.7	810	205	25.3	22.4	28.4	Adjusted odds ratios were not calculated for these patient groups.			
Total acute inpatients	11 605	4094	35.3	33.8	36.7	11 822	3858	32.6	31.6	34.0				
Non-acute inpatients	1074	148	13.8	11.8	16.0	1654	162	9.8	8.5	11.3				

Table A29: Prevalence of antimicrobial use in Scottish acute adult inpatients (including independent hospital inpatients) in 2016, by specialty

Specialty	Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI
Burns Care	13	4	30.8	12.7	57.6
Cardiac Surgery	42	14	33.3	21.0	48.4
Cardiology	498	154	30.9	27.0	35.1
Clinical Oncology	113	53	46.9	38.0	56.1
Dermatology	20	4	20.0	8.1	41.6
Digestive Tract	70	28	40.0	29.3	51.7
Ear, Nose and Throat	93	34	36.6	27.5	46.7
Endocrinology	126	59	46.8	38.3	55.5
Gastroenterology	406	149	36.7	32.2	41.5
General Medicine	2026	773	38.2	36.1	40.3
General Surgery (excluding vascular)	1047	480	45.8	42.8	48.9
Geriatric Medicine	1428	424	29.7	27.4	32.1
Geriatric Rehabilitation	559	106	19.0	15.9	22.4
Gynaecology	129	52	40.3	32.2	48.9
Haematology	128	88	68.8	60.3	76.1
ICU - not known	12	6	50.0	25.4	74.6
ICU Medical	27	13	48.1	30.7	66.0
ICU Mixed	67	38	56.7	44.8	67.9
ICU Other	2	1	50.0	9.5	90.5
ICU Specialised	13	6	46.2	23.2	70.9
ICU Surgical	27	19	70.4	51.5	84.1
Infectious Diseases	137	81	59.1	50.8	67.0
Long Term Care	31	0	0.0	0.0	11.0
Maxillo-Facial Surgery	25	13	52.0	33.5	70.0
Medical - not known	30	7	23.3	11.8	40.9
Medical Oncology	106	49	46.2	37.0	55.7
Neurology	57	11	19.3	11.1	31.3
Neurosurgery	125	47	37.6	29.6	46.3
Obstetrics	328	74	22.6	18.4	27.4
Ophthalmology	29	7	24.1	12.2	42.1
Other (not listed)	153	27	17.6	12.4	24.5
Palliative Medicine	36	11	30.6	18.0	46.9
Plastic Surgery	55	30	54.5	41.5	67.0
Psychiatry	437	32	7.3	5.2	10.2
Rehabilitation Medicine	305	56	18.4	14.4	23.1
Renal Medicine	168	77	45.8	38.5	53.4
Respiratory Medicine	588	333	56.6	52.6	60.6
Rheumatology	27	15	55.6	37.3	72.4
Surgical - not known	44	14	31.8	20.0	46.6
Thoracic Surgery	22	2	9.1	2.5	27.8
Transplant Surgery	15	13	86.7	62.1	96.3
Trauma and Orthopaedic Surgery	908	321	35.4	32.3	38.5
Urology	192	83	43.2	36.4	50.3
Vascular Surgery	188	63	33.5	27.2	40.5
Not recorded	17	7	41.2	21.6	64.0
Total	**10 869**	**3878**	**35.7**	**34.8**	**36.6**

Table A30: Number and percentage distribution of antimicrobials prescribed for treatment of infection at the time of survey in acute adult inpatients (including independent hospital inpatients) in 2016 and 2011, by infection type

Infection type	2016			2011		
	Number of antimicrobials being used to treat infection at the time of survey	N	%	Number of antimicrobials being used to treat infection at the time of survey	N	%
Respiratory	1	810	66.5	1	652	65.2
	2	373	30.6	2	327	32.7
	3	32	2.6	3	18	1.8
	>3	3	0.2	>3	3	0.3
Skin and soft tissue	1	316	70.1	1	264	49.7
	2	100	22.2	2	138	26.0
	3	30	6.7	3	26	4.9
	>3	5	1.1	>3	3	0.6
Sepsis/ bloodstream	1	141	68.4	1	117	67.2
	2	44	21.4	2	41	23.6
	3	21	10.2	3	16	9.2
	>3	0	0.0	>3	0	0.0
Intraabdominal	1	118	38.3	1	123	47.1
	2	61	19.8	2	54	20.7
	3	127	41.2	3	84	32.2
	>3	2	0.6	>3	0	0.0

Table A31 Prevalence of antimicrobial prescribing in acute adult inpatients (including independent hospitals) in 2016 and univariate logistic regression analysis

Risk factor	Category	Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
Sex	Female*	6034	2077	34.4	33.2	35.6	1				0.005
	Male	4834	1800	37.2	35.9	38.6	1.13	1.04	1.23	0.005	
Age group	16-29	597	205	34.3	30.6	38.2	1.11	0.90	1.38	0.34	<0.001
	30-49	1331	452	34.0	31.5	36.5	1.09	0.93	1.28	0.29	
	50-64	1909	738	38.7	36.5	40.9	1.33	1.17	1.52	<0.001	
	65-79	3429	1326	38.7	37.1	40.3	1.33	1.20	1.48	<0.001	
	80+*	3598	1155	32.1	30.6	33.6	1				
McCabe Score	None/non-fatal*	6277	2104	33.5	32.4	34.7	1				<0.001
	Ultimately fatal	3254	1246	38.3	36.6	40.0	1.23	1.10	1.38	<0.001	
	Rapidly fatal	1271	495	38.9	36.3	41.7	1.27	1.09	1.47	0.002	
	Not recorded	67	33	49.3	37.7	60.9	1.93	1.12	3.33	0.02	
Hospital type	General*	5993	2068	34.5	33.3	35.7	1				0.09
	Obstetrics	106	31	29.2	21.4	38.5	0.80	0.49	1.29	0.35	
	Teaching	4770	1779	37.3	35.9	38.7	1.13	0.99	1.29	0.06	
Ward type	General*	10205	3562	34.9	34.0	35.8	1				<0.001
	General/HDU	210	83	39.5	33.2	46.3	1.24	0.98	1.57	0.07	
	HDU	267	124	46.4	40.6	52.4	1.63	1.21	2.20	0.001	
	HDU/ICU Mixed	96	49	51.0	41.2	60.8	1.95	1.39	2.74	<0.001	
	ICU	91	60	65.9	55.7	74.8	3.62	2.28	5.73	<0.001	
Specialty	Geriatric medicine*	1987	530	26.7	24.8	28.7	1				<0.001
	Intensive care	148	83	56.1	48.0	63.8	3.52	2.44	5.08	<0.001	
	Medicine	4770	1920	40.3	38.9	41.7	1.86	1.57	2.21	<0.001	
	Obstetrics and gynaecology	457	126	27.6	23.7	31.8	1.05	0.78	1.42	<0.001	
	Psychiatry	437	32	7.3	5.2	10.2	0.22	0.13	0.37	<0.001	
	Surgery	2868	1153	40.2	38.4	42.0	1.85	1.54	2.21	<0.001	
	Other	202	34	16.8	12.3	22.6	0.56	0.34	0.91	0.02	
Surgery since admission to hospital	No*	8571	2929	34.2	33.2	35.2	1				<0.001
	Yes	2197	894	40.7	38.7	42.8	1.32	1.16	1.50	<0.001	
	Not recorded	101	55	54.5	44.8	63.8	2.27	1.57	3.29	<0.001	
Length of stay	<8d*	5612	2441	43.5	42.2	44.8	1				<0.001
	8-14d	1834	632	34.5	32.3	36.7	0.68	0.61	0.77	<0.001	
	15-21d	916	291	31.8	28.8	34.9	0.60	0.51	0.71	<0.001	
	22-28d	553	133	24.1	20.7	27.8	0.41	0.33	0.51	<0.001	
	29-35d	426	98	23.0	19.3	27.2	0.39	0.30	0.49	<0.001	
	>35d	1479	269	18.2	16.3	20.2	0.28	0.24	0.34	<0.001	

*reference category

Modelling excludes records with unknown antimicrobial status, sex, age and length of stay leaving n=10834 records for modelling. Specialty category 'Other Specialty' includes specialties 'long term care', 'Obstetrics and gynaecology', 'Surgery', and those recorded as 'Other'.

Table A32: Factors associated with antimicrobial prescribing in acute adult inpatients (including independent patients) in 2016 - multivariate analysis results

Risk factor	Category	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
Age group	16-29	1.23	0.98	1.53	0.07	0.006
	30-49	1.13	0.95	1.33	0.16	
	50-64	1.16	1.01	1.32	0.03	
	65-79	1.22	1.10	1.35	<0.001	
	80+*	1				
McCabe score	None/non-fatal*	1				<0.001
	Ultimately fatal	1.40	1.25	1.56	<0.001	
	Rapidly fatal	1.70	1.45	1.98	<0.001	
	Not recorded	2.01	1.18	3.41	0.01	
Ward type	General*	1				0.005
	General/HDU	0.89	0.66	1.21	0.47	
	HDU	1.10	0.79	1.53	0.59	
	HDU/ICU Mixed	1.86	0.86	4.01	0.11	
	ICU	3.33	1.77	6.26	<0.001	
Specialty	Geriatric medicine*	1				<0.001
	Intensive care	1.11	0.57	2.15	0.76	
	Medicine	1.47	1.25	1.73	<0.001	
	Obstetrics and gynaecology	0.67	0.48	0.93	0.02	
	Psychiatry	0.28	0.16	0.48	<0.001	
	Surgery	1.27	1.04	1.54	0.02	
	Other	0.54	0.34	0.87	0.01	
Surgery since admission to hospital	No *	1.00				<0.001
	Yes	1.35	1.17	1.56	<0.001	
	Not recorded	1.91	1.29	2.80	0.001	
Length of stay	<8d*	1			<0.001	<0.001
	8-14d	0.63	0.56	0.71	<0.001	
	15-21d	0.57	0.48	0.67	<0.001	
	22-28d	0.39	0.31	0.48	<0.001	
	29-35d	0.37	0.29	0.47	<0.001	
	>35d	0.31	0.26	0.37	<0.001	

*reference category

Modelling excludes records with unknown antimicrobial status, sex, age and length of stay leaving n=10834 records for modelling. Specialty category 'Other' includes specialties 'long term care', 'Obstetrics and gynaecology', 'Surgery', and those recorded as 'Other'.

Table A33: Prevalence of antimicrobial use in Scottish paediatric inpatients in 2016, by specialty

Specialty	Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI
Cardiology	5	2	40.0	11.8	76.9
Dermatology	1	1	100.0	20.7	100.0
Digestive Tract	2	0	0.0	0.0	65.8
Ear, Nose and Throat	8	4	50.0	21.5	78.5
Endocrinology	1	0	0.0	0.0	79.3
Gastroenterology	9	6	66.7	35.4	87.9
General Medicine	81	29	35.8	26.2	46.7
General Paediatrics (paediatric patient in an adult ward)	18	10	55.6	33.7	75.4
General Surgery (excluding vascular)	27	8	29.6	15.9	48.5
Haematology	20	16	80.0	58.4	91.9
Healthy neonates (maternity ward)	167	5	3.0	1.3	6.8
Healthy neonates (paediatric ward)	3	2	66.7	20.8	93.9
ICU Mixed	2	1	50.0	9.5	90.5
ICU Neonatal	111	39	35.1	26.9	44.4
ICU Paediatrics	26	13	50.0	32.1	67.9
Infectious Diseases	2	2	100.0	34.2	100.0
Medical - not known	1	1	100.0	20.7	100.0
Medical Oncology	4	3	75.0	30.1	95.4
Neonate - not known	9	9	100.0	70.1	100.0
Neurology	9	5	55.6	26.7	81.1
Neurosurgery	4	0	0.0	0.0	49.0
Oral Surgery and Dentistry	1	0	0.0	0.0	79.3
Paediatric Neonatology (other than healthy babies and NICU)	129	21	16.3	10.9	23.6
Paediatrics - not known	43	17	39.5	26.4	54.4
Plastic Surgery	2	2	100.0	34.2	100.0
Psychiatry	4	0	0.0	0.0	49.0
Renal Medicine	6	2	33.3	9.7	70.0
Respiratory Medicine	23	15	65.2	44.9	81.2
Trauma and Orthopaedic Surgery	18	3	16.7	5.8	39.2
Total	**736**	**216**	**29.3**	**26.2**	**32.7**

Table A34: Number and percentage distribution of antimicrobials prescribed for treatment of infection at the time of survey in paediatric inpatients in 2016, by infection type

Infection type	2016			2011		
	Number of antimicrobials being used to treat infection at the time of survey	N	%	Number of antimicrobials being used to treat infection at the time of survey	N	%
Respiratory	1	21	65.6	1	20	55.6
	2	7	21.9	2	14	38.9
	3	3	9.4	3	2	5.6
	>3	1	3.1	>3	0	0.0
Skin and soft tissue	1	8	57.1	1	7	63.6
	2	4	28.6	2	4	36.4
	3	1	7.1	3	0	0.0
	>3	0	0.0	>3	0	0.0
Sepsis/ bloodstream	1	11	19.0	1	6	20.7
	2	20	34.5	2	17	58.6
	3	5	8.6	3	5	17.2
	>3	0	0.0	>3	1	3.4
Intraabdominal	1	1	12.5	1	3	25.0
	2	2	25.0	2	6	50.0
	3	4	50.0	3	3	25.0
	>3	1	12.5	>3	0	0.0

Table A35: Prevalence of antimicrobial prescribing in paediatric inpatients in 2016 and univariate logistic regression analysis

Risk factor	Category	Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
Sex	Female*	334	93	27.8	23.3	32.9	1				0.31
	Male	402	123	30.6	26.3	35.3	1.17	0.86	1.59	0.31	
Age group	<1m*	333	68	20.4	16.4	25.1	1				<0.001
	1-23m	192	55	28.6	22.7	35.4	1.53	0.81	2.89	0.19	
	2-4y	61	24	39.3	28.1	51.9	2.61	1.21	5.64	0.02	
	5-18y	150	69	46.0	38.2	54.0	3.36	1.85	6.11	<0.001	
McCabe score	None/non-fatal*	638	173	27.1	23.8	30.7	1				<0.001
	Ultimately fatal	74	38	51.4	40.2	62.4	2.87	1.63	5.05	<0.001	
	Not recorded	23	4	17.4	7.0	37.1	0.62	0.46	0.84	0.003	
Ward type	General*	442	126	28.5	24.5	32.9	1				0.79
	General/ HDU	49	16	32.7	21.2	46.6	1.25	0.70	2.21	0.45	
	HDU/ICU Mixed	175	52	29.7	23.4	36.9	1.06	0.58	1.94	0.84	
	ICU	62	21	33.9	23.3	46.3	1.28	0.73	2.23	0.39	
Specialty	Medicine*	162	82	50.6	43.0	58.2	1				<0.001
	Healthy newborns	177	16	9.0	5.6	14.2	0.10	0.03	0.27	<0.001	
	Neonates (excluding NICU)	128	21	16.4	11.0	23.8	0.19	0.09	0.41	<0.001	
	General paediatrics	61	27	44.3	32.5	56.7	0.77	0.32	1.86	0.56	
	Intensive care	139	53	38.1	30.5	46.4	0.65	0.35	1.20	0.17	
	Surgery	62	17	27.4	17.9	39.6	0.35	0.19	0.67	0.002	
Surgery since admission to hospital	No*	653	182	27.9	24.6	31.4	1				0.047
	Yes	80	33	41.3	31.1	52.2	1.80	1.02	3.19	0.047	
Length of stay	<8d*	486	149	30.7	26.7	34.9	1				0.49
	8-35d	159	47	29.6	23.0	37.1	0.97	0.53	1.79	0.93	
	>35d	88	20	22.7	15.2	32.5	0.73	0.41	1.33	0.31	

*reference category

Modelling excludes records with unknown antimicrobial status, sex, age, surgery, and length of stay, and McCabe score category 'rapidly fatal', ward type category 'HDU' and specialty 'psychiatry' due to small numbers leaving n=717 records for modelling. The specialty category 'Neonates (excluding NICU)' includes neonates other than healthy newborns and other than NICU.

Table A36: Factors associated with antimicrobial prescribing in paediatric inpatients in 2016 - multivariate analysis results

Risk factor	Category	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
McCabe score	None/non-fatal*	1				<0.001
	Ultimately fatal	2.23	1.35	3.68	0.003	
	Rapidly fatal	0.69	0.47	1.02	0.07	
Specialty	Medicine*	1				<0.001
	Healthy newborns	0.09	0.03	0.25	<0.001	
	Neonates (excluding NICU)	0.25	0.11	0.54	0.001	
	General paediatrics	0.72	0.31	1.64	0.43	
	Intensive care	0.81	0.42	1.55	0.52	
	Surgery	0.32	0.18	0.58	<0.001	
Length of stay	<8d*	1				0.01
	8-35d	0.57	0.31	1.03	0.07	
	>35d	0.40	0.22	0.72	0.003	

*reference category

Modelling excludes records with unknown antimicrobial status, sex, age, surgery, and unknown length of stay, and McCabe score category 'rapidly fatal', ward type category 'HDU' and specialty 'psychiatry' due to small numbers leaving n=717 records for modelling. The specialty category 'Neonates (excluding NICU)' includes neonates other than healthy newborns and other than NICU.

Table A37: Prevalence of antimicrobial use in Scottish non-acute inpatients in 2016, by specialty

Specialty	Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI
Gastroenterology	1	0	0.0	0.0	79.3
General Medicine	58	18	31.0	20.6	43.8
Geriatric General Practice (GP)	67	16	23.9	15.3	35.3
Geriatric Medicine	237	25	10.5	7.2	15.1
Geriatric Rehabilitation	327	41	12.5	9.4	16.6
Long Term Care	16	0	0.0	0.0	19.4
Neurology	14	0	0.0	0.0	21.5
Obstetrics	1	0	0.0	0.0	79.3
Other (not listed)	1	0	0.0	0.0	79.3
Palliative Medicine	13	1	7.7	1.4	33.3
Psychiatry	214	25	11.7	8.0	16.7
Rehabilitation Medicine	122	20	16.4	10.9	24.0
Renal Medicine	2	1	50.0	9.5	90.5
Trauma and Orthopaedic Surgery	1	1	100.0	20.7	100.0
Total	**1074**	**148**	**13.8**	**11.8**	**16.0**

Table A38: Number and percentage distribution of antimicrobials prescribed for treatment of infection at the time of survey in non-acute inpatients in 2016, by infection type

Infection type	2016			2011		
	Number of antimicrobials being used to treat infection at the time of survey	N	%	Number of antimicrobials being used to treat infection at the time of survey	N	%
Respiratory	1	23	85.2	1	26	81.3
	2	3	11.1	2	6	18.8
	3	0	0.0	3	0	0.0
	>3	1	3.7	>3	0	0.0
Skin and soft tissue	1	21	9.3	1	15	83.3
	2	3	1.3	2	3	16.7
	3	1	0.4	3	0	0.0
	>3	0	0.0	>3	0	0.0
Sepsis/ bloodstream	1	3	100.0	1	4	100.0
	2	0	0.0	2	0	0.0
	3	0	0.0	3	0	0.0
	>3	0	0.0	>3	0	0.0
Intraabdominal	1	0	0.0	1	0	0.0
	2	0	0.0	2	0	0.0
	3	0	0.0	3	0	0.0
	>3	0	0.0	>3	0	0.0

Table A39: Prevalence of antimicrobial prescribing in non-acute inpatients in 2016 and univariate logistic regression analysis

Risk factor	Category	Number of patients surveyed	Number of patients receiving antimicrobials	Prevalence (%)	95% Lower CI	95% Upper CI	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
Sex	Female*	625	90	14.4	11.9	17.4	1				0.24
	Male	449	58	12.9	10.1	16.3	0.81	0.57	1.15	0.24	
Age group	17-64	213	15	7.0	4.3	11.3	0.31	0.16	0.60	0.001	0.001
	65-79	302	49	16.2	12.5	20.8	1.06	0.70	1.61	0.78	
	80+*	559	84	15.0	12.3	18.2	1				
McCabe Score	None/non-fatal*	360	41	11.4	8.5	15.1	1				<0.001
	Ultimately fatal	451	76	16.9	13.7	20.6	2.57	1.64	4.03	<0.001	
	Rapidly fatal	241	24	10.0	6.8	14.4	1.22	0.73	2.03	0.44	
	Not recorded	22	7	31.8	16.4	52.7	7.34	1.73	31.15	<0.001	
Specialty	Geriatric medicine*	631	82	13.0	10.6	15.8	1				0.3
	Medicine	210	40	19.0	14.3	24.9	1.61	0.84	3.09	0.16	
	Psychiatry	214	25	11.7	8.0	16.7	0.79	0.44	1.44	0.45	
	Other	19	1	5.3	0.9	24.6	0.37	0.03	3.99	0.42	
Surgery since admission to hospital	No *	1036	142	13.7	11.7	15.9	1				0.57
	Yes	30	5	16.7	7.3	33.6	1.26	0.56	2.84	0.57	
length of stay	<14d*	225	53	23.6	18.5	29.5	1				0.02
	14-35	230	27	11.7	8.2	16.5	0.46	0.24	0.90	0.03	
	>35	636	67	10.5	8.4	13.2	0.48	0.28	0.82	0.008	

*reference category

Modelling excludes records with unknown antimicrobial status, sex, age, surgery, and unknown length of stay leaving n=1061 records for modelling. Specialty category 'Other' includes specialties 'long term care', 'Obstetrics and gynaecology', 'S

Table A40: Factors associated with antimicrobial prescribing in non-acute inpatients in 2016 - multivariate analysis results

Risk factor	Category	Odds ratio	Odds ratio 95% Lower CI	Odds ratio 95% Upper CI	Category p-value	Risk factor p-value
Age group	17-64	0.26	0.13	0.54	0.001	0.008
	65-79	0.83	0.54	1.28	0.4	
	80+*	1				
McCabe score	None/non-fatal*	1				0.003
	Ultimately fatal	1.99	1.25	3.17	0.005	
	Rapidly fatal	0.99	0.60	1.62	0.96	
	Not recorded	5.46	1.31	22.77	0.02	
Specialty	Geriatric medicine*	1				0.04
	Medicine	2.19	1.23	3.88	0.009	
	Psychiatry	1.45	0.87	2.43	0.16	
	Other	0.42	0.04	4.70	0.48	
Length of stay	<14d*	1				0.004
	14-35d	0.41	0.22	0.76	0.007	
	>35d	0.47	0.30	0.74	0.002	

*reference category
Modelling excludes records with unknown antimicrobial status, sex, age, surgery, and unknown length of stay leaving n=1061 records for modelling. Specialty category 'Other' includes specialties 'long term care', 'Obstetrics and gynaecology', 'Surgery', and those recorded as 'Other'.

Table A41: Number and percentage distribution of antimicrobials prescribed for treatment of infection in acute adult inpatients (including independent hospital inpatients) in 2016, by diagnosis

Diagnosis	Antimicrobials	
	N	%
Pneumonia	1258	26.7
Intraabdominal sepsis (including hepatobiliary)	629	13.3
Cellulitis, wound, deep soft tissue not involving bone	530	11.2
Acute bronchitis or exacerbations of chronic bronchitis	389	8.2
Symptomatic lower urinary tract infection	357	7.6
Symptomatic upper urinary tract infection	284	6.0
Infections of ear, nose, throat, larynx and mouth	170	3.6
Laboratory confirmed bacteraemia	156	3.3
Clinical sepsis (suspected BSI without lab confirmation), excluding febrile neutropaenia	136	2.9
Surgical site infection involving bone	101	2.1
Septic arthritis (including prosthetic joint), osteomyelitis	101	2.1
Gastrointestinal infections	98	2.1
Surgical site infection (skin or soft tissue)	96	2.0
Febrile neutropaenia	75	1.6
Systemic inflammatory response with no clear anatomic site	74	1.6
Cardiovascular infections: endocarditis, vascular graft	58	1.2
Obstetric or gynaecological infections, STI in women	49	1.0
Infections of the central cervous system	36	0.8
Cystic fibrosis	18	0.4
Completely undefined, site with no systemic inflammation	16	0.3
Asymptomatic bacteriuria	7	0.1
Prostatitis, epididymoorchitis, STI in men	4	0.1
Endophthalmitis	3	0.1
Urinary tract infection, unknown site of infection (not known if upper or lower)	2	0.0
Not recorded	73	1.5
Total	**4720**	**100.0**

Table A42: Number and percentage distribution of antimicrobials prescribed for treatment of infection in acute adult inpatients (including independent hospital inpatients) in 2016, by antimicrobial

Antimicrobial name	Antimicrobials	
	N	%
Amoxicillin	812	17.2
Metronidazole	524	11.1
Co-amoxiclav	499	10.6
Flucloxacillin	381	8.1
Gentamicin	280	5.9
Clarithromycin	271	5.7
Piperacillin/tazobactam	270	5.7
Doxycycline	227	4.8
Trimethoprim	175	3.7
Ciprofloxacin	167	3.5
Vancomycin	160	3.4
Nystatin	99	2.1
Meropenem	82	1.7
Co-trimoxazole	73	1.5
Fluconazole	69	1.5
Nitrofurantoin	69	1.5
Clindamycin	61	1.3
Levofloxacin	61	1.3
Benzylpenicillin	57	1.2
Temocillin	57	1.2
Rifampicin	51	1.1
Aztreonam	45	1.0
Teicoplanin	31	0.7
Ceftriaxone	30	0.6
Linezolid	22	0.5
Cefalexin	19	0.4
Ceftazidime	12	0.3
Daptomycin	10	0.2
Ofloxacin	9	0.2
Phenoxymethylpenicillin	9	0.2
Azithromycin	7	0.1
Caspofungin	7	0.1
Fusidic acid	7	0.1
Pivmecillinam	7	0.1
Tobramycin	6	0.1
Cefuroxime	5	0.1
Ertapenem	5	0.1
Amphotericin B	4	0.1
Anidulafungin	4	0.1
Erythromycin	4	0.1
Fosfomycin	4	0.1
Tigecycline	3	0.1
Amikacin	2	0.0
Ethambutol	2	0.0
Isoniazid	2	0.0
Itraconazole	2	0.0
Miconazole	2	0.0

Antimicrobial name	Antimicrobials	
	N	%
Oxytetracycline	2	0.0
Tetracycline	2	0.0
Ceftolozane and enzyme inhibitor	1	0.0
Doripenem	1	0.0
Imipenem	1	0.0
Lymecycline	1	0.0
Moxifloxacin	1	0.0
Posaconazole	1	0.0
Procaine benzylpenicillin	1	0.0
Pyrazinamide	1	0.0
Rifabutin	1	0.0
Terbinafine	1	0.0
Voriconazole	1	0.0
Total	**4720**	**100.0**

Table A43: Number and percentage distribution of antimicrobials prescribed for treatment of infection in paediatric inpatients in 2016, by diagnosis

Diagnosis	Antimicrobials	
	N	%
Clinical sepsis (suspected BSI without lab confirmation), excluding febrile neutropaenia	54	21.9
Febrile neutropaenia	22	8.9
Intraabdominal sepsis (including hepatobiliary)	21	8.5
Acute bronchitis or exacerbations of chronic bronchitis	17	6.9
Cystic fibrosis	17	6.9
Pneumonia	15	6.1
Cellulitis, wound, deep soft tissue not involving bone	15	6.1
Infections of ear, nose, throat, larynx and mouth	15	6.1
Systemic inflammatory response with no clear anatomic site	14	5.7
Symptomatic upper urinary tract infection	13	5.3
Infections of the central nervous system	13	5.3
Laboratory confirmed bacteraemia	12	4.9
Symptomatic lower urinary tract infection	5	2.0
Surgical site infection involving skin or soft tissue but not bone	4	1.6
Completely undefined, site with no systemic inflammation	2	0.8
Septic arthritis (including prosthetic joint), osteomyelitis	2	0.8
Gastrointestinal infections	2	0.8
Obstetric or gynaecological infections, STI in women	1	0.4
Not recorded	3	1.2
Total	**247**	**100.0**

Table A44: Number and percentage distribution of antimicrobials prescribed for treatment of infection in paediatric inpatients in 2016, by antimicrobial

Antimicrobial name	Antimicrobials	
	N	%
Gentamicin	39	15.8
Piperacillin/tazobactam	22	8.9
Benzylpenicillin	21	8.5
Amoxicillin	19	7.7
Cefotaxime	19	7.7
Flucloxacillin	19	7.7
Vancomycin	19	7.7
Co-amoxiclav	12	4.9
Metronidazole	12	4.9
Ceftriaxone	9	3.6
Meropenem	7	2.8
Clarithromycin	6	2.4
Fluconazole	5	2.0
Azithromycin	4	1.6
Ciprofloxacin	4	1.6
Amphotericin B	3	1.2
Ceftazidime	3	1.2
Nystatin	3	1.2
Phenoxymethylpenicillin	3	1.2
Teicoplanin	3	1.2
Tobramycin	3	1.2
Co-trimoxazole	2	0.8
Amikacin	1	0.4
Caspofungin	1	0.4
Cefuroxime	1	0.4
Clindamycin	1	0.4
Erythromycin	1	0.4
Nitrofurantoin	1	0.4
Posaconazole	1	0.4
Primaxin	1	0.4
Rifampicin	1	0.4
Voriconazole	1	0.4
Total	**247**	**100.0**

Table A45: Number and percentage distribution of antimicrobials prescribed for treatment of infection in non-acute inpatients in 2016, by diagnosis

Diagnosis	Antimicrobials	
	N	%
Symptomatic lower urinary tract infection	29	25.2
Cellulitis, wound, deep soft tissue not involving bone	25	21.7
Pneumonia	21	18.3
Symptomatic upper urinary tract infection	12	10.4
Acute bronchitis or exacerbations of chronic bronchitis	12	10.4
Surgical site infection (skin or soft tissue)	5	4.3
Clinical sepsis (suspected BSI without lab confirmation), excluding febrile neutropaenia	2	1.7
Infections of ear, nose, throat, larynx and mouth	2	1.7
Gastrointestinal infections	1	0.9
Prostatitis, epididymoorchitis, STI in men	1	0.9
Completely undefined, site with no systemic inflammation	1	0.9
Laboratory confirmed bacteraemia	1	0.9
Not recorded	3	2.6
Total	**115**	**100.0**

Table A46: Number and percentage distribution of antimicrobials prescribed for treatment of infection in non-acute inpatients in 2016, by antimicrobial

Antimicrobial name	Antimicrobials	
	N	%
Amoxicillin	19	16.5
Doxycycline	16	13.9
Trimethoprim	14	12.2
Nitrofurantoin	11	9.6
Co-amoxiclav	10	8.7
Ciprofloxacin	8	7.0
Flucloxacillin	8	7.0
Metronidazole	8	7.0
Gentamicin	4	3.5
Co-trimoxazole	3	2.6
Piperacillin/tazobactam	3	2.6
Clarithromycin	2	1.7
Benzylpenicillin	1	0.9
Cefalexin	1	0.9
Lymecycline	1	0.9
Meropenem	1	0.9
Oxytetracycline	1	0.9
Phenoxymethylpenicillin	1	0.9
Pivmecillinam	1	0.9
Tetracycline	1	0.9
Vancomycin	1	0.9
Total	**115**	**100.0**

Figure A1: Number and cumulative percentage of antimicrobials prescribed for the treatment of intra-abdominal infection in all patients surveyed, in 2016

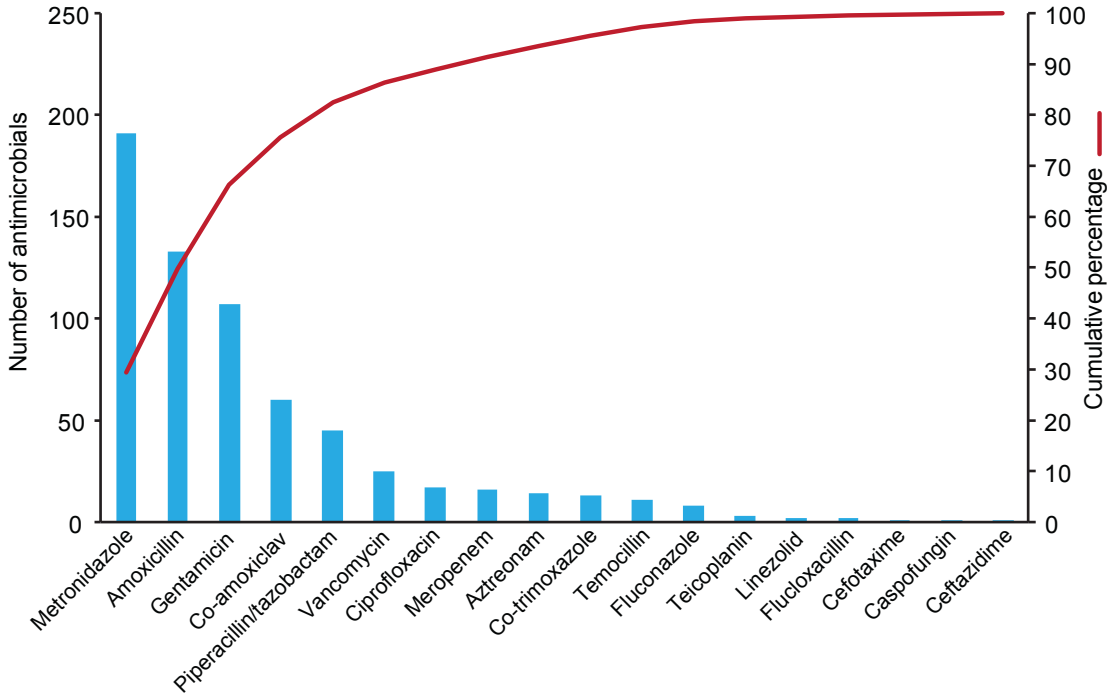


Figure A2: Number and cumulative percentage of antimicrobials prescribed for the treatment of respiratory infection in all patients surveyed, in 2016

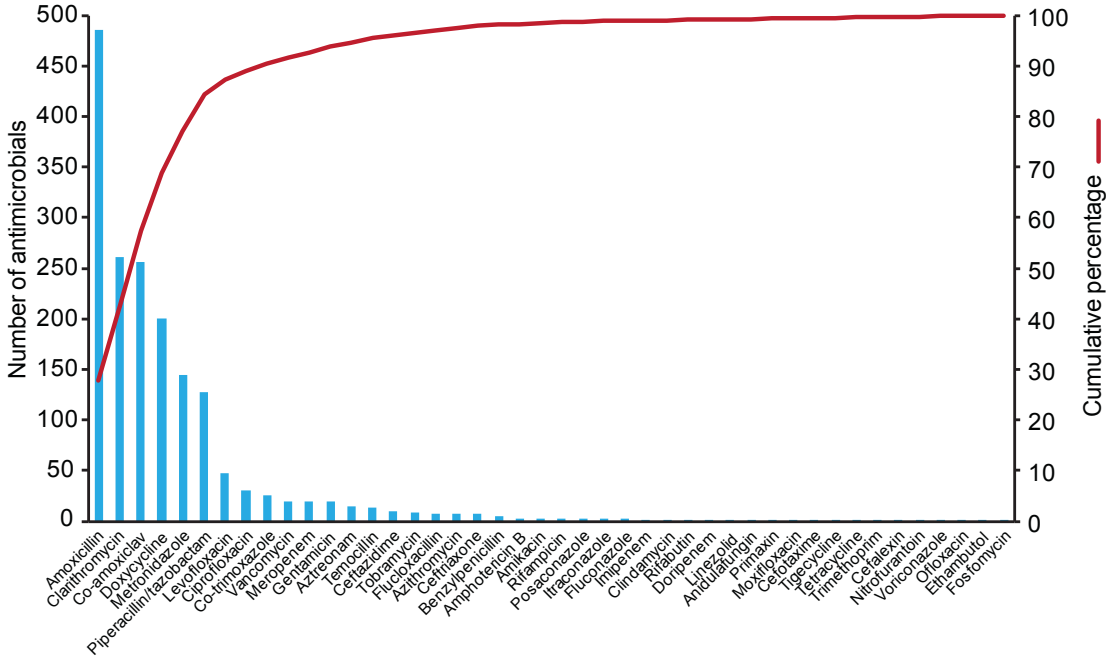


Figure A3: Number and cumulative percentage of antimicrobials prescribed for the treatment of skin and soft tissue infection in all patients surveyed, in 2016

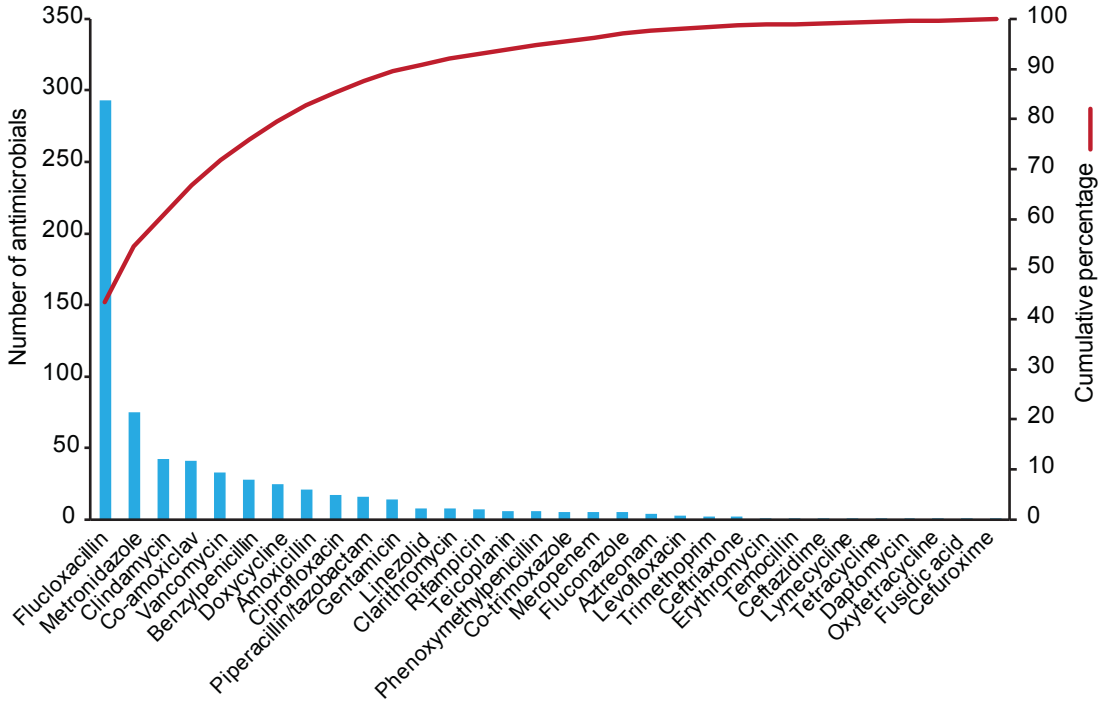


Figure A4: Number and cumulative percentage of antimicrobials prescribed for the treatment of urinary tract infection in all patients surveyed, in 2016

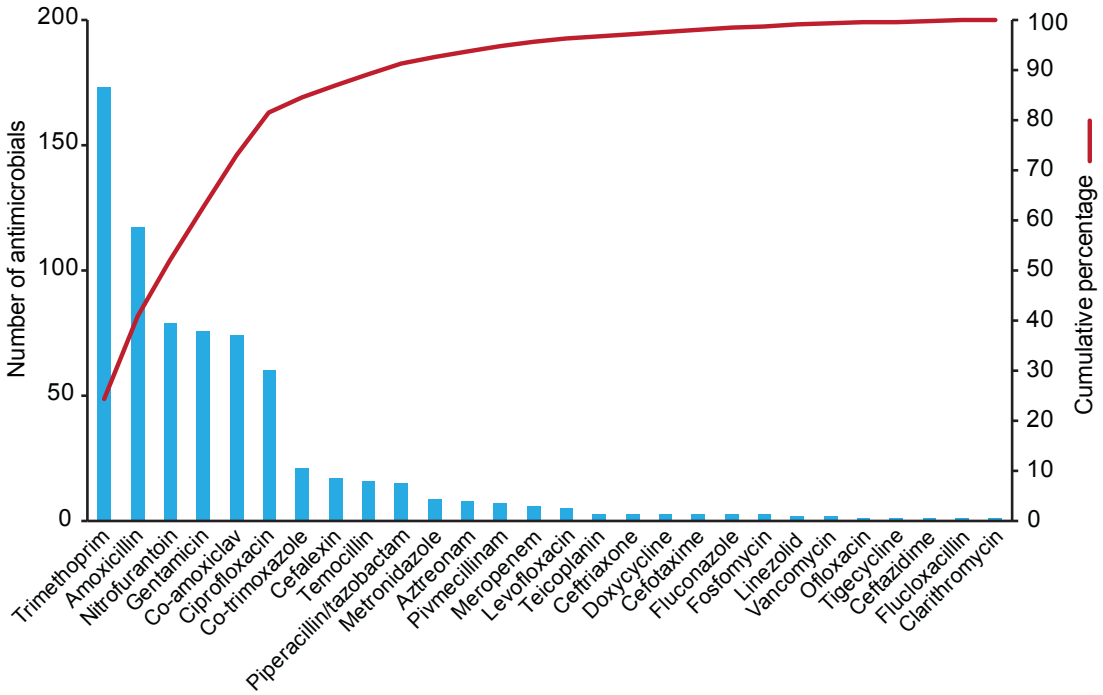


Table A47: Number and percentage distribution of antimicrobials prescribed for surgical prophylaxis in acute adult inpatients (including independent hospital inpatients) in 2016, by surgical procedure

Surgical procedure	Antimicrobials	
	N	%
Orthopaedic surgery (bone or joint)	125	37.3
Surgery of the GI tract, liver or biliary tree	74	22.1
Obstetric or gynaecological surgery	56	16.7
Urological surgery	18	5.4
Cardiac or vascular surgery	16	4.8
Neurosurgery	14	4.2
Plastic surgery	11	3.3
Ear, nose or throat surgery	4	1.2
Eye operations	1	0.3
Pulmonary surgery	1	0.3
Not recorded	15	4.5
Total	**335**	**100.0**

Table A48: Number and percentage distribution of antimicrobials prescribed for surgical prophylaxis in paediatric inpatients in 2016, by surgical procedure

Surgical procedure	Antimicrobials	
	N	%
Plastic surgery	2	50.0
Surgery of the GI tract, liver or biliary tree	1	25.0
Cardiac or vascular surgery	1	25.0
Total	**4**	**100.0**

Table A49: Number and percentage distribution of antimicrobials prescribed for surgical prophylaxis in acute adult inpatients (including independent hospital inpatients) in 2016, by antimicrobial

Antimicrobial name	Antimicrobials	
	N	%
Gentamicin	68	20.3
Cefuroxime	65	19.4
Co-amoxiclav	65	19.4
Flucloxacillin	38	11.3
Metronidazole	35	10.4
Teicoplanin	25	7.5
Amoxicillin	14	4.2
Clindamycin	6	1.8
Piperacillin/tazobactam	5	1.5
Ceftriaxone	3	0.9
Cefotaxime	2	0.6
Trimethoprim	2	0.6
Ciprofloxacin	1	0.3
Clarithromycin	1	0.3
Co-trimoxazole	1	0.3
Daptomycin	1	0.3
Meropenem	1	0.3
Rifampicin	1	0.3
Vancomycin	1	0.3
Total	**335**	**100.0**

Table A50: Number and percentage distribution of antimicrobials prescribed for surgical prophylaxis in paediatric inpatients in 2016, by antimicrobial

Antimicrobial name	Antimicrobials	
	N	%
Flucloxacillin	1	25.0
Co-amoxiclav	1	25.0
Cefuroxime	1	25.0
Ciprofloxacin	1	25.0
Total	**4**	**100.0**

Table A51: Duration of surgical prophylaxis prescribing in acute adult inpatients (including independent hospital inpatients) in 2016, by patient specialty

Specialty	Single dose		More than one dose (within 24 hours)		More than one dose (>24 hours)		Total	
	N	%	N	%	N	%	N	%
Trauma and Orthopaedic Surgery	80	36.7	27	51.9	17	26.2	124	37.0
General Surgery (excluding vascular)	45	20.6	3	5.8	6	9.2	54	16.1
Obstetrics	21	9.6	4	7.7	5	7.7	30	9.0
Gynaecology	22	10.1	0	0.0	5	7.7	27	8.1
Neurosurgery	8	3.7	5	9.6	4	6.2	17	5.1
Urology	9	4.1	4	7.7	4	6.2	17	5.1
Plastic Surgery	5	2.3	1	1.9	5	7.7	11	3.3
Cardiac Surgery	3	1.4	3	5.8	2	3.1	8	2.4
Cardiology	5	2.3	2	3.8	1	1.5	8	2.4
ICU Mixed	3	1.4	0	0.0	5	7.7	8	2.4
Renal Medicine	4	1.8	0	0.0	1	1.5	5	1.5
ICU Surgical	3	1.4	1	1.9	0	0.0	4	1.2
Maxillo-Facial Surgery	0	0.0	0	0.0	4	6.2	4	1.2
Digestive Tract	2	0.9	0	0.0	1	1.5	3	0.9
General Medicine	0	0.0	0	0.0	3	4.6	3	0.9
ICU - not known	3	1.4	0	0.0	0	0.0	3	0.9
Ear, Nose and Throat	0	0.0	0	0.0	2	3.1	2	0.6
Vascular Surgery	2	0.9	0	0.0	0	0.0	2	0.6
Burns Care	1	0.5	0	0.0	0	0.0	1	0.3
Gastroenterology	1	0.5	0	0.0	0	0.0	1	0.3
Specialty not known	0	0.0	1	1.9	0	0.0	1	0.3
Surgical - not known	1	0.5	0	0.0	0	0.0	1	0.3
Other (not listed)	0	0.0	1	1.9	0	0.0	1	0.3
Total	**218**	**100.0**	**52**	**100.0**	**65**	**100.0**	**335**	**100.0**

Table A52: Duration of surgical prophylaxis prescribing in paediatric inpatients in 2016, by patient specialty

Specialty	Single dose		More than one dose (within 24 hours)		More than one dose (>24 hours)		Total	
	N	%	N	%	N	%	N	%
Plastic Surgery	2	100.0	0	0.0	0	0.0	2	50.0
Gastroenterology	0	0.0	0	0.0	1	50.0	1	25.0
ICU Paediatrics	0	0.0	0	0.0	1	50.0	1	25.0
Total	**2**	**100.0**	**0**	**0.0**	**2**	**100.0**	**4**	**100.0**

Figure A5: Number and cumulative percentage of antimicrobials prescribed as surgical prophylaxis for orthopaedic surgery in all patients surveyed, in 2016

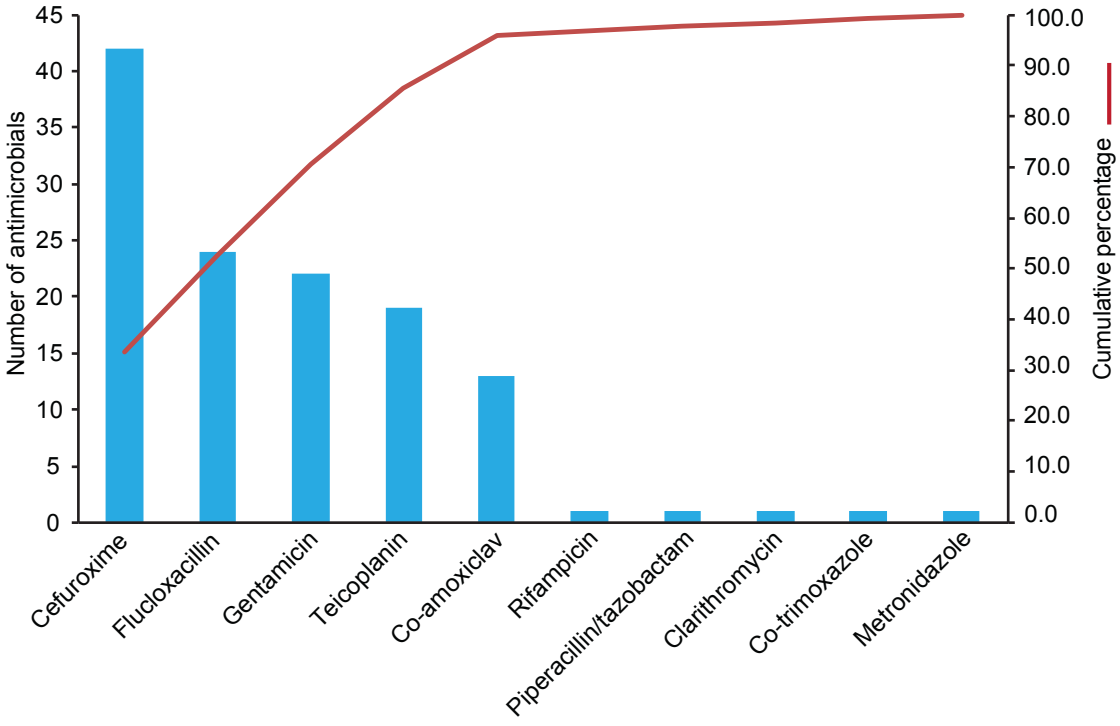


Figure A6: Number and cumulative percentage of antimicrobials prescribed as surgical prophylaxis for obstetric or gynaecological surgery, in all patients surveyed, in 2016

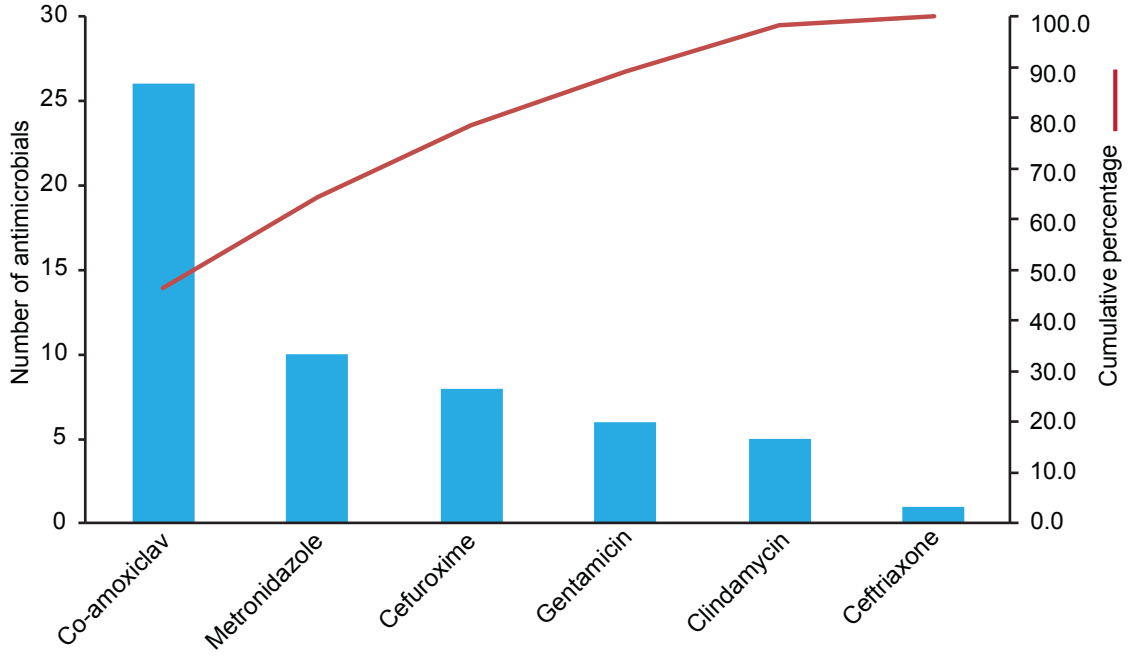


Figure A7: Number and cumulative percentage of antimicrobials prescribed as surgical prophylaxis for urological surgery in all patients surveyed, in 2016

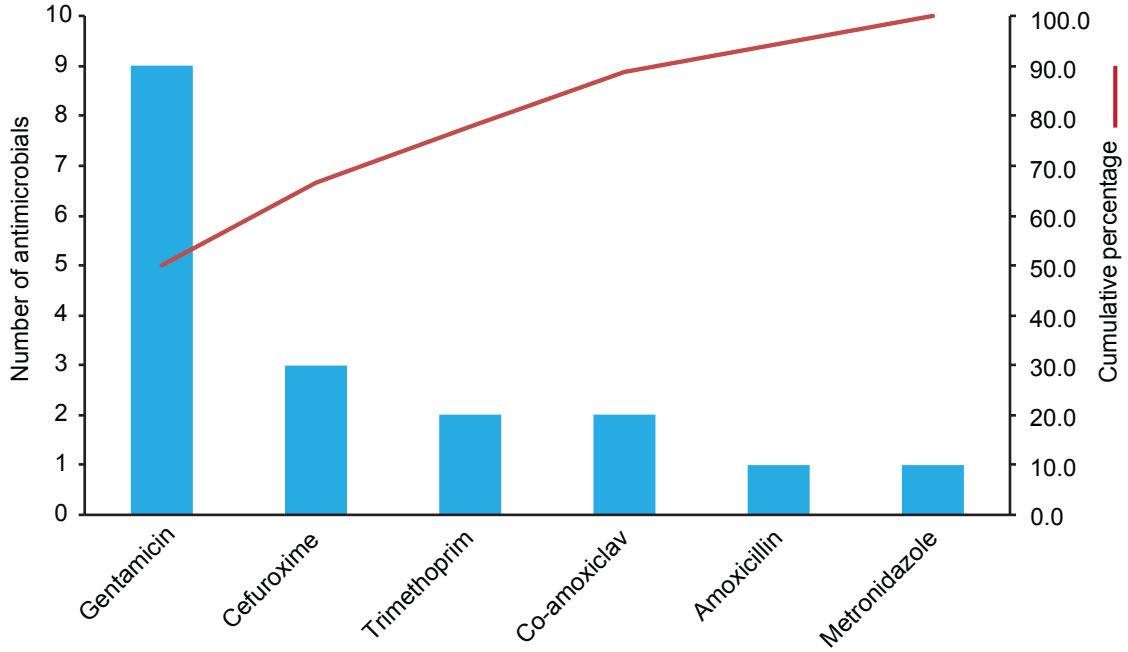


Figure A8: Number and cumulative percentage of antimicrobials prescribed as surgical prophylaxis for vascular surgery in all patients surveyed, in 2016

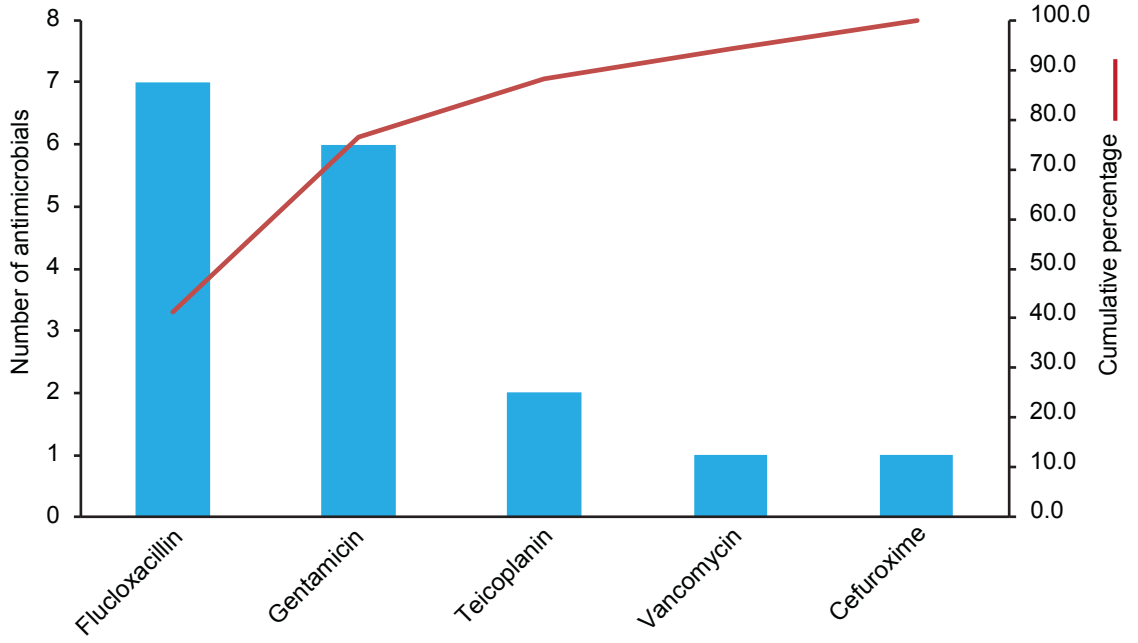


Figure A9: Number and cumulative percentage of antimicrobials prescribed as surgical prophylaxis for gastrointestinal surgery including intraabdominal surgery, in all patients surveyed, in 2016

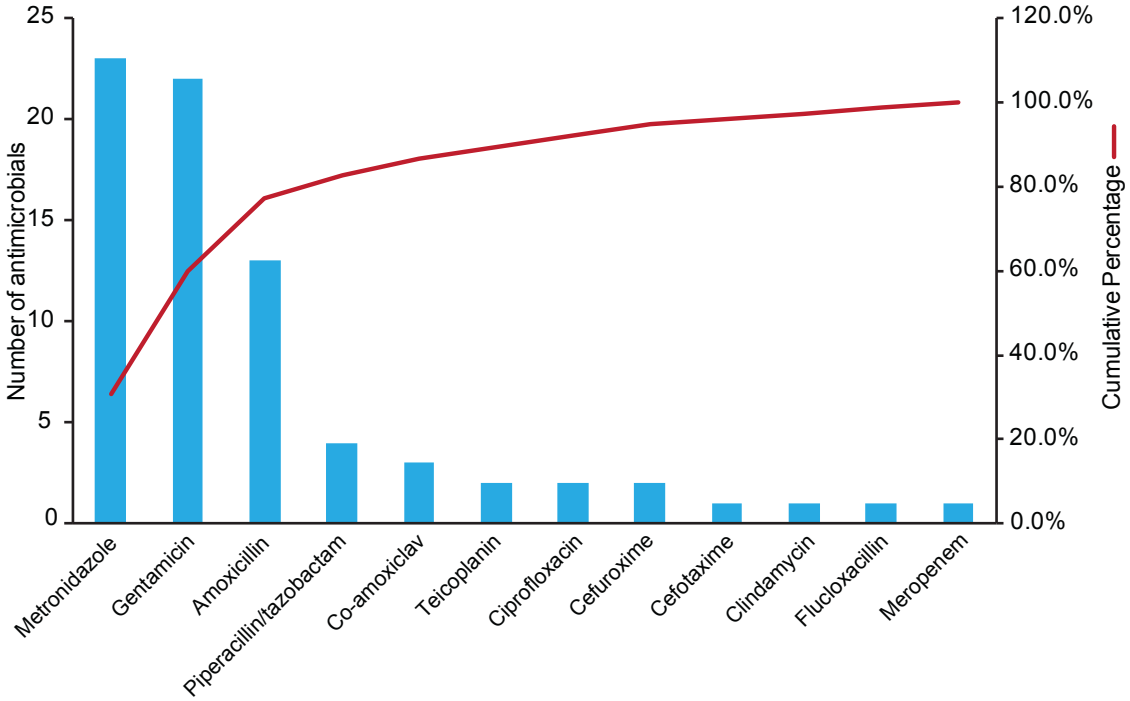


Table A53: Number and percentage distribution of antimicrobials prescribed for medical prophylaxis in acute adult inpatients (including independent hospital inpatients) in 2016, by infection type

Infection type	Antimicrobials	
	N	%
General medical, not directed at a specific site	161	51.9
Respiratory	49	15.8
Urinary tract	47	15.2
Gastrointestinal	30	9.7
Cystic fibrosis	6	1.9
Obstetric or gynaecological	4	1.3
Ear, nose or throat	4	1.3
Skin and soft tissue	1	0.3
Eye	1	0.3
Not recorded	7	2.3
Total	**310**	**100.0**

Table A54: Number and percentage distribution of antimicrobials prescribed for medical prophylaxis in acute adult inpatients (including independent hospital inpatients) in 2016, by antimicrobial

Antimicrobial name	Antimicrobials	
	N	%
Co-trimoxazole	56	18.1
Azithromycin	39	12.6
Ciprofloxacin	23	7.4
Rifaximin	22	7.1
Fluconazole	21	6.8
Posaconazole	19	6.1
Trimethoprim	18	5.8
Nitrofurantoin	17	5.5
Cefalexin	13	4.2
Phenoxymethylpenicillin	13	4.2
Erythromycin	8	2.6
Amoxicillin	7	2.3
Nystatin	7	2.3
Co-amoxiclav	6	1.9
Clarithromycin	5	1.6
Metronidazole	5	1.6
Colistin	3	1.0
Doxycycline	3	1.0
Flucloxacillin	3	1.0
Amphotericin B	2	0.6
Cefradine	2	0.6
Gentamicin	2	0.6
Isavuconazole	2	0.6
Isoniazid	2	0.6
Lymecycline	2	0.6
Piperacillin/tazobactam	2	0.6
Voriconazole	2	0.6
Cefazolin	1	0.3
Clindamycin	1	0.3
Meropenem	1	0.3
Oxytetracycline	1	0.3
Rifampicin	1	0.3
Teicoplanin	1	0.3
Total	**310**	**100.0**

Table A55: Number and percentage distribution of antimicrobials prescribed for medical prophylaxis in paediatric inpatients in 2016, by infection type

Infection type	Antimicrobials	
	N	%
General medical, not directed at a specific site.	46	56.1
Respiratory	13	15.9
Completely undefined, site with no systemic inflammation	8	9.8
Urinary tract	7	8.5
Gastrointestinal	2	2.4
Cystic fibrosis	2	2.4
Central nervous system	1	1.2
Not recorded	3	3.7
Total	**82**	**100.0**

Table A56: Number and percentage distribution of antimicrobials prescribed for medical prophylaxis in paediatric inpatients in 2016, by antimicrobial

Antimicrobial name	Antimicrobials	
	N	%
Co-trimoxazole	19	23.2
Benzylpenicillin	11	13.4
Gentamicin	10	12.2
Azithromycin	8	9.8
Trimethoprim	5	6.1
Fluconazole	4	4.9
Nystatin	4	4.9
Amphotericin B	3	3.7
Flucloxacillin	3	3.7
Caspofungin	2	2.4
Ciprofloxacin	2	2.4
Posaconazole	2	2.4
Cefalexin	1	1.2
Ceftazidime	1	1.2
Co-amoxiclav	1	1.2
Colistin	1	1.2
Metronidazole	1	1.2
Nitrofurantoin	1	1.2
Phenoxymethylpenicillin	1	1.2
Piperacillin/tazobactam	1	1.2
Vancomycin	1	1.2
Total	**82**	**100.0**

Table A57: Number and percentage distribution of antimicrobials prescribed for medical prophylaxis in non-acute inpatients in 2016, by infection type

Infection type	Antimicrobials	
	N	%
Urinary tract	16	50.0
General medical, not directed at a specific site.	6	18.8
Respiratory	4	12.5
Gastrointestinal	3	9.4
Not recorded	3	9.4
Total	**32**	**100.0**

Table A58: Number and percentage distribution of antimicrobials prescribed for medical prophylaxis in non-acute inpatients in 2016, by antimicrobial

Antimicrobial name	Antimicrobials	
	N	%
Nitrofurantoin	9	28.1
Trimethoprim	8	25.0
Azithromycin	3	9.4
Cefalexin	2	6.3
Ciprofloxacin	2	6.3
Lymecycline	2	6.3
Phenoxymethylpenicillin	2	6.3
Rifaximin	2	6.3
Gentamicin	1	3.1
Oxytetracycline	1	3.1
Total	**32**	**100.0**

References

1 World Health Organization. Report on the Burden of Endemic Health Care-Associated Infection Worldwide. Geneva: WHO; 2011. Available from: http://www.who.int/gpsc/country_work/burden_hcai/en/

2 European Centre for Disease Prevention and Control. Point prevalence survey of healthcare-associated infection and antimicrobial use in European acute care hospitals 2011- 2012. Stockholm: ECDC; 2013. Available from: http://www.ecdc.europa.eu/en/publications/Publications/healthcare-associated-infections-antimicrobial-use-PPS.pdf

3 Health Protection Scotland. Scottish National Point Prevalence Survey of Healthcare Associated Infection and Antimicrobial Prescribing 2011. Glasgow: HPS; 2012. Available from: http://www.hps.scot.nhs.uk/haiic/sshaip/resourcedetail.aspx?id=732

4 Health Protection Scotland. Healthcare Associated Infection Annual Report 2013. Glasgow: HPS; 2014. Available from: http://www.hps.scot.nhs.uk/haiic/sshaip/resourcedetail.aspx?id=1719

5 Harbarth S, Sax H, Gastmeier P. The preventable proportion of nosocomial infections: an overview of published reports. J Hosp Infect 2003;54(4):258-66.

6 Reilly J, Stewart S, Allardice G, Cairns S, Ritchie L, Bruce J. Evidence-based infection control planning based on national healthcare-associated infection prevalence data. Infect Control Hosp Epidemiol 2009

7 Health Protection Scotland. NHS Scotland National HAI Prevalence Survey. Final Report 2007. Glasgow: HPS; 2007.

8 European Centre for Disease Prevention and Control. Point prevalence survey of healthcare associated infections and antimicrobial use in European acute care hospitals 2011-2012. Stockholm: ECDC; 2013. Available from: http://www.ecdc.europa.eu/en/publications/Publications/healthcare-associated-infections-antimicrobial-use-PPS.pdf

9 Scottish Government Chief Nursing Directorate. Healthcare Associated Infection (HAI) and Antimicrobial Resistance (AMR) Policy Requirements. DL(2015)19. Edinburgh: Scottish Government; 2015. Available from: www.sehd.scot.nhs.uk/dl/DL(2015)19.pdf

10 European Centre for Disease Prevention and Control. Point prevalence survey of healthcare associated infections and antimicrobial use in European acute care hospitals. Protocol version 5.2. Stockholm: ECDC; 2016.

11 Health Protection Scotland. Point Prevalence Survey of Healthcare Associated Infection and Antimicrobial Prescribing 2016: Protocol for the collection of patient and ward level data. Glasgow: HPS; 2016.

12 Information Services Division. Hospital Classification. Edinburgh: ISD; 2016.

13 McCabe WR, Jackson GG. Gram-negative bacteremia. I. Etiology and ecology. Arch Intern Med 1962;110(6):847-55.

14 Centers for Disease Control and Prevention. Surgical Site Infection Event Protocol, January 2017. Atlanta: CDC; 2017.

15 Information Services Division. Number of whole time equivalent (WTE) registered nurses for all Acute and Non-Acute NHS hospitals in Scotland by Qualified and Unqualified, in post 30th June 2016. Edinburgh: ISD; 2016.

16 Information Services Division. Average available staffed beds, total occupied bed days for acute and all specialties and number of admissions and discharges by hospital, 2015/16. Edinburgh: ISD; 2016.

17 Information Services Division. Number of admissions and discharges by hospital, 2015/16. Edinburgh: ISD; 2016.

18 Health Protection Scotland. Point Prevalence Survey of Healthcare Associated Infection and Antimicrobial Prescribing 2016: Protocol for the collection of NHS hospital indicator data. Glasgow: HPS; 2016.

19 Spiegelhalter DJ. Funnel plots for comparing institutional performance. Stat Med 2005;24(8):1185-202.

20 Health Protection Scotland. Point Prevalence Survey of Healthcare Associated Infection and Antimicrobial Prescribing 2016: Validation Protocol. Glasgow: HPS; 2016.

21 European Centre for Disease Prevention and Control. Point prevalence survey of healthcare associated infections and antimicrobial use in European acute care hospitals. PPS Validation Protocol Version 3.1. Stockholm: ECDC; 2015.

22 Scottish Government. Route Map to the 2020 Vision for Health and Social Care. SGHSCD 2017. Edinburgh: Scottish Government; 2017. Available from: http://www.gov.scot/Topics/Health/Policy/Quality-Strategy/routemap2020vision

23 Cassini A, Plachouras D, Eckmanns T, Abu Sin M, Blank H, Ducomble T, et al. Burden of Six Healthcare-Associated Infections on European Population Health: Estimating Incidence-Based Disability-Adjusted Life Years through a Population Prevalence-Based Modelling Study. LoS Med 2016 Oct 18;13(10):1-16.

24 World Health Organization. Global Action Plan on Antimicrobial Resistance. WHO 2015. Available from: http://www.who.int/antimicrobial-resistance/publications/global-action-plan/en/

25 Health Protection Scotland. Healthcare Associated Infection Annual Report 2013. Glasgow: HPS; 2014. Available from: http://www.hps.scot.nhs.uk/haiic/sshaip/resourcedetail.aspx?id=1719

26 National Records of Scotland. Mid-Year Population Estimates Scotland, Mid-2016. Edinburgh: NRS; 2017 Available from: www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-estimates/mid-year-population-estimates/mid-2016

27 National Records of Scotland. Projected Population of Scotland (2014-based). Edinburgh: NRS; 2015 Available from: https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-projections/population-projections-scotland/2014-based

28 Parker SG, Fadayevatan R, Lee SD. Acute hospital care for frail older people. Age Ageing 2006;35(6):551-2.

29 Strausbaugh LJ. Emerging health care-associated infections in the geriatric population. Emerg Infect Dis 2001;7(2):268-71.

30 Paillaud E, Herbaud S, Caillet P, Lejonc JL, Campillo B, Bories PN. Relations between undernutrition and nosocomial infections in elderly patients. Age Ageing 2005;34(6):619-25.

31 Vincent J, Rello J, Marshall J. International study of the prevalence and outcomes of infection in intensive care units. JAMA 2009;302(21):2323-9.

32 Health Protection Scotland. National Infection Prevention and Control Manual. Glasgow: HPS; 2017 Available from: http://www.nipcm.hps.scot.nhs.uk/

33 Health Protection Scotland. Bundle for preventing infection when inserting and maintaining a urinary catheter (acute settings). Glasgow: HPS;2014. Available from: http://www.hps.scot.nhs.uk/haiic/ic/resourcedetail.aspx?id=653

34 Health Protection Scotland. Bundle for preventing catheter associated urinary tract infections in community settings. Glasgow: HPS; 2014. Available from: http://www.hps.scot.nhs.uk/news/newsdetail.aspx?id=20565

35 Gould CV, Umscheid CA, Agarwal RK, Kuntz G, Pegues DA. Guideline for prevention of catheter-associated urinary tract infections 2009. Infect Control Hosp Epidemiol 2010; 31(4):319-26.

36 Health Protection Scotland. Urinary Catheter Care Passport. Glasgow: HPS; 2017. Available from: http://www.hps.scot.nhs.uk/pubs/detail.aspx?id=3234

37 McCabe WR, Jackson GG. Gram-negative bacteraemia. Etiology and ecology. Arch Intern Med 1962;110:845.

38 Scottish Intensive Care Society Audit Group. VAP Prevention Bundle: Guidance for Implementation. Edinburgh: SICSAG; 2008. Available from: http://www.sicsag.scot.nhs.uk/hai/care.html

39 Passaro L, Harbarth S, Landelle C. Prevention of hospital-acquired pneumonia in non-ventilated adult patients: a narrative review. Antimicrob Resist Infect Control 2016 14; (5):43-54.

40 National Institute for Health and Care Excellence. Pneumonia in adults: diagnosis and management. Londond: NICE; 2014. Available from: https://www.nice.org.uk/guidance/cg191

41 Health Protection Scotland. Healthcare Associated Infections in European Long Term Care Facilities (HALT). Prevalence Study 2010 in Scotland. Glasgow: HPS; 2011. June [cited 2017 May 2];Available from: http://www.hps.scot.nhs.uk/haiic/sshaip/resourcedetail.aspx?id=221

42 World Health Organization. Global Guidelines for the Prevention of Surgical Site Infection. Geneva: WHO; 2016. Available from: http://www.who.int/gpsc/ssi-prevention-guidelines/en/

43 Public Health England. Surveillance of surgical site infections in NHS hospitals in England 2015/16. London: PHE; 2016. Available from: https://www.gov.uk/government/publications/surgical-site-infections-ssi-surveillance-nhs-hospitals-in-england

44 Health Protection Scotland. Bundle for preventing surgical site infections. Glasgow: HPS; 2015. Available from: http://www.hps.scot.nhs.uk/haiic/ic/resourcedetail.aspx?id=663

45 Healthcare Improvement Scotland. Prevention and Management of Pressure Ulcers Standards. Glasgow: HIS; 2016. Available from: http://www.healthcareimprovementscotland.org/his/idoc.ashx?docid=ba35a1fc-b390-4f70-893e-3ab5eaf93c37&version=-1

46 Abernethy JK, Johnson AP, Guy R, Hinton N, Sheridan EA, Hope RJ. Thirty day all-cause mortality in patients with Escherichia coli bacteraemia in England. Clin Microbiol Infect. 2015;21(3): 251e1-e8.

47 Goto M, Al-Hasan MN. Overall burden of bloodstream infection and nosocomial bloodstream infection in North America and Europe. Clin Microbiol Infect 2013;19(6):501-509.

48 Kate H, Nicholas G. Economic Evaluation and Catheter-related Bloodstream Infections. J Emerg Infect Dis 2007;13(6):815.

49 Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. J Antimicrob Agents 2009;34:S38-42.

50 Health Protection Scotland. Bundle for preventing infection when inserting and maintaining a Central Venous Catheter (CVC) v2.0. Glasgow: HPS; 2014. Available from: http://www.hps.scot.nhs.uk/haiic/ic/resourcedetail.aspx?id=659

51 Health Protection Scotland. Bundle for preventing infection when inserting and mainting a Peripheral Venous Catheter (PVC) v2. Glasgow: HPS; 2014. Available from: http://www.hps.scot.nhs.uk/haiic/ic/resourcedetail.aspx?id=660

52 Scottish Government. Next Steps for Acute Adult Safety- Patient Safety Essentials and Safety Priorities. CEL (2013)19. Edinburgh: Scottish Government; 2013. Available from: http://www.sehd.scot.nhs.uk/mels/CEL2013_19.pdf

53 Zingg W, Hopkins S, Gayet-Ageron A, Holmes A, Sharland M, Suetens C, et al. Health-care-associated infections in neonates, children, and adolescents: an analysis of paediatric data from the European Centre for Disease Prevention and Control point-prevalence survey. Lancet Infect Dis 2017; 17(4):381-389.

54 Scottish Intensive Care Society Audit Group. Audit of Critical Care in Scotland 2016 Report. Edinburgh: SICSAG; 2016. Available from: http://www.sicsag.scot.nhs.uk/Publications/Main.htm

55 Djordjevic ZM, Markovic-Denic L, Folic MM, Igrutinovic Z, Jankovic SM. Health care acquired infections in neonatal intensive care units: Risk factors and etiology. Am J Infect Control 2015;43(1):86-88.

56 Gadallah MAH, Fotouh AMA, Habil IS, Imam SS, Wassef G. Surveillance of health care-associated infections in a tertiary hospital neonatal intensive care unit in Egypt: 1-year follow-up. Am J Infect Control 2014; 42(11):1207-1211

57 Rozanska A, Wojkowska-Mach J, Adamski P, Borszewska-Kornacka M, Gulczynska E, Nowiczewski M, et al. Infections and risk-adjusted length of stay and hospital mortality in Polish Neonatology Intensive Care Units. Int J Infect Dis 2015;35:e87-e92.

58 Health Protection Scotland. Healthcare Associated Infection Annual Report 2016. Glasgow: HPS; 2017. Available from: http://www.hps.scot.nhs.uk/pubs/detail.aspx?id=3213

59 Scottish Government. Chief Medical Officer for Scotland Annual Report 2015/16. Realising Realistic Medicine. Edinburgh: Scottish Government; 2017. Available from: http://www.gov.scot/Publications/2017/02/3336

60 Peleg AY, Hooper DC. Hospital-acquired infections due to gram-negative bacteria. N Engl J Med 2010;362(19):13.

61 Health Protection Scotland. Scottish UTI Network (SUTIN). Glasgow: HPS; 2017. Available from: http://www.hps.scot.nhs.uk/haiic/sutin.aspx

62 Wilson APR, Livermore DM, Otter JA, Warren RE, Jenks P, Enoch DA, et al. Prevention and control of multi-drug-resistant Gram-negative bacteria: recommendations from a Joint Working Party. J Hosp Infect 2016;92:S1-S44.

63 Health Protection Scotland. Toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae in Scottish acute setting. Glasgow: HPS; 2016. Available from: http://www.hps.scot.nhs.uk/haiic/amr/publicationsdetail.aspx?id=55186

64 Scottish Government. Carbapenemase-producing Enterobacteriaceae (CPE) policy requirement. DL(2017)04. Edinburgh: Scottish Government; 2017. Available from: http://www.sehd.scot.nhs.uk/dl/DL(2017)02.pdf

65 Reilly JS, Stewart S, Christie P, Allardice GM, Stari T, Matheson A, et al. Universal screening for meticillin-resistant *Staphylococcus aureus* in acute care: risk factors and outcome from a multicentre study. J Hosp Infect 2012;80(1):31-5.

66 Scottish Government Health Department. MRSA Key Performance Indicators. CNO(2013)01. Edinburgh: Scottish Government; 2013. Available from: http://www.sehd.scot.nhs.uk/cmo/CNO(2013)01.pdf

67 Public Health England. UK Five Year Antimicrobial Resistance Strategy 2013 to 2018. London: PHE; 2013. Available from: https://www.gov.uk/government/publications/uk-5-year-antimicrobial-resistance-strategy-2013-to-2018

68 Malcolm W, Nathwani D, Davey P, Cromwell T, Patton A, Reilly J, et al. From intermittent antibiotic point prevalence surveys to quality improvement: experience in Scottish hospitals. Antimicrob Resist Infect Control 2013;2(1):3-12.

69 Scottish Antimicrobial Prescribing Group. Local Surveillance of Antimicrobial Use. Glasgow: SMC; 2014. Available from: https://www.scottishmedicines.org.uk/files/sapg1/Local_surveillance_framework_for_antimicrobial_use_2015.pdf

70 Health Protection Scotland and Information Services Division. Scottish Antimicrobial Use and Resistance in Humans in 2015. Glasgow: HPS; 2016. Available from: http://www.hps.scot.nhs.uk/haiic/amr/resourcedetail.aspx?id=2055

71 Health Protection Network. Guidance on Prevention and Control of Clostridium difficile Infection (CDI) in Care Settings in Scotland. Glasgow: HPS; 2014. Available from: http://www.hps.scot.nhs.uk/haiic/sshaip/resourcedetail.aspx?id=184

72 Scottish Antimicrobial Prescribing Group. Good Practice Recommendations for Hospital Antimicrobial Stewardship in NHSScotland. Glasgow: SMC; 2016. Available from: http://www.scottishmedicines.org.uk/files/sapg/Good_practice_recommendations_for_hospital_antimicrobial_stewardship_December_2016.pdf

73 Scottish Government Health Department. A revised framework for national surveillance of healthcare associated infection and the introduction of a new health efficiency and access to treatment (HEAT) target for *Clostridium difficile* Associated Disease (CDAD) for NHS Scotland. CEL(2009)11. Edinburgh: Scottish Government; 2009. Available from: http://www.sehd.scot.nhs.uk/mels/CEL2009_11.pdf

74 Scottish Antimicrobial Prescribing Group. CDI HEAT Target supporting prescribing indicator: Revised Measures 2015-16. Glasgow: SMC; 2015. Available from: http://www.scottishmedicines.org.uk/SAPG

75 Scottish Government. Revised Antibiotic Prescribing Indicators. CMO(2011)5 . Edinburgh: Scottish Government; 2011. Available from: http://www.sehd.scot.nhs.uk/cmo/CMO(2011)05.pdf

76 Scottish Intercollegiate Guidelines Network. SIGN 104. Antibiotic prophylaxis in surgery. Edinburgh: SIGN; 2014. Available from: http://www.sign.ac.uk/guidelines/fulltext/104/index.html

77 Scottish Antimicrobial Prescribing Group. Good Practice Recommendations for Surgical and Procedural Antibiotic Prophylaxis in Adults in NHSScotland. Glasgow: SMC; 2016. Available from: https://www.scottishmedicines.org.uk/files/sapg/Good_practice_recommendations_for_surgical_prophylaxis_October_2016.pdf.

78 Public Health England. Start Smart- Then Focus. Antimicrobial stewardship toolkit for English hospitals. London: PHE; 2015. Available from: https://www.gov.uk/government/publications/antimicrobial-stewardship-start-smart-then-focus

79 Public Health England. English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) Report 2016. London: PHE; 2016. Available from: https://www.gov.uk/government/publications/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur-report

80 Public Health England. Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infection (ARHAI): 4th Annual Report, February 2012 - March 2013 . London: PHE; 2013. Available from: https://www.gov.uk/government/publications/advisory-committee-on-antimicrobial-resistance-and-healthcare-associated-infections-annual-reports

81 Scottish Antimicrobial Prescribing Group. Position paper on optimising antimicrobial prescribing in possible or suspected infections due to multi-drug resistant Gram negative bacteria. Glasgow: SMC; 2016. Available from: www.scottishmedicines.org.uk/files/sapg1/Position_paper_to_Optimise_Antimicrobial_Prescribing_in_MDRGNB.pdf

82 Rhodes A, Evans L, Alhazzani W. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. Intensive Care Med 2017 Jan 18;45(3):304-77.

83 Zingg W, Holmes A, Dettenkofer M, Goetting T, Secci F, Clack L, et al. Hospital organisation, management, and structure for prevention of health-care-associated infection: A systematic review and expert consensus. Lancet Infect Dis 2015;15(2):212-224

84 World Health Organization. Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level. Geneva: WHO; 2016. Available from: http://www.who.int/gpsc/ipc-components/en/

85 European Centre for Disease Prevention and Control. Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals - protocol version 5.3. Stockholm: ECDC; 2015. Available from: http://ecdc.europa.eu/en/healthtopics/Healthcare-associated_infections/point-prevalence-survey/Pages/Point-prevalence-survey.aspx

86 Healthcare Improvement Scotland. Scottish Patient Safety Programme. Glasgow: HIS; 2017. Available from: http://www.patientsafetyalliance.scot.nhs.uk/programme/

87 Health Protection Scotland. Compendium of Healthcare Associated Infection Guidance v6.0. Glasgow: HPS; 2017. Available from: http://www.hps.scot.nhs.uk/haiic/resourcedetail.aspx?id=104

88 Information Services Division. Annual trends in available beds by NHS Board of treatment and hospital. Edinburgh: ISD; 2016. Available from: http://www.isdscotland.org/Health-Topics/Hospital-Care/Beds/

89 Information Services Division. Average length of stay in hospital, by admission type and specialty, Scotland. Edinburgh: ISD; 2016. Available from: http://www.isdscotland.org/Health-Topics/Hospital-Care/Inpatient-and-Day-Case-Activity/

90 Information Services Division. Number of whole time equivalent (WTE) registered nurses for all Acute and Non-Acute NHS hospitals in Scotland by Qualified and Unqualified, in post 30th June 2016. Edinburgh: ISD; 2016.

91 Infection Prevention Society. Outcome competences for practitioners in infection prevention and control. J Infect Prev 2011;12(2):67-90.

92 Scottish Health Protection Network, Scottish Government. Management of Public Health Incidents. Guidance on the Roles and Responsibilities of NHS led Incident Management Teams. Edinburgh: Scottish Government; 2013 July. Available from: http://www.gov.scot/Publications/2013/08/6455

93 Healthcare Improvement Scotland. Healthcare Associated Infection (HAI) Standards. Glasgow: HIS; 2015. Available from: http://www.healthcareimprovementscotland.org/our_work/inspecting_and_regulating_care/hei_policies_and_procedures/hai_standards_2015.aspx

94 Stiller A, Salm F, Bischoff P, Gastmeier P. Relationship between hospital ward design and healthcare-associated infection rates: A systematic review and meta-analysis. Antimicrob Resist Infect Control 2016;5(1):51-61.

95 Scottish Government. Provision of Single Room Accommodation and Bed Spacing. CEL 48 (2008). Edinburgh: Scottish Government; 2008. Available from: www.sehd.scot.nhs.uk/mels/CEL2008_48.pdf

96 World Health Organization. WHO Guidelines on Hand Hygiene in Health Care. Geneva: WHO; 2009. Available from: http://www.who.int/gpsc/5may/tools/9789241597906/en/

97 Pollack LA, Plachouras D, Sinkowitz-Cochran R, Gruhler H, Monnet DL, Weber J. A Concise Set of Structure and Process Indicators to Assess and Compare Antimicrobial Stewardship Programs Among EU and US Hospitals: Results From a Multinational Expert Panel. Infection Control & Hospital Epidemiology 2016; 37(10): 1201-1211.

98 Scottish Government. Prudent Antimicrobial Prescribing: The Scottish Action Plan for Managing Antibiotic Resistance and Reducing Antibiotic Related *Clostridium difficile* Associated Disease. CEL 30 (2008). Edinburgh: SEHD; 2008. Available from: www.sehd.scot.nhs.uk/mels/CEL2008_30.pdf

99 Public Health England, NHS Improvment. Preventing healthcare associated Gram-negative bloodstream infections: an improvement resource. London: PHE; 2017. Available from: https://improvement.nhs.uk/resources/preventing-gram-negative-bloodstream-infections/

100 Healthcare Improvement Scotland. Food, Fluid and Nutritional Care Standards. Glasgow: HIS; 2014. Available from: http://www.healthcareimprovementscotland.org/our_work/patient_safety/improving_nutritional_care/nutritional_care_standards.aspx