Northern Ireland Point Prevalence Survey of Hospital Associated Infections and Antimicrobial Use

2017

HSC Public Health Agency

Acknowledgements

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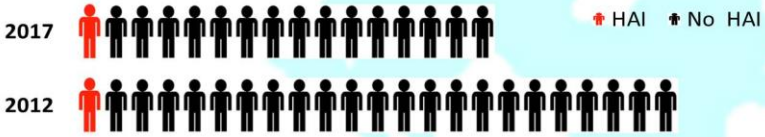
Glossary

AM	Antimicrobial
AMU	Antimicrobial use
AMR	Antimicrobial resistance
BSI	Bloodstream infection
CAUTI	Catheter-associated urinary tract infection
CDC	Centers for Disease Control and Prevention
CDI	*Clostridium difficile* Infection
CI	Confidence interval
CNS	Central nervous system
CVC	Central vascular catheter
CVS	Cardiovascular system
DoH	Department of Health
DHSSPS	Department of Health, Social Services and Public Safety
ECDC	European Centre for Disease Prevention and Control
ENT	Ear, nose, throat
ESAC	European Surveillance of Antimicrobial Consumption
ESBL	Extended spectrum beta-lactamase
GI	Gastrointestinal infection
HELICS	Hospitals in Europe Link for Infection Control through Surveillance
HAI	Hospital associated infection
HIS	Healthcare Infection Society
HSCB	Health and Social Care Board
HPSC	Health Protection Surveillance Centre
IPCN	Infection prevention and control nurse
ICU	Intensive care unit
IPSE	Improving Patient Safety in Europe
KISS	Krankenhaus Infektions Surveillance System (German)
LRTI	Lower respiratory tract infection other than pneumonia
MRSA	Meticillin resistant *Staphylococcus aureus*
MSSA	Meticillin sensitive *Staphylococcus aureus*
NHSN	National Healthcare Safety Network
NNIS	National Nosocomial Infection Surveillance
PHA	Public Health Agency
PPS	Point Prevalence Survey
PVC	Peripheral vascular catheter
SSI	Surgical site infection
UC	Urinary catheter
UTI	Urinary tract infection
VAP	Ventilator-associated pneumonia

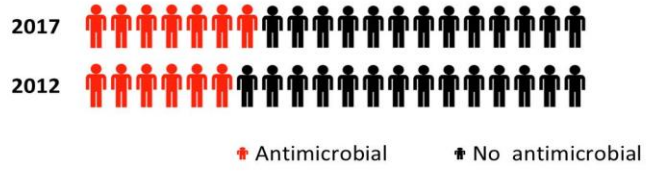
Executive Summary

The composition of inpatients was older, 55.5% over 65 years compared with 50.9% in 2012. In addition, a larger group of patients was classified as seriously ill in 2017 (5.4% v 2.9%)

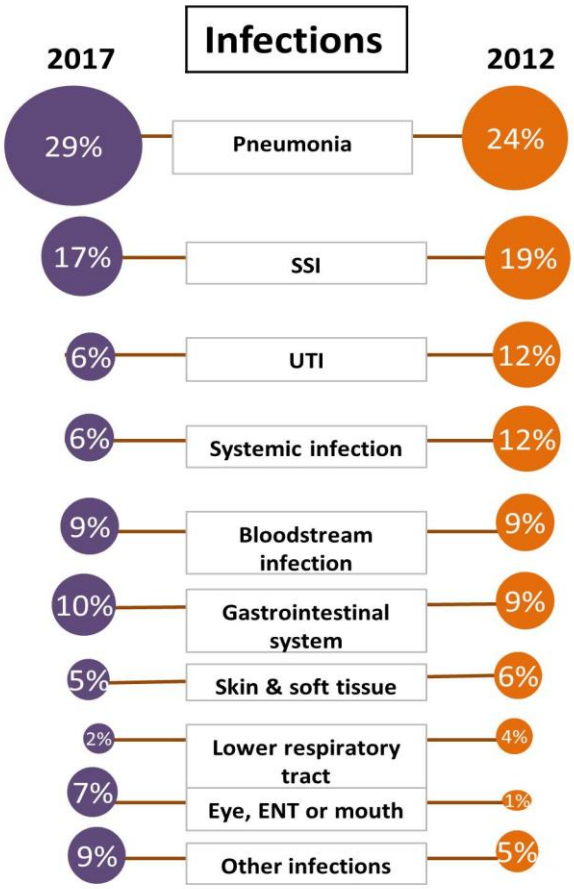
A larger proportion of patients had an infection. Approximately 1 in 16 acute inpatients had a healthcare acquired infection. The comparable figure in 2012 was 1 in 23 inpatients

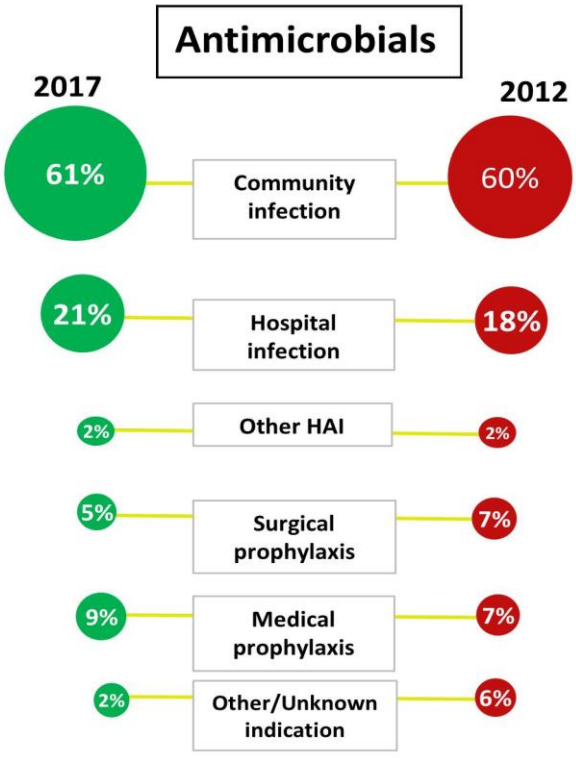


A larger proportion of patients were receiving antimicrobials. Approximately 6 in 20 acute inpatients received one or more antimicrobials in 2012, the comparable proportion rose to 7 in 20 in 2017



The distribution of HAI showed that the most common HAI were: pneumonia (29%), surgical site infection (17%) and gastrointestinal infection (10.4%) . There was a notable decline in the proportion of urinary tract infections





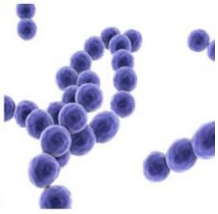
The proportion of medical devices in use between 2012 and 2017 was similar for central vascular catheters (1 in 20), intubation (1 in 50) and urinary catheter (1 in 6) but was higher for peripheral vascular catheter, 52.8%

As in 2012 all sixteen acute hospitals participated in the PPS survey in 2017. The most common healthcare associated infections were: pneumonia (29%), surgical site infection (17%), gastrointestinal infection (10.4%), bloodstream infection (8.7%), urinary tract infection (6.2%) and systemic infection (6.2%).

The proportion of paediatric patients included in the survey was 8.5%, which was similar to 2012, although there was a fall in those aged between 1 and 23 months. The proportion of neonates was similar at 4.4%. The number of HAI reported in neonates was greater, at 8.3%, compared to the previous study when it was 1.6%.

The highest prevalence of antimicrobial prescribing was in adult ICU, where 64.9% of patients received antimicrobials, an increase of almost ten percentage points since 2012. This was followed by mixed specialty wards and medical wards, where 50.8% and 40.6% of patients respectively received antimicrobials.

Gram-positive cocci accounted for 37.3% of all microorganisms, with the largest proportion being *Staphylococcus aureus* 18.6% and *Enterococcus spp* 9.8%. Gram-negative Enterobacteriaceae accounted for 35.3% - the largest proportion being *Escherichia coli* 20.6%.



Overall, 11.7% of prescribed antimicrobials were not compliant with local guidelines and significant proportions were prescribed off guideline including; co-amoxiclav (28.4%), meropenem (10.7%), and piperacillin/tazobactam (15.5%). The majority of antimicrobials were delivered parenterally (63%).

The majority of hospitals reported having an active review of antimicrobial prescribed after 72 hours, but this was restricted to patients in ICU and other selected wards.

ANTIBIOTIC GUARDIAN

The most common reason for antimicrobial prescribing was for infections considered to be community acquired. There were 861 patients treated for community acquired infection or 22.6% of the hospital population. Treatment of community acquired infection accounted for 60.6% of all prescribed antimicrobials. Surgical prophylaxis and medical prophylaxis accounted for 5.3% and 8.9% of all antimicrobials respectively.

Key results

Prevalence of HAI

The 2017 point prevalence survey of hospital associated infections and antimicrobial consumption in Northern Ireland included all sixteen acute hospitals and 3,813 patients. The overall HAI prevalence was 6.1% (95%CI 5.4 – 6.9).

Comparable rates of hospital associated infections in Europe and UK		
Country	**HAI prevalence 2011/12**	**HAI prevalence 2016/17**
Europe – ECDC PPS	6.0 (5.9 – 6.1)	To be published
England (Acute) (1)	6.5 (4.8 – 8.8)	To be published
Scotland (Acute) (2) (3)	4.9 (4.4 – 5.4)	4.5 (4.0 – 5.0)
Wales (Acute) (4) (5)	4.3 (3.8 – 4.8)	5.5 (5.0 – 6.1)
Northern Ireland (6)	4.2 (3.6 – 4.8)	6.1 (5.4 – 6.9)

The most commonly identified HAIs were pneumonia (29% of all HAI), followed by surgical site infection (17%), gastrointestinal infection (10.4%), bloodstream infections (8.7%), urinary tract infection (6.2%) and systemic infection (6.2%).

Overall the prevalence of urinary catheter and central vascular catheter use has not changed since 2012. However, when similar survey populations were compared, the use of peripheral vascular catheters was significantly higher in 2017 than in either 2006 or 2012.

Gram-positive cocci accounted for 37.3% of all microorganisms, with the largest proportion being *Staphylococcus aureus* 18.6% and *Enterococcus spp* 9.8%. Gram-negative Enterobacteriaceae accounted for 35.3% - the largest proportion being *Escherichia coli* 20.6%.

As in the 2012 PPS, the proportion of MRSA identified in 2017 was very low (< 0.1%) maintaining the decrease from the PPS in 2006. *Clostridium difficile* accounted for 16.7% of all microorganisms reported. When similar survey populations were compared, *Clostridium difficile* prevalence remained around 0.3% of the patient population surveyed, similar to 2012 and lower than 1% identified in 2006.

Prevalence of antimicrobial use

The overall prevalence of antimicrobial use was 36.3% (95%CI 34.8 – 37.9). The highest antimicrobial use (64.9%) was reported in adult intensive care units (ICUs) followed by mixed specialty (50.8%) and medical specialty (40.6%) wards. The prevalence of antimicrobial use in paediatrics was (31.3%).

The most common indication for antimicrobial prescribing was for community acquired infections - 22.6% (95%CI; 21.3-23.9) of all patients; 60.6% of all prescribed antimicrobials. Overall 8.1% (95%CI; 7.2-9.0) patients were prescribed antimicrobials specifically for hospital associated infection. Prophylaxis accounted for 14.2% of all antimicrobials (5.3% surgical prophylaxis, 8.9% medical prophylaxis).

Overall, 11.7% of prescribed antimicrobials were not compliant with local guidelines, and significant proportions were prescribed off guideline including co-amoxiclav (28.4%), meropenem (10.7%), and piperacillin/tazobactam (15.5%).

The majority of antimicrobials were delivered parenterally (63%), and there was limited evidence of adoption of a formal 72 hour review of antimicrobial treatment.

Comparable rates of antimicrobial use in Europe and UK		
Country	**AMU prevalence 2011/12**	**AMU prevalence 2016/17**
Europe – ECDC PPS	35.0 (34.8 – 35.2)	To be published
England (Acute) (1)	34.3 (30.1 – 39.2)	To be published
Scotland (Acute) (2) (3)	32.3 (30.9 – 33.8)	35.3 (33.8 – 36.7)
Wales (Acute) (4) (5)	32.7 (31.6 – 33.9)	34.2 (33.0 – 35.3)
Northern Ireland (6)	29.5 (28.1 – 30.9)	36.3 (34.8 – 37.9)

Priorities

Summary of HAI priorities

1. Explore feasibility for scoping and implementing a project aimed at reducing the burden of non-ventilator associated pneumonia.
2. Continued emphasis on education and training of clinical staff on methods for improvement and prevention of HAI, with particular emphasis on learning tools for prevention of healthcare associated pneumonia and LRTI.
3. Consideration should be given to the development of methodologies to support standardised incidence surveillance of respiratory tract infections and clinical sepsis most commonly reported in the hospital context.
4. Continue to promote evidence based practice to reduce surgical site infection across surgical specialties (WHO bundle compliance, application of NICE and CDC guidelines as well as other relevant guidance).
5. Given an increased rate of surgical site infection observed in this survey, a review and validation of the case ascertainment and reporting arrangements in the current SSI surveillance programmes (caesearean section, orthopaedic, cardiac and neurosurgery) is recommended.
6. The future SSI surveillance arrangements should consider the need for improved methodology for the SSI incidence surveillance programme with a view to developing more efficient systems for data collection.
7. The requirement for potential extension of the SSI surveillance programme into other speciality/procedure areas should be taken forward in collaboration with relevant stakeholders.
8. Continue to focus on a programme to reduce overall use of urinary catheters and ensure best practice for management of catheters *in situ*.

9. Further investigation is required to examine the PPS findings related to increasing oral cavity infections, and infections in paediatrics and mixed specialty hospital wards.

Summary of Device Use priorities

1. Continue to promote awareness of the presence of invasive devices as a significant risk factor for development of HAI in the hospital setting by strengthening the implementation of high impact interventions such as care bundles. Countinued emphasis on education and training of clinical staff responsible for insertion and maintenance of invasive devices, including the regular assessment of competency of clinical staff and the use of hand hygiene/care bundles.
2. Emphasis should be on maintaining the current ICU incidence surveillance programme, validating data reported on, Ventilator Associated Pneumonia (VAP), Central Line Associated Blood Stream Infection (CLABSI) and Catheter Associated Urinary Tract Infection (CAUTI), and continue to ensure that units are recording data accurately and using it for quality improvement and benchmarking against other regions.
3. In wards where the prevalence of patients with a peripheral vascular catheter was high, a review should be considered with a view to developing interventions that ensure appropriate use and maintenance of peripheral lines including line reviews.

Summary of Microbiology priorities

1. Continued focus on the importance of developing appropriate regional and local capacity to monitor antimicrobial use and antimicrobial resistance across hospitals as well as the characteristics of patients affected and relevant risk factors. This should include capacity to monitor gram-negative infections.

Summary of Antimicrobial Use priorities

1. Continued focus on the development and importance of effective antimicrobial stewardship in the hospital, primary, and community care settings.
2. Further developments are required for accurate assessment and monitoring of antimicrobial use, and implementation of regional guidelines across all Trusts, addressing the appropriate use of broad spectrum antimicrobials e.g. meropenem and piperacillin-tazobactam.
3. A set of quality indicators relating to antimicrobial prescribing needs to be considered at a Trust and Northern Ireland level. These should include compliance with local policy, review of antimicrobial use within 72 hours, recording of indication for treatment and reason for any departure. Monitoring of these quality indicators should be facilitated through ongoing surveillance and feedback by regular reporting.
4. Regular reporting and assessment of antimicrobial consumption data for each hospital, with case-mix stratification should be implemented.
5. Sustained emphasis on ensuring appropriate antimicrobial use and on promoting early switch from parenteral to oral agents as clinically appropriate.

6. Consideration of a targeted programme aimed at reducing antimicrobial requirements and ensuring appropriate antimicrobial use for infections of the respiratory system, particularly including the diagnosis and treatment of pneumonia across the region.
7. Ongoing monitoring in relation to antimicrobials used for prophylaxis, and in particular surgical prophylaxis lasting longer than 24 hours / or more than one dose administered.
8. Sustained emphasis on antimicrobial stewardship and prescribing competencies, with particular emphasis on leadership provided through multi-disciplinary team working.

1. Introduction

Healthcare-associated infections (HAI) can develop either as a direct result of healthcare interventions such as medical or surgical treatment, or from being in contact with an acute or community healthcare setting. The term HAI covers a wide range of infections (7). The most well-known include those caused by meticillin-resistant *Staphylococcus aureus* (MRSA), meticillin-sensitive *Staphylococcus aureus* (MSSA), *Clostridium difficile* (C.diff) and *Escherichia coli* (E. coli).

More than four million people in Europe acquire a healthcare-associated infection (HAI) every year. Of these approximately 37,000 die as a direct result of the infection (8). The death toll from HCAI is comparable to the number of people who die each year in road traffic accidents. Antimicrobial use (AMU) is a key driver of antimicrobial resistance; understanding the indications, dose prescribed, and adherence to guidelines is essential to develop better stewardship of antimicrobials (9).

Surveillance of HAI and AMU is an essential component of infection prevention and antimicrobial stewardship (10). It drives key actions by planning and implementing more effective, evidence-based policies, surveillance and strategies. However, robust comparable data for HAI and AMU (other than mandatory reporting) are not currently available for the Health & Social Care (HSC) in Northern Ireland, making it difficult to quantify if there have been any changes in the rates of HAI and AMU across HSC trusts other than those reported on a mandatory basis.

Prevalence surveys are useful in providing data on the proportion of HAI and proportion and types of AMU at any one point (or period) in time in hospitals and give a better understanding of the burden of both HAI and community-acquired infection (CAI) treated with antibiotics and AMU. To reduce the burden of HAI and antimicrobial use there is a requirement for good, representative baseline and trend information. Regional point prevalence surveys (PPS) are undertaken every five years in Northern Ireland (NI) to understand the current epidemiological situation and to review local and national policy. Therefore, Northern Ireland participated in the ECDC PPS survey.

This PPS is the fifth national PPS on healthcare-associated infections and the third national combined survey on HAI and antimicrobial use in Northern Ireland. Whilst there have been certain changes to the definitions used for surveillance in the different years in which surveys have been completed, there has been greater consistency since 2012, meaning that comparisons between 2012 and 2017 have greater validity. This report compares and contrasts the 2012 and 2017 surveys so that a better insight into the pattern of infections and antimicrobial use affecting patients can be obtained. This will provide clarity on the ongoing burden of HAIs and will help to shape antimicrobial stewardship and infection control measures further to reduce HAIs in NI's hospitals. Key protocol changes are summarised in Appendix A.9

2. Background

Northern Ireland (NI) first participated in a UK point prevalence survey (PPS) of healthcare-associated infections (HAI) in acute hospitals in 1994. This was followed by another PPS in acute hospitals in 2006.

In 2008, the dedicated surveillance network for European HAI surveillance was transferred to the European Centre for Disease Prevention and Control (ECDC). ECDC undertook to develop an agreed EU protocol for a European PPS of hospital associated infection (HAI) and antimicrobial use in acute hospitals during 2011 and 2012. Northern Ireland participated in the PPS during 2012. In total, 33 administrative areas in 29 EU Member States provided data on 231,459 patients in 947 hospitals (8). The European HAI prevalence was 6% and antimicrobial use prevalence was 35%. In Northern Ireland, the HAI prevalence was 4.2% and antimicrobial use prevalence was 29.5%.

The second EU-wide PPS took place during 2016 and 2017. Northern Ireland completed the PPS data collection during June – July 2017. The PPS in Northern Ireland was coordinated by the Public Health Agency on behalf of Department of Health. The results from this PPS 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 Northern Ireland hospitals (refer to Section 7). Information from this survey 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.

2.1. Previous prevalence studies of HAI across UK and Ireland

In 2012, Northern Ireland, along with the rest of the UK and Republic of Ireland, took part in the ECDC point prevalence survey of Health-care Associated Infections.

Preceding this, Northern Ireland took part in UK prevalence surveys in 1993 and 2006.

Table 1 Northern Ireland, UK & Ireland prevalence of HAI

Prevalence survey	Patients surveyed	Number with HAI	Prevalence	95%CI
Northern Ireland 2012 (6)	3,992	166	4.2#	3.6 – 4.8
Northern Ireland 2006	3,644	198	5.4	4.7 – 6.2
UK* & Ireland 2006 (11)	75,856	5,773	7.6	7.4 – 7.8
UK 1993/94 (12)	37,111	3,353	9.0	8.8 – 9.3

* Scotland not included
# If psychiatric wards were excluded the prevalence of HAI increases to 4.3% (CI 3.7 – 5.0)
The definitions used in the 2006 survey differ from the definitions used in the 2012 and 2017 PPS, so care must be taken with interpretation of results, outlined above.

The results of the 2012 PPS showed an overall HAI prevalence of 4.2%. Pneumonia, surgical site and urinary tract infections were the most common HAIs. The prevalence of antimicrobial use was 29.5%. Gram negative organisms were the most common group of microorganisms.

3. Methodology

3.1. Aims and objectives of the 2017 PPS

The aims and objectives of the PPS 2017 were to:

- Estimate the overall prevalence of HAI and AMU in hospitals in Northern Ireland.
- Identify HAI and AMU by patient demographics, hospital specialities and healthcare facilities.
- Measure the types of HAI and define these by site, microorganism identified and resistance patterns.
- Identify the types of antibiotics prescribed, their indications for use and compliance with quality indicators.
- Capture any emerging antibiotic resistance patterns in comparison with data from the 2012 PPS.
- Describe key structures and processes for the prevention of HAIs and antimicrobial resistance at hospital and ward level in Northern Ireland.
- Report and disseminate the PPS findings at a local, regional and national level and for these findings to help further shape and advise antimicrobial stewardship and infection control measures.
- Contribute data to ECDC European Wide Study in order to create an overall picture of HAI in Europe.
- Compare 2017 findings with the 2012 PPS and to evaluate if local and national priorities have been achieved and if there are any further areas of improvement.

3.2. Timetable and organisation

The Public Health Agency (PHA) coordinated the 2017 Point Prevalence Survey (PPS) of hospital associated infection (HAI) and antimicrobial use (AMU) in Northern Ireland, on behalf of the Department of Health (DoH).

In February 2016, the Deputy Chief Medical Officer wrote to HSC Trust Medical Directors and Trust Directors of Nursing inviting their support and participation in PPS 2017. All acute hospitals in Northern Ireland were encouraged to participate in the survey.

In December 2016, the Assistant Regional Director of Public Health (Health Protection) wrote to all HAI Trust leads inviting them to assemble a PPS team and to nominate a local PPS coordinator. All Trusts replied indicating their willingness to participate and identified a local

coordinator, who would be responsible for liaising with PHA and completing the PPS in their Trust.

HAI surveillance staff in PHA led on the overall coordination of the regional PPS including planning and preparation of survey materials, delivery of survey-specific training, data collection, analysis and reporting of PPS data.

3.3. Study design and limitations

A rolling point prevalence survey was carried out in Northern Ireland hospitals from 6th to 30th June 2017. The Northern Ireland protocol was developed in collaboration with colleagues in Health Service Executive, Ireland (HSE) using the ECDC protocol for PPS (13) (14). Ethical approval was not required as the study was not deemed to be research and was part of a high level audit cycle which will enable individual hospitals to review their own performance. A PPS Delivery Group was established to oversee the survey – membership of this group is attached in Appendix A.1.

A cross sectional survey design is used to conduct prevalence surveys. This means that patients who have a longer inpatient stay are over-represented in the sample and hospital associated infections of a longer duration will also be over represented. Readers should also be aware that the survey measures prevalence on the day the survey was conducted and may not represent the prevalence at all times within the hospital.

One of the main limitations of measuring hospital associated infections is the correct use, by a large number of individuals, of standardised definitions and algorithms. To ensure that the data collected are reliable, a series of in-depth training workshops were held for each Trust and a major validation survey was also undertaken to estimate sensitivity and specificity. The other major limitation of the design is the availability of clinical information and microbiological results. If those who assess patients do not have timely information on samples taken, or do not have access to complete patients notes, then it may affect the accuracy of identifying a hospital associated infection, as only information available at the time of the survey was included and any outstanding results were not followed up after the day of data collection. Readers should be aware that prevalence surveys do not provide information regarding trends and do not allow attribution of the impact of individual interventions to be assessed between surveys, therefore comparisons of results should be treated with some caution as they may be influenced by a complex interplay of survey related and non-survey related factors.

3.4. Training and support

PHA co-ordinated a comprehensive training programme on methodology, organisation of survey, application of case definitions, validation study and interpretation of the survey results.

Nine one-day training courses were delivered by PHA to members of multidisciplinary PPS Teams in the five Health and Social Care (HSC) Trusts. Two additional sessions were held in Belfast. Training sessions were delivered in two parts, (i) why the PPS was being undertaken, methodology and patient eligibility; (ii) training on detailed definitions of hospital associated infection (targeted at infection prevention and control teams, microbiology and pharmacy staff).

A total of 225 staff received PPS-specific training. Feedback on training was collected at the end of each session via a written evaluation form and was largely positive. Participants requested additional case studies to assist with assignment of survey definitions in advance of PPS commencement to facilitate training, a set of case studies was developed addressing specific clinical scenarios, and these were shared with Trusts.

Patient and staff information leaflets were produced and distributed to all participating hospitals. Leaflets provided general information about the survey, see Appendix A.2.and A.3. Members of the PHA team provided on-going support to Trusts throughout the survey period. A helpdesk facility was provided by PHA to support the local data collection teams. This was operational during normal working hours in June and July 2017. Questions regarding data collection, including application of the protocol of definitions, were answered promptly by the PHA PPS Team. 'Frequently Asked Questions' were drafted and shared with Trust PPS Teams.

3.5. Inclusion and exclusion criteria

The survey included all HSC acute and paediatric hospitals. All wards with the exception of day units, psychiatric wards 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.

3.6. Data Collection

Data were collected by members of each Trust's PPS teams. Each data collection team was headed by a local PPS coordinator who was responsible for successful delivery of the PPS at hospital level and also for liaison with PHA PPS team. Local coordinators were responsible for agreeing training arrangements and timetables for data collection.

Each ward surveyed was completed on one day (Monday to Friday); wards where elective procedures were carried out were surveyed between Tuesday and Friday. Data were gathered from a number of sources available on the ward at the time of survey. These included: nursing notes, medical notes, NEWS charts, drug charts, electronic prescribing systems, surgical notes, laboratory reports and other relevant charts, for example care plans. Data collectors were advised to seek clarification from ward staff if the information in the records was not clear.

Data was collected on forms (Appendix A.4 – A.6). After completion the data was entered into a specifically designed web entry programme. Data entry was the responsibility of participating hospitals (15).

3.7. Validation of the 2017 PPS

Gold standard validation study

A gold standard validation study was carried out concurrently with the Northern Ireland PPS using the NI PPS validation protocol (16). 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 Northern Ireland protocol was based on the ECDC PPS Validation Protocol. The PHA validation team consisted of six ECDC trained data collectors along with other staff to support the data collection process.

Thirteen of the largest hospitals from the 16 acute hospitals in Northern Ireland were selected for inclusion in the validation study. 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/AMU were identified to maximise precision in the validity analysis. All patients in the selected wards were surveyed.

The validation team obtained data using the same sources available to the primary data collection teams in participating hospitals. The sensitivity and specificity for the presence of HAI and antimicrobial use were calculated with 95% CI.

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 (resampling) methods were used to calculate the 95% CI around the adjusted prevalence.

3.8. Data Management

Data capture was facilitated over the web using Formic Fusion Web Forms software (15) which included internal data checking and validation rules. Data analysis was undertaken using IBM SPSS Statistics 19.0 and data were further quality checked using specifically designed validation routines. A series of predefined reports were generated using IBM SPSS Data Collection Interviewer server Administration - PASW Web reports for surveys (Version 7.0.1). These reports were made available to participating hospitals within eight weeks of the final date of data entry.

3.9. Data Definitions

3.9.1. Hospital Type

Each hospital in Northern Ireland was designated a hospital type using ECDC definitions (14):

Hospital Type	Description
Primary	• Often referred to as 'district hospital' or 'first-level referral'. • Few specialities (mainly internal medicine, obstetrics-gynaecology, paediatrics, general surgery or only general practice). • Limited laboratory services are available for general, but not for specialised pathological analysis. • Often corresponds to general hospital without teaching function.
Secondary	• Often referred to as 'provincial hospital'. • Hospital is highly differentiated by function with five to ten clinical specialities, such as haematology, oncology, nephrology, ICU. • Takes some referrals from other (primary) hospitals. • Often corresponds to general hospital with teaching function.
Tertiary	• Often referred to as 'central', 'regional' or 'tertiary-level' hospital. • Highly specialised staff and technical equipment (ICU, haematology, transplantation, cardio-thoracic surgery, neurosurgery). • Clinical services are highly differentiated by function. • Specialised imaging units. • Provides regional services and regularly takes referrals from other (primary and secondary) hospitals. • Often a university hospital or associated to a university.
Specialised	• Single clinical specialty, possibly with sub-specialties. • Highly specialised staff and technical equipment. • Specify (e.g. paediatric hospital, infectious diseases hospital).

3.9.2. Risk factors

Risk factor data were collected including underlying disease prognosis and National Healthcare Safety Network (NHSN) operative procedure categories (17) and used to categorise patients who had undergone minimally invasive or invasive surgery since admission to hospital. Each patient was assessed for the presence of invasive devices *in situ*, i.e. peripheral vascular catheters (PVC), central vascular catheters (CVC) and urinary catheters (UC).

Underlying disease prognosis – to assess the severity of a patient's condition, clinical opinion was sought on the likely health outcome for each patient included in the PPS. For each patient 'underlying disease prognosis' was captured rather than the 'McCabe Score' as learning arising from an ECDC pilot undertaken in 2010 highlighted that clinicians may be reluctant to code patients to the ultimately fatal and rapidly fatal categories, see Appendix A.7.

3.9.3. HAI definitions

The 2017 European PPS protocol used European definitions of infection and complemented them with case definitions from the Centers for Disease Control and Prevention (CDC), as used by National Healthcare Safety Network (NHSN, formerly NNIS).

There were some changes to SSI, pneumonia and *Clostridium difficile* HAI case definitions in 2017 which are detailed in Appendix A.9.

The infection definitions used in the European PPS were the following:

- Surgical site infection (18)
- Pneumonia (19)
- Bloodstream infection (19)
- Central vascular catheter related infection (19)
- Urinary tract infections (19)
- Clostridium difficile infection (20)
- Specific neonatal definitions – established by the KISS network (21)
- All other case definitions used were CDC/NHSN definitions of infection (17)

This PPS was concerned with active infections acquired *during* or *as a consequence of* admission to an acute hospital. Data were collected on active HAI at the time of survey. HAI was considered active on the basis of the following (see Appendix A.9)

- Patient met one of the HAI case definitions on the day of survey.
  Or
- 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 one of antimicrobial treatment and day of survey.

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

- Day 3 of current admission onwards (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 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, UTI, bloodstream infection) following insertion of device (including Day 1 or 2 of admission).

Infections originating in other hospitals were included but those originating in long-term care facilities, care homes, or nursing homes were excluded.

Data were recorded for each HAI including: type, date of onset and origin of infection. Infections that were present on admission to the survey hospital were identified. Additional data were collected to identify whether a relevant device was *in situ* in a defined period prior to onset of infection; specifically central vascular catheter in context of bloodstream infections, intubation in context of pneumonia and urinary catheter in context of urinary tract infections.

3.9.4. Antimicrobial use

Data on antimicrobial use was collected if the patient was:

- Receiving an antimicrobial for treatment or medical prophylaxis at the time of survey *and/or*
- Received at least one dose of surgical prophylaxis prior to 8 a.m. on the survey day.

Antifungal treatment was included in this PPS, but tuberculosis and antiviral treatments were excluded. Data were recorded on each antimicrobial administered including: name of antimicrobial, route of administration, indication for prescription and diagnosis.

The indication for the prescription was recorded as either treatment of infection (community associated; hospital associated; long/intermediate care acquired), surgical prophylaxis (single dose; within 24 hour; >24 hours), medical prophylaxis or reason other than treatment or prevention of infection. The definition of hospital associated infection used when describing the indication for prescription was: an infection that the prescribing clinician considered to be a hospital associated infection or when 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.

Data was gathered to assess three quality indicators for prescribing: (i) if the reason for prescription was recorded in the medical notes (ii) if empirical prescriptions for infection or surgical prophylaxis prescriptions were compliant with local prescribing policy and (iii) if the current antimicrobial represented a change from the original prescription and the reason for change e.g. escalation/de-escalation, IV to oral switch.

Compliance with local prescribing guideline for type of antimicrobial was assessed by Trust PPS Team. Route, dose and duration were not required to be assessed as compliant. If the guideline recommended a combination of two or more antimicrobials, compliance was met if all relevant antimicrobials were prescribed. Antimicrobials were recorded as ‘not assessable’ if any of the following applied:

- Reason for antimicrobial prescription could not be determined from review of the patient’s notes and/or discussion with staff caring for patient
- Medical prophylaxis
- Use of erythromycin as a pro-kinetic agent.
- A local prescribing guideline was not available for the specific infection being treated
- A local surgical antimicrobial prophylaxis guideline was not available for the specific surgical procedure that the patient had undergone
- Patient had a documented antimicrobial allergy which would prevent compliance with local guideline.

3.9.5. 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 completion of the survey.

Antimicrobial resistance data were collected for a number of organisms of ECDC defined public health significance; namely *Staphylococcus aureus* (flucloxacillin, glycopeptides), *Enterococcus* spp. (glycopeptides), Enterobacteriaceae (third generation cephalosporins,

carbapenems), *Pseudomonas aeruginosa* (carbapenems), *Acinetobacter baumannii* (carbapenems).

4. Results

4.1.Trusts, Hospitals and Wards

4.1.1. Trusts and Hospitals

All 16 acute care hospitals were included and a total of 3,813 eligible patients were surveyed. Based on returns from each hospital this represented 3813/4331 (88%) of available acute beds. The largest proportion of eligible patients recorded was from Belfast HSC Trust (37% of all patients) followed by South Eastern HSC Trust (17.3%) Northern HSC (15.7%) Western HSC Trust (14.97%) and Southern HSC Trust (14.92%), see Table 2. The change of coverage between the different trusts is also displayed in Table 2. The largest proportion of patients (49.6%) was in a secondary level hospital, and this was the same in the 2012 survey (see Table 3). These data corresponded closely with data from other administrative sources (22).

Table 2 Hospital type, bed numbers and % of patients/beds surveyed

Trust	Number of hospitals	2012 Number eligible patients surveyed	2017 Number eligible patients surveyed	Change in coverage
Total	16	3,992	3,813	-4.48%
Belfast HSC	7	1,617	1,414	-12.5%
South-Eastern HSC	3	675	659	-2.4%
Southern HSC	2	614	569	-7.3%
Western HSC	2	556	571	+2.7%
Northern HSC	2	530	600	+13.2%

Table 3 Hospitals by Type and numbers of patients surveyed

Hospital type	Hospitals	Patient numbers 2012	Patient numbers 2017
Primary	Causeway Hospital Daisy Hill Hospital Downe Hospital Lagan Valley Hospital South West Acute Hospital	672	663
Secondary	Altnagelvin Hospital Antrim Area Hospital Craigavon Area Hospital Mater Infirmorum Hospital Ulster Hospital	1,947	1,892
Tertiary	Belfast City Hospital Royal Victoria Hospital	952	858
Specialised	Belvoir Park Hospital Musgrave Park Hospital Royal Belfast Hospital for Sick Children Royal Jubilee Maternity Service	421	400

4.1.2. Ward specialty

Ward specialties were grouped into seven categories, with the largest proportion of patients being on medical wards (41.9%). Surgical wards represented the 2nd largest ward speciality with 26%. There were 74 (1.9%) patients in Adult ICU, which is a 0.6% reduction since 2012. Overall 227 (6%) of patients were classified in paediatrics and neonatal wards which included paediatric and neonatal ICU. Table 4.

Table 4 Ward specialty

Ward specialty	2012 Number of patients (n=3,992)	% of patients surveyed (95%CI)	2017 Number of patients (n=3,813)	% of patients surveyed (95%CI)
Care of the Elderly	282	7.1 (6.3 - 7.9)	371	9.7 (8.8-10.7)
Adult ICU	99	2.5 (2.0 - 3.0)	74	1.9 (1.5-2.4)
Medical	1,687	42.3 (40.7 - 43.8)	1,597	41.9 (40.3-43.5)
Obstetrics/Gynaecology	385	9.6 (8.8 – 10.6)	329	8.6 (7.8-9.6)
Paediatrics (inc paediatric & neonatal ICU)	178	4.5 (3.9 – 5.1)	227	6.0 (5.2-6.7)
Surgical	1,041	26.1 (24.7 - 27.5)	988	26.0 (24.5-27.3)
Other* (mixed ward, rehabilitation, other)	320	8.0 (7.2 - 8.9)	227	6.0 (5.2-6.7)

*In 2012 psychiatry specialty was included in 'other'; in 2017 this acute specialty was not included in eligible sample

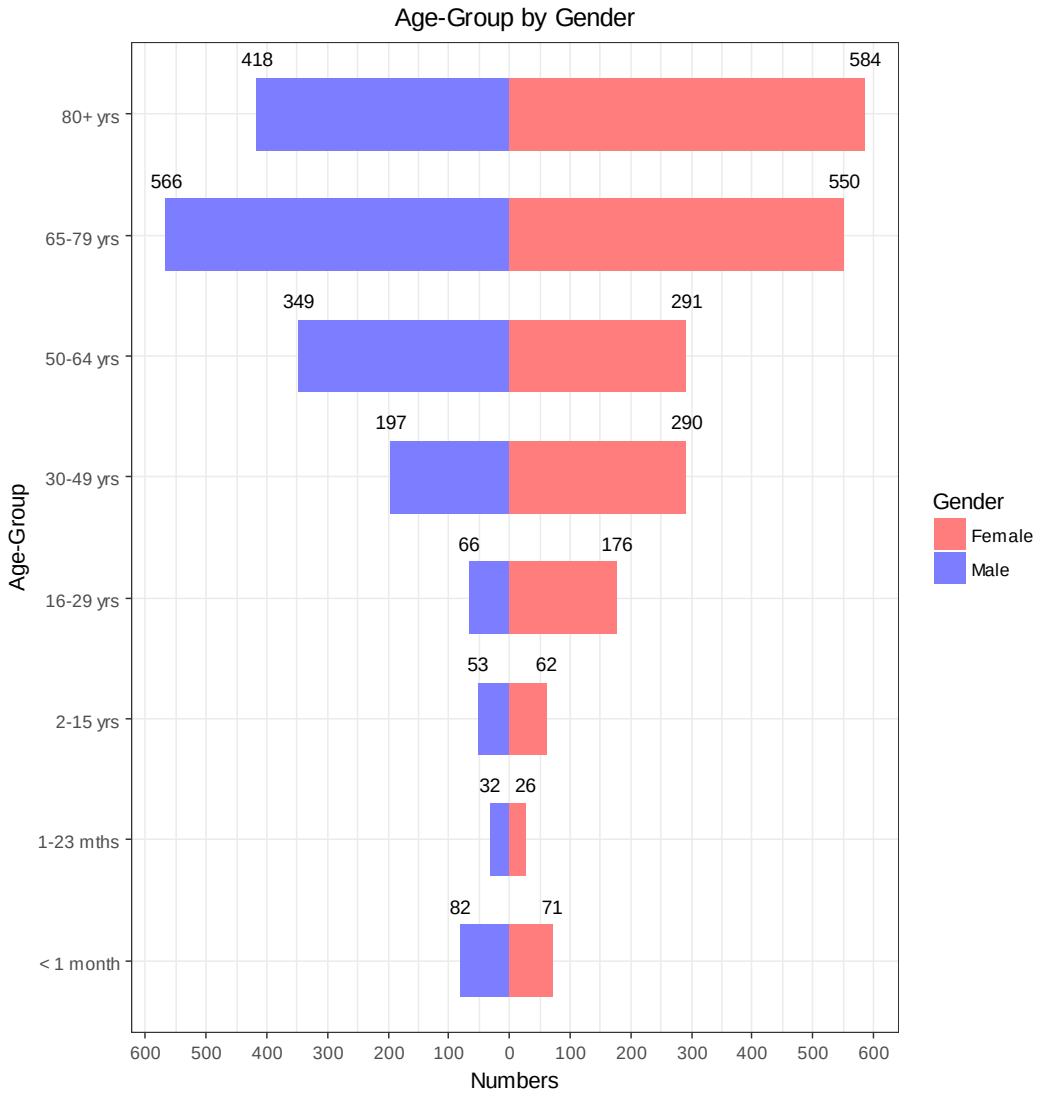
4.2. Patient demographics

Females represented 53.8% of the survey population and males accounted for 46.2%. The median age was 68 years (IQR 46 – 80; range 0 –102) which has increased from 66 years in 2012. The proportion of the population aged less than one month was 4.4% the combined population under age 16 was 8.5%; the proportion aged 16-64 years was 35.9% and aged 65 and over 55.5% (CI 54-57.1), see Table 5 and Figure 1. There has been a statistically significant increase in the proportion of patients aged 65 and over, which was 51.7% (CI 50.2-53.3) in 2012.

Table 5 Demographic characteristics of survey population

Risk factors	2012 Number of patients (n=3,992)	% of patients surveyed (95%CI)	2017 Number of patients (n=3,813)	% of patients surveyed (95%CI)
Gender				
Male	1,823	45.7 (44.1 - 47.2)	1,763	46.2 (44.7 - 47.8)
Female	2,169	54.3 (52.8 - 55.9)	2,050	53.8 (52.2 - 55.3)
Age Group				
< 1 month	186	4.7 (4.1 - 5.4)	168	4.4 (3.8 – 5.1)
1-23 months	96	2.4 (2.0 - 2.9)	43	1.1 (0.8 – 1.5)
2-15 years	101	2.5 (2.1 - 3.1)	115	3.0 (2.5 – 3.6)
16-29 years	299	7.5 (6.7 - 8.4)	242	6.3 (5.6 – 7.2)
30-49 years	590	14.8 (13.7 - 15.9)	487	12.8 (11.8 – 13.9)
50-64 years	654	16.4 (15.3 - 17.6)	640	16.8 (15.6 – 18.0)
65-79 years	1,059	27.4 (26.0 - 28.8)	1,116	29.3 (27.8 – 30.7)
80+ years	974	24.4 (23.1 - 25.8)	1,002	26.3 (24.9 – 27.7)

Figure 1 Population pyramid: Number of patients surveyed by age and sex



4.3. Device usage

Over 6 in 10 (60.3%) of patients (n=2298) had at least one device *in situ* at the time of the survey. Peripheral vascular catheter (either arterial or venous) was the most frequently used device with over half of all patients on the day of the survey having one in situ (52.8%), see Figure 2. This is a statistically significant increase of over nine percentage points since 2012 (43.4%). The ECDC definition of intubation for this survey was 'Patient is intubated with or without mechanical ventilation (endotracheal tube or tracheostomy) at the time of the survey'. Adult ICU had the highest proportion of intubated patients (48.6%).

The use of all devices (CVC, PVC, urinary catheter and intubation) varied across ward specialties, with the highest utilisation seen in Adult ICU – see Table 6.

Figure 2 Proportion of patients with invasive device in situ

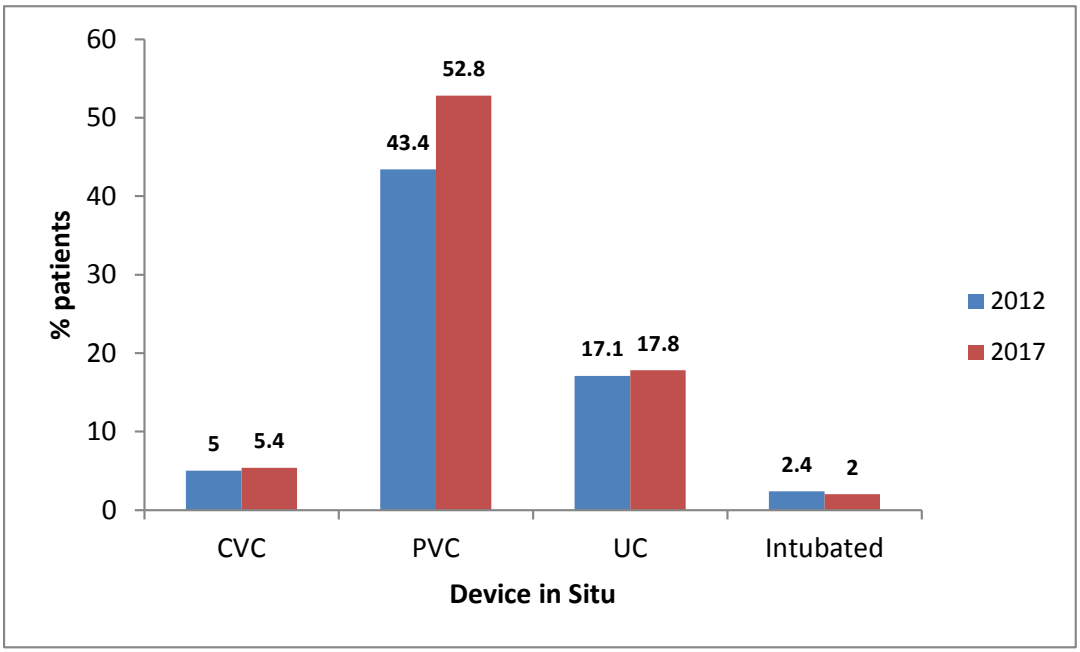


Table 6 2017 - Ward specialty and invasive devices in situ

Ward specialty	Central Vascular Catheter		Peripheral Vascular Catheter		Urinary Catheter		Intubated	
	N	%	N	%	N	%	N	%
All specialties	207	5.4	2013	52.8	679	17.8	78	2.0
Care of the Elderly	2	0.5	123	33.2	54	14.6	0	0.0
Adult ICU	55	74.3	57	77.0	73	98.6	36	48.6
Medical	65	4.1	919	57.5	271	17.0	2	0.1
Obstetrics/Gynaecology	3	0.9	103	31.3	37	11.2	0	0.0
Paediatrics	16	10.3	72	46.5	8	5.2	7	4.5
Neonatal	7	9.7	24	33.3	0	0.0	1	1.4
Surgical	44	4.5	603	61.0	203	20.5	29	2.9
Rehabilitation	0	0.0	6	15.0	3	7.5	0	0.0
Mixed Ward	13	9.8	60	45.5	21	15.9	1	0.8
Other	2	3.6	46	83.6	9	16.4	2	3.6

Table 7 Comparison of invasive devices between 2012 and 2017

All specialities	2012		2017	
Device	N	% (95% CI)	N	% (95% CI)
Central Vascular Catheter	200	5.0% (4.4-5.7)	207	5.4% (4.8-6.2)
Peripheral Vascular Catheter	1733	43.4% (41.9-45)	2013	52.8% (51.2-54.4)
Urinary Catheter	681	17.1% (15.9-18.3)	679	17.8% (16.6-19.1)
Intubated	97	2.4% (2.0-3.0)	78	2.0% (1.6-2.5)

4.4. Intrinsic risk factors – Surgery and underlying disease prognosis

Overall, the proportion of patients who had surgery since admission was 15.9%. Overall 12.6% had an NHSN operative procedure and the remaining 3.3% had minimally invasive surgery, see Table 8.

Definition of NHSN operative procedure is a procedure which:

- Takes place during an operation where at least one incision (including laparoscopic approach) is made through the skin or mucous membrane, or reoperation via an incision that was left open during a prior operative procedure.

And

- Takes place in an operating room, defined as a patient care area that meets criteria for an operating room when it was constructed or renovated. This may include an operating room, C-section room, interventional radiology room, or cardiac catheterisation lab.

NOTE: As of October 2014, incisional closure is no longer a part of the operative procedure definition; all otherwise eligible procedures are included, regardless of closure type.

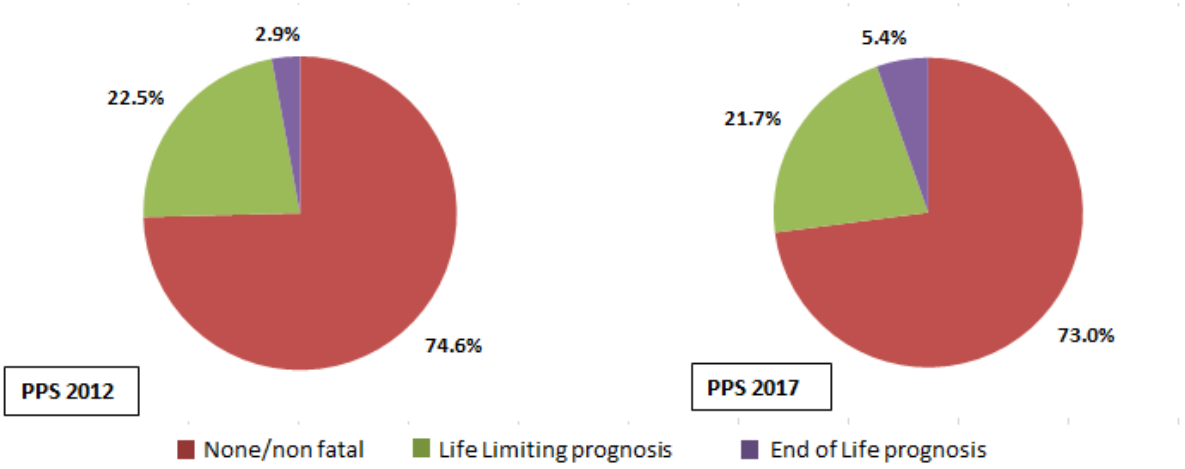
Table 8 Intrinsic risk factors

Risk factors	2012 Number	Percent (95%CI)	2017 Number	Percent (95%CI)
Surgery Since Admission				
Yes (NHSN)	533	13.4 (12.3–14.4)	482	12.6 (11.6-13.7)
Yes (Non-NHSN)	131	3.3 (2.8–3.9)	123	3.3 (2.7-3.8)
No	3,286	82.3 (81.1–83.5)	3181	83.4 (82.2 -84.6)
Not known	42	1.1 (0.8–1.4)	27	0.7 (0.5-1.0)
Underlying Disease Prognosis				
None/Non-fatal	2,792	74.6 (73.1 – 75.9)	2477	73.0 (71.5 – 74.4)
Life limiting prognosis	844	22.5 (21.2 – 23.9)	735	21.7 (20.3 – 23.1)
End of life prognosis	109	2.9 (2.4 – 3.5	18	5.4 (4.7 – 6.2)

Underlying disease prognosis was provided for 89% patients. The majority of patients (73%) had a non-fatal disease prognosis. A further 21.7% were considered to have a life limiting prognosis and 5.4% of patients had an end-of-life prognosis, see Figure 3. There was a statistically significant increase in the percentage of patients with an end-of-life prognosis compared to 2012.

Over sixty-five per cent (65.4%) of those with end-of-life prognosis had a device *in situ* compared to 57.4% with a non-fatal prognosis.

Figure 3 Underlying disease prognosis



4.5. Hospital associated infection (HAI)

4.5.1. HAI prevalence in Northern Ireland

The overall HAI prevalence in Northern Ireland acute care hospitals was 6.1% (95% CI 5.4 – 6.9). A total of 234 patients had 241 infections (the comparable figures for 2012 were 166 patients with 169 infections), the vast majority were identified as having one HAI and only seven patients had two infections reported (the comparable figure for 2012 was three). Comparable rates of HAI for 2011/12 PPS in Europe and UK administrations are shown in Table 9.

Table 9 Prevalence of HAI PPS for Europe and UK 2011/12

Comparable rates of hospital associated infections in Europe and UK		
Country	**HAI prevalence 2011/12**	**HAI prevalence 2016/17**
Europe – ECDC PPS (8)	6.0 (5.9 – 6.1)	To be published
England (Acute) (1)	6.5 (4.8 – 8.8)	To be published
Scotland (Acute) (2) (3)	4.9 (4.4 – 5.4)	4.5 (4.0 – 5.0)
Wales (Acute) (4) (5)	4.3 (3.8 – 4.8)	5.5 (5.0 – 6.1)
Northern Ireland# (6)	4.2 (3.6 – 4.8)	6.1 (5.4 – 6.9)
# if patients in acute psychiatry specialty in 2012 are excluded, the overall HAI rate is 4.3% (CI 3.7 – 5.0)		

4.5.2. HAI prevalence by gender and age

The HAI prevalence for males was 7.7% compared with 4.8% for females, and this difference was statistically significant, Table 10. The prevalence of HAI was highest for those aged 1-23 months (9.3%).

Table 10 Distribution of HAI by gender and age group

Risk factors	**2012**	**2017**		
	HAI prevalence	**Number of patients (n=3,813)**	**Number of patients with HAI**	**HAI prevalence % (95%CI)**
Gender				
Male	4.7 (3.8-5.8)	1763	135	7.7 (6.5-9.0)
Female	3.7 (3.0-4.6)	2050	99	4.8 (4.0-5.8)
Age Group				
< 1 month	1.6 (0.6-4.6)	168	14	8.3 (5.0-13.5)
1-23 months	8.3 (4.3-15.6)	43	4	9.3 (3.7-21.6)
2-15 years	2.0 (0.5-6.9)	115	0	0.0 (0.0-3.2)
16-29 years	2.0 (0.9-4.3)	242	4	1.7 (0.6-4.2)
30-49 years	3.1 (1.9-4.8)	487	29	6.0 (4.2-8.4)
50-64 years	5.8 (4.3-7.9)	640	35	5.5 (4.0-7.5)
65-79 years	4.3 (3.3-5.7)	1116	85	7.6 (6.2-9.3)
80+ years	4.5 (3.4-6.0)	1002	63	6.3 (4.9-8.0)

4.5.3. HAI prevalence by hospital type

All 16 hospitals in Northern Ireland were coded to the same hospital type as in 2012 (see Table 3). In both 2012 and 2017, tertiary hospitals had the highest HAI prevalence (6.8% and 6.9% respectively).

Since the 2012 survey, there has been a significant increase in the HAI prevalence in secondary hospitals from 3.2% to 6.2%. The HAI prevalence has also increased in the other three hospital types. When HAI prevalence was compared for individual hospitals within each hospital type, i.e. Tertiary, Secondary, Primary and Specialised, there was considerable overlap in the rates except for secondary hospitals where one unit had higher rates in comparison with others in the same group, see Figure 4.

The lowest prevalence of HAI (5.1%) was in primary hospitals, see Table 11.

Figure 4 HAI prevalence for individual hospitals by hospital type

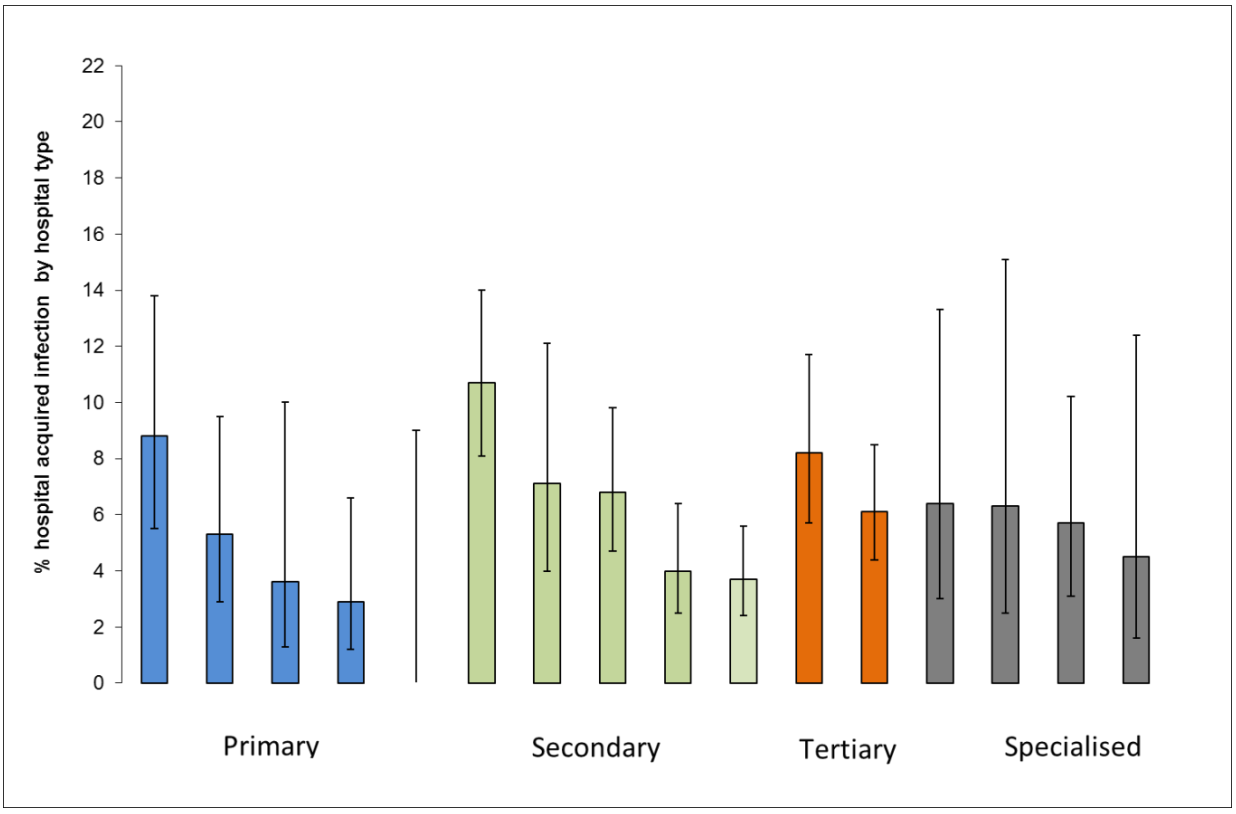


Table 11 Distribution of HAI by hospital type

Hospital type	2012	2017		
	HAI prevalence % (95%CI)	Number of patients	Number of HAI	HAI prevalence % (95%CI)
Primary	2.2 (1.4 – 3.7)	663	34	5.1 (3.7-7.1)
Secondary	3.2 (2.6 – 4.2)	1892	124	6.2 (5.2-7.4)
Tertiary	6.8 (5.8 – 9.2)	858	60	6.9 (5.4-8.8)
Specialised	5.7 (4.1 – 8.8)	400	23	5.8 (3.9-8.5)

4.5.4. HAI increase by hospital type

As the increase in the number of hospital associated infections tended to be concentrated in primary and secondary type hospitals, an analysis of the type of infections was undertaken by comparing the data for 2012 with that collected in 2017. In 2017, the number of infections in both primary and secondary type hospitals was double the number observed in 2012 – from 15 to 34 HAI in primary hospitals and 62 to 124 in secondary level hospitals (see Figure 5a-5d).

In secondary hospitals, an increase in infections was identified for: pneumonia, bloodstream, gastrointestinal, neonatal, skin and soft tissue and eye, ear, nose, throat and mouth infections.

Figure 5 (a) Type of hospital associated infection – Primary hospitals 2012 & 2017

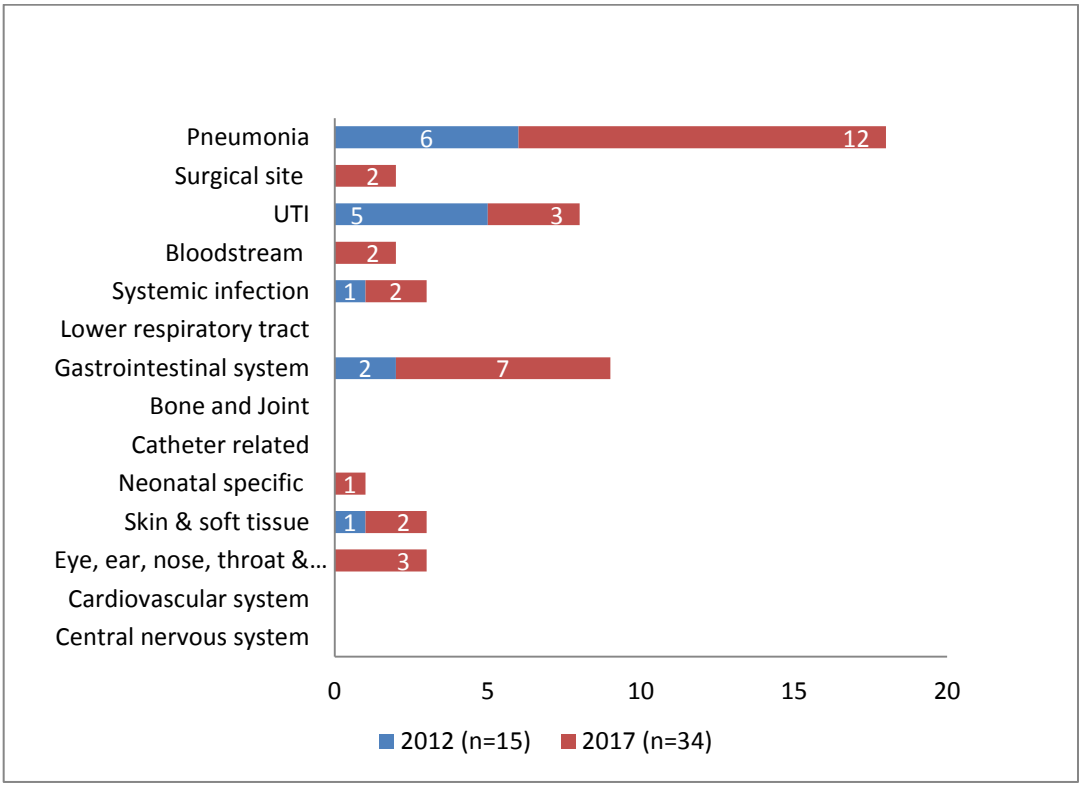


Figure 5 (b) Type of hospital associated infection – Secondary hospitals 2012 & 2017

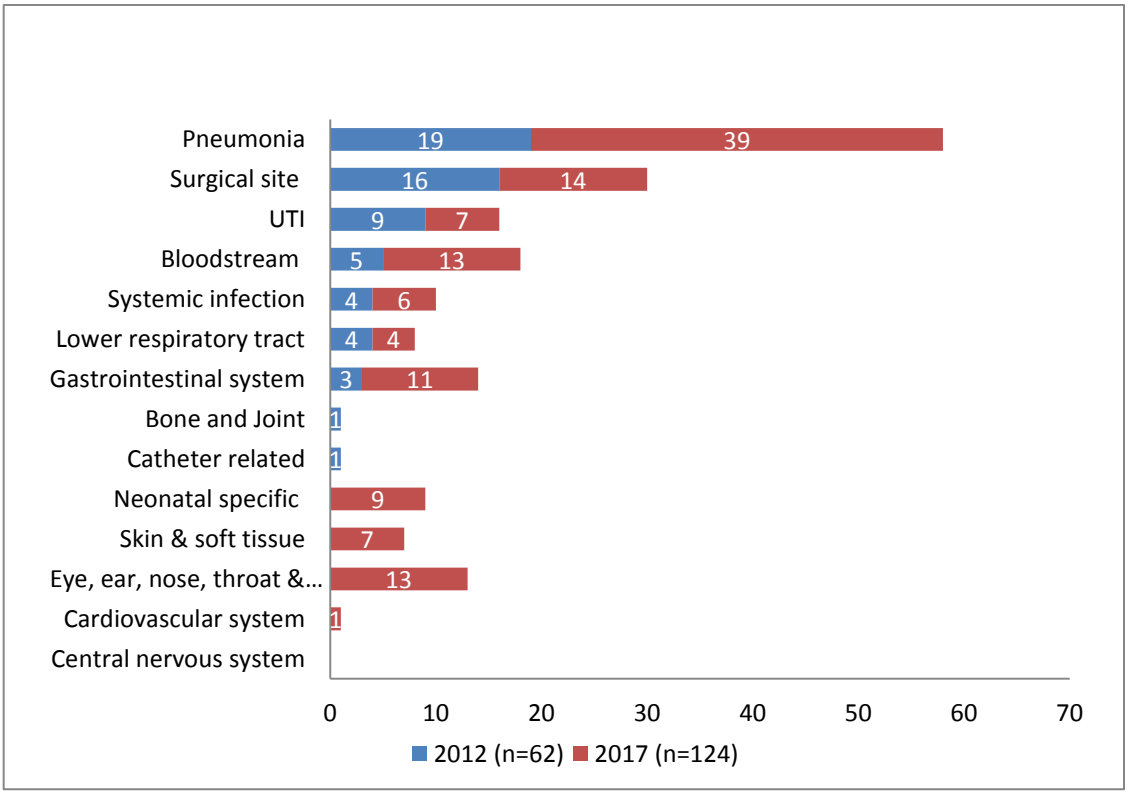


Figure 5 (c) Type of hospital associated infection – Tertiary hospitals 2012 & 2017

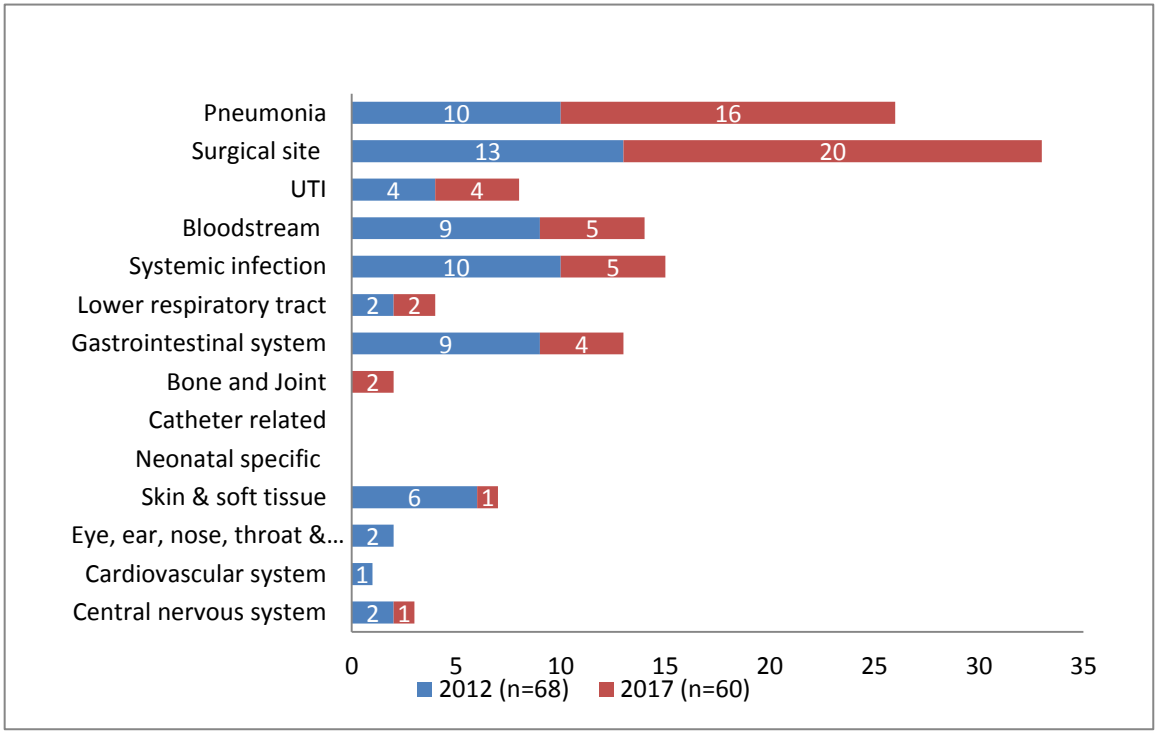
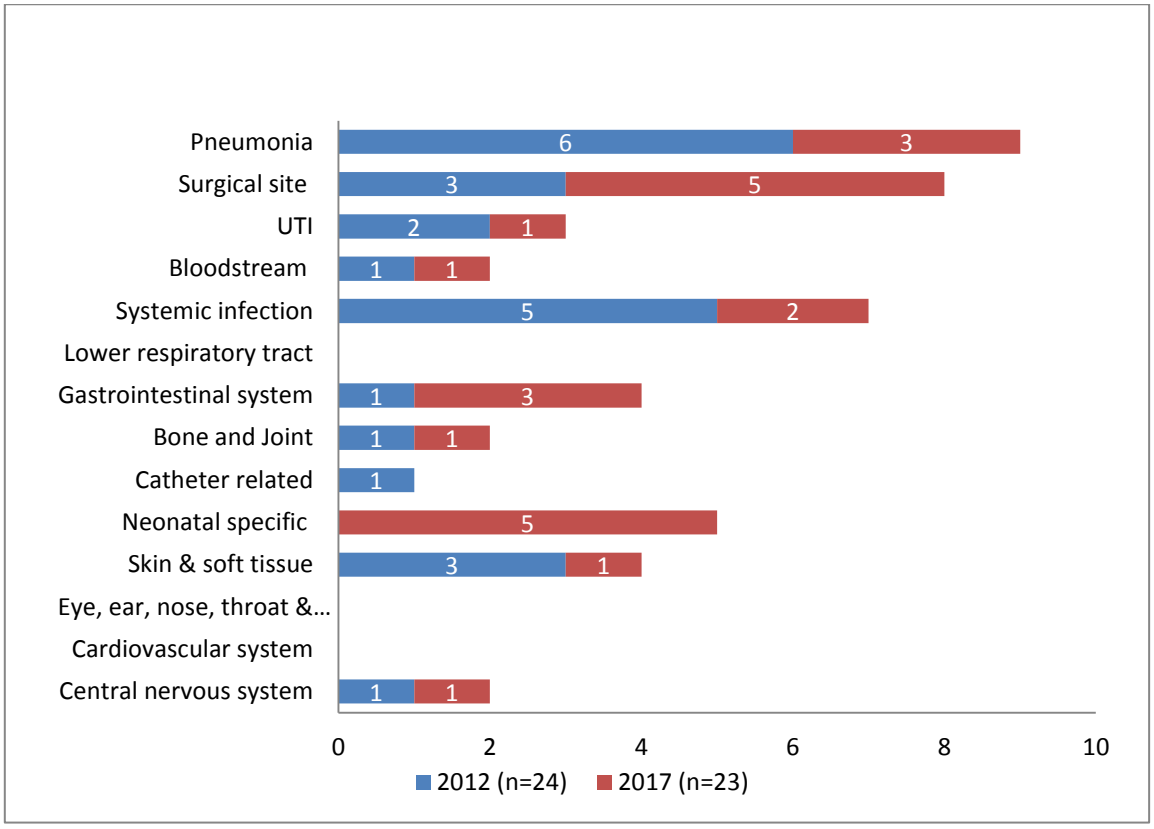


Figure 5 (d) Type of hospital associated infection – Specialised hospitals 2012 & 2017



4.5.5. HAI prevalence by risk factors

While the overall HAI prevalence was 6.1%, if a patient had a device *in situ* the HAI prevalence was significantly higher (8.4%). The presence of each device was associated with higher HAI prevalence: central vascular catheter (HAI prevalence 14.9%, $p < 0.01$), peripheral vascular catheter (HAI prevalence 8.6%, $p < 0.01$), urinary catheter (HAI prevalence 12.5%, $p < 0.01$) and intubation (HAI prevalence 11.5%, $p < 0.01$), see Table 12.

This was similar to 2012 where all four invasive devices included in the survey also had a higher prevalence of HAI.

Almost one in five patients (19.6%) who has a central vascular catheter, peripheral vascular catheter and urinary catheter in situ were diagnosed with an hospital associated infection, but this related to a small number of cases (10 out of 51 patients).

A total of 632 patients (16.6%) had some form of surgery (operative procedure or minimally invasive procedure) since admission. Prevalence of HAI was higher for patients having undergone surgery than for those who did not have surgery (11.2% versus 5.1%; $p<0.01$).

Higher HAI prevalence was observed in patients with a life-limiting prognosis (7.8%) or end-of-life prognosis (8.2%) compared with those with non-fatal prognosis (5.6%), $p<0.01$.

Table 12 Distribution of HAI by intrinsic risk factors

Risk factors	2012	2017		
	HAI prevalence % (95%CI)	Number of patients (n=3,813)	Number with HAI	HAI prevalence % (95%CI)
Invasive device in situ				
Any device – Yes	7.1(6.1 – 8.3)	2,298	194	8.4 (7.4 – 9.6)
Any device – No	1.1 (0.7 – 1.6)	1,515	40	2.6 (1.9 – 3.6)
CVC	20.5 (15.5 – 26.6)	207	31	14.9 (10.8 – 20.5)
PVC	6.3 (5.3 – 7.6)	2,013	174	8.6 (7.5 – 10.0)
Urinary catheter	9.4 (7.4 – 11.8)	679	85	12.5 (10.2 – 15.2)
Intubation	16.5 (10.4 – 25.1)	78	9	11.5 (6.2 – 20.5)
Surgery Since Admission				
Yes	7.8 (6.0 – 10.0)	632	71	11.2 (9.0-13.9)
No	3.4 (2.8 – 4.1)	3181	163	5.1 (4.4-5.9)
Underlying Disease Prognosis				
None/Non-fatal	3.0 (2.4 – 3.7)	2477	139	5.6 (4.8-6.6)
Life limiting prognosis	7.0 (5.5 – 8.9)	735	57	7.8 (6.0-9.9)
End of life prognosis	8.3 (4.4 – 15.0)	182	15	8.2 (5.1-13.2)
Not Known	6.1 (3.7 – 9.8)	419	23	5.5 (3.7-8.1)

4.5.6. HAI prevalence by ward specialty

HAI prevalence varied across ward specialties, with the highest prevalence in ICU (17.6%) followed by mixed specialty wards (7.6%), Care of the Elderly (7.5%) and Paediatrics (7.0%).

The lowest HAI prevalence was found in 'Other' wards (including rehabilitation) where no HAI were recorded, see Table 13.

Table 13 Distribution of HAI by ward specialty

Ward specialty	2012	2017			
	HAI prevalence % (95%CI)	Number	% total patients	Number with HAI	HAI prevalence % (95%CI)
All ward specialties	4.2 (3.6 – 4.8)	3,813	100.0	234	6.1 (5.4 – 6.9)
Adult ICU	9.1 (4.7 – 16.4)	74	1.9	13	17.6 (10.6 – 27.8)
Care of the Elderly	5.7 (3.5 – 9.0)	371	9.7	28	7.5 (5.3 – 10.7)
Surgical	5.2 (4.0 – 6.7)	988	25.9	65	6.6 (5.2 – 8.3)
Paediatrics (inc. paediatric ICU & Neonatal)	4.5 (2.3 – 8.6)	227	5.9	16	7.0 (4.4 – 11.1)
Medical	4.0 (3.1 – 5.0)	1597	41.9	87	5.4 (4.4 – 6.7)
Mixed specialty wards	-	132	3.5	10	7.6 (4.2 – 13.4)
Other (other, rehab)	2.8 (1.5 – 5.3)	95	2.5	0	0 (0.0 – 3.9)
Obstetrics/Gynaecology	0.8 (0.3 – 2.3)	329	8.6	15	4.6 (2.8 – 7.4)

4.5.7. HAI prevalence for paediatric patients

Paediatric patients were defined as those aged less than 16 years, whether on an adult or paediatric ward. There were 326 paediatric patients surveyed with 16 on adult wards. There were 18 patients with HAI, the most prevalent HAI was clinical sepsis in neonates (n=10; 55.6% of paediatric HAI), see Table 14.

The prevalence of HAI in the paediatric population was 5.5% (95%CI 3.5% – 8.6%). Neonates on postnatal wards, 'well babies' (n=86) had a low HAI prevalence (2.3%). HAI prevalence in paediatric patients, excluding 'well babies', was 2.0% (95%CI 0.7 – 5.6). HAI prevalence in Neonatal (including neonatal ICU) was 18.1%.Table 15.

Table 14 Distribution of paediatric HAI types

HAI groups	Number of HAI	% of paediatric HAI
Clinical sepsis in neonates	10	55.6
Laboratory confirmed bloodstream infection non-CNS (NEO)	2	11.1
Laboratory confirmed bloodstream infection with coagulase-negative staphylococci (NEO)	1	5.6
Skin infection	1	5.6
Pneumonia (NEO)	1	5.6
Symptomatic urinary tract infection	1	5.6
Intracranial infection	1	5.6
Necrotising enterocolitis (NEO)	1	5.6

Table 15 2017 Distribution of Paediatric HAI by ward specialty

Ward specialty	Total patients	Number with HAI	HAI prevalence % (95%CI)
Total paediatric	326	18	5.5 (3.5 – 8.6)
Neonatal	72	13	18.1 (10.9 – 28.5)
Gynaecology/Obstetrics	86	2	2.3 (0.6 – 8.1)
Paediatrics	152	3	2.0 (0.7 – 5.6)
Surgery	10	0	-
Medicine	4	0	-
Intensive care	2	0	-

4.5.8. HAI categories

The number, proportion and prevalence of HAI by infection category are shown in Table 16 and by HAI type in Appendix B, Table I. The most common HAI category was pneumonia (29.0%), followed by surgical site infection (17.0%), gastrointestinal system infection (10.4%), bloodstream infection (8.7%) and ENT infection (6.6%).

Table 16 Distribution of HAI categories

HAI category	2012		2017		
	% of all HAI	HAI prevalence (95%CI)	Number HAI	% of all HAI	HAI prevalence % (95%CI)
Pneumonia	24.3	1.0 (0.8 – 1.4)	70	29.0	1.8 (1.5-2.3)
Surgical site infection	18.9	0.8 (0.6 – 1.1)	41	17.0	1.1 (0.8-1.5)
Urinary tract infection	11.8	0.5 (0.3 – 0.8)	15	6.2	0.4 (0.2-0.6)
Systemic infection	11.8	0.5 (0.3 – 0.8)	15	6.2	0.4 (0.2-0.6)
Bloodstream infection	8.9	0.4 (0.2 – 0.6)	21	8.7	0.6 (0.4-0.8)
Gastrointestinal system infection	8.9	0.4 (0.2 – 0.6)	25	10.4	0.7 (0.4-1.0)
Skin & soft tissue infection	5.9	0.3 (0.1 – 0.5)	11	4.6	0.3 (0.2-0.5)
Lower respiratory tract infection, other than pneumonia	3.6	0.2 (0.1 – 0.3)	6	2.5	0.2 (0.1-0.3)
Central nervous system infection	1.8	0.1 (0.0 – 0.2)	2	0.8	0.1 (0.0-0.2)
Vascular catheter-related infection	1.2	0.1 (0.0 – 0.2)	0	-	-
Bone and joint infection	1.2	0.1 (0.0 – 0.2)	3	1.2	0.1 (0.0-0.2)
Eye, ENT or mouth infection	1.2	0.1 (0.0 – 0.2)	16	6.6	0.4 (0.3-0.7)
Cardiovascular system infection	0.6	<0.1 (0.0 – 0.1)	1	0.4	<0.1 (0.0-0.1)
Neonatal Specific Infection	0	0.0	15	6.2	8.9 (5.5-14.2)
Total number of HAI	166	4.2 (3.6 – 4.8)	241	100.0	6.1 (5.4 – 6.9)

Pneumonia

A total of 70 pneumonia infections were identified in the survey, only 3 patients had a relevant device *in situ* before onset, i.e. intubated within 48 hours before onset (known as ventilator-associated pneumonia or VAP). The definition of pneumonia was subdivided into 5 categories (PN1 to PN5). PN1 to PN3 required microbiological confirmation and PN4 and PN5 were defined as clinical pneumonia without microbiological evidence. The vast majority of pneumonia identified in Northern Ireland were classified as PN4 (n=6) or PN5 (n=63).

Surgical site infection (SSI)

A total of 41 surgical site infections (SSI) were identified; one quarter (24.4%) were deep incisional infections and half (48.8%) were organ space infections .The surgical site procedure categories that were linked with SSI are shown in Table 17. Appendix B, Table II contains a list of specific surgical procedures and their associated HAI and antimicrobial use. Eleven (26.8%) SSI followed general surgery, eight of these were deep incisional/organ space infections and three were superficial. Eight surgical site infections occurred following orthopaedic surgery, six of these were deep or organ space infections and two were superficial incisional.

Table 17 Prevalence of surgical site infection by surgical procedure category

Surgical category	Number	% of SSI	Superficial	Deep incisional and Organ space
Total	41	100.0	11 (26.8%)	30 (73.2%)
General surgery	11	26.8	3	8
Cardiac surgery	2	4.9	2	0
Neurosurgery	2	4.9	0	2
Orthopaedics	8	19.5	2	6
Obstetrics & Gynaecology	7	17.1	2	5
Vascular surgery	2	4.9	0	2
Urology/kidney transplant	3	7.3	1	2
Not recorded	6	14.6	1	5

Urinary tract infection (UTI)

A total of 15 UTI (6.2%) were recorded. This was a lower proportion than in the 2012 survey - 20 (11.8%). Nine of the infections (60%) were microbiologically confirmed, and six had signs and symptoms but were not microbiologically confirmed. Five of the patients with a UTI (33%) had a urinary catheter *in situ* in the seven days prior to onset of infection, i.e. catheter associated urinary tract infection (CAUTI).

Systemic infection

There were 15 systemic infections identified. Thirteen were classified as clinical sepsis, i.e. the patients presented with clinical signs/symptoms but with no other recognised cause and treatment for sepsis was started. The remaining two cases were reported as a disseminated infection involving multiple organs and systems.

Eye, ENT or mouth infection

Sixteen patients were recorded as having an eye, ear, nose, throat or mouth infection (6.6%). This was a significant increase since 2012 when only 2 patients were recorded. All 16 were oral cavity infections and 9 of these patients were age 80+ (56.2%).

The majority of prescriptions (81.2%) were for Nystatin, which is commonly used for the treatment of oral thrush. Only one infection had an identified microorganism.

Bloodstream infection (BSI)

Table 18, provides information on the source of bloodstream infections (BSI). There were 21 BSIs identified in adults and three in neonates. Of these, eleven (45.8%) were primary BSIs and 13 were secondary blood stream infections. Thirteen infections were classified as secondary to other infections and four were infections secondary to UTI.

Table 18 Source of bloodstream infections

	2012		2017	
Source of BSI	**Number**	**% of BSI**	**Number**	**% of BSI**
Total BSI	15	100%	24	100%
Primary BSI	12	80.0	11	45.8
BSI of unknown origin	9		8	
Vascular Catheter related	3		3	
Secondary BSI	3	20.0	13	54.2
Secondary to urinary tract infection	2		4	
Secondary to pulmonary infection	0		2	
Secondary to digestive tract infection	1		2	
Secondary to SSI	0		0	
Secondary to skin & soft tissue inf	0		1	
Secondary to other infection	0		4	

Gastrointestinal system infections (GI)

The number of gastrointestinal system infections was 25. Half of *Clostridium difficile* infections (n=7) were found in patients aged over 80 years. Six intra-abdominal GI infections were recorded relating either to gall bladder, bile duct, liver, spleen, pancreas, peritoneum or sub phrenic/sub diaphragmatic space. The five remaining GI infections included: oesophagus, stomach, small and large bowel and rectum.

4.5.9. HAI onset and origin

Almost four-fifths (77.2%) of HAI (186 of 241) developed following admission to the survey hospital; the remaining 55 (22.8%) were present on admission. Of those HAI present on admission, 30 (54.5%) were readmissions, the remaining 25 infections were related to another hospital.

The median time from admission to onset of infection, for patients with an HAI which was not present at admission, was 9 days, 40.9% developed within the first week and 65.6% within the first fortnight. The proportion of HAI which developed more than three weeks after admission was 18.8% - see Table 19.

Table 19 Onset of HAI for all infections

	2012		2017	
Onset (admission to infection date)	**Number**	**% of total HAI**	**Number**	**% of total HAI**
up to one week	75	46.3	76	40.9
8-14 days	38	23.5	46	24.7
15-21 days	15	9.3	29	15.6
22 days or more	34	21.0	35	18.8

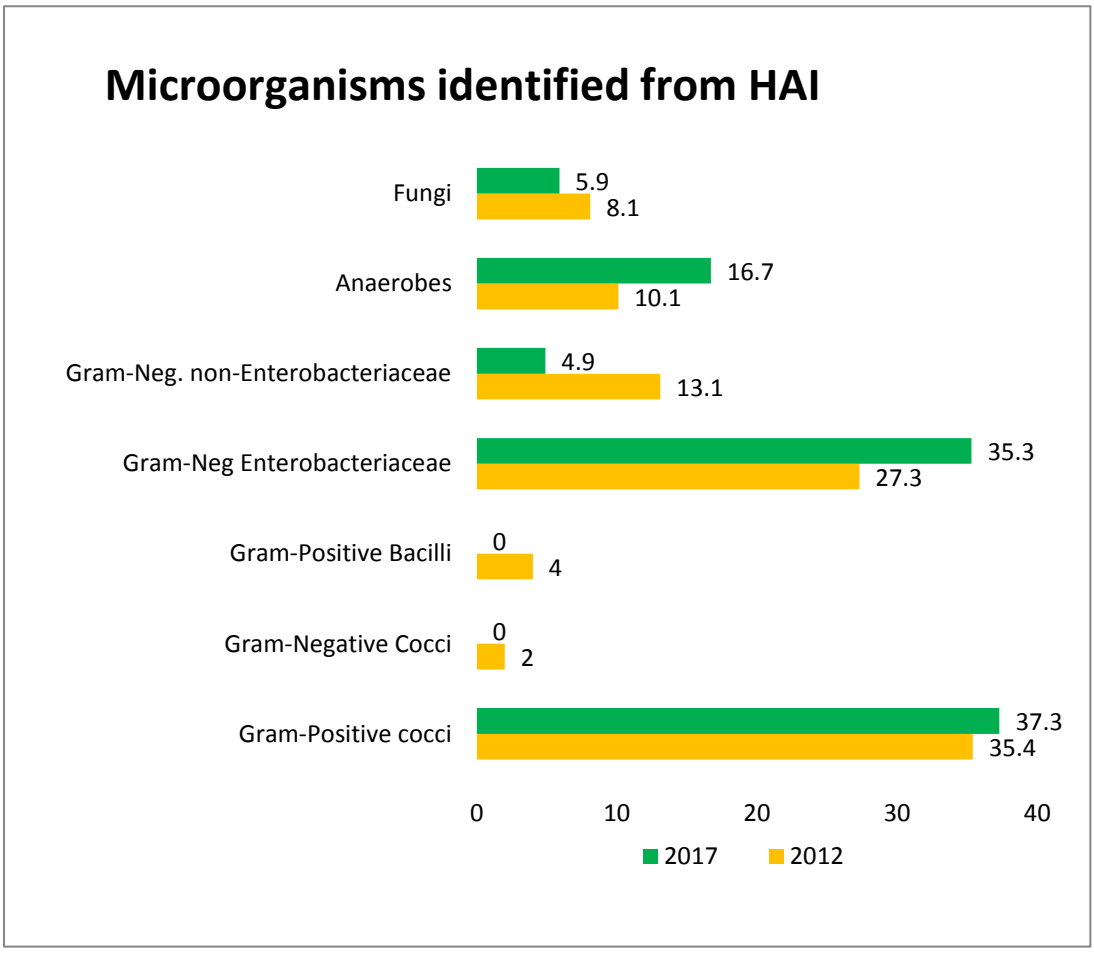
5. Microbiology results

5.1. Microorganisms

One third (35.3%) of infections had positive microbiology available, the remaining infections were determined on the basis of clinical signs and symptoms. A total of 102 microorganisms were reported for 241 infections (up to three microorganisms could be recorded per infection). Positive microbiology results were not available in approximately two thirds of HAI, either because the result was not available (27.3%), the examination was not done (29.9%), microorganism was not identified (7.5%) or a sterile specimen was received (0.4%).

Gram-positive cocci were the most frequently recorded organisms accounting for 37.3% of all microorganisms (*Staphylococcus aureus 18.6% and Enterococcus spp*. *9.8%*); followed by gram-negative Enterobacteriaceae 35.2% (*Escherichia coli 20.6%* was the most common organism in this group).The proportion of anaerobic bacilli was 16.7%, with *Clostridium difficile* being the most common at 12.7%, followed by Fungi and Gram negative non-enterobacteriaceae - 5.9% and 4.9% respectively - see Figure 6 and Table 20.

Figure 6 Classification of microorganisms



A detailed breakdown of microorganisms for the most common HAIs (pneumonia/LRTI, SSI, UTI, BSI and GI) is shown in Appendix B Table VI

Table 20 Microorganisms in Northern Ireland PPS 2012 & 2017

Microorganisms	Number in 2012	% of total	Number in 2017	% of total
Total	99	100	102	100
Gram-positive cocci	35	35.4	38	37.3
Staphylococcus aureus	14	14.1	19	18.6
Coag. negative staphylococci	7	7.1	5	4.9
***Streptococcus* spp.**	2	2.0	3	3.0
***Enterococcus* spp.**	12	12.1	10	9.8
Other gram positive or not specified	0	-	1	1.0
Gram-negative cocci	2	2.0	0	-
Gram-positive bacilli	4	4.0	0	-
Gram-negative Enterobacteriaceae	27	27.3	36	35.3
***Citrobacter* spp.**	2	2.0	0	-
***Enterobacter* spp.**	2	2.0	1	1.0
Escherichia coli	8	8.1	21	20.6
***Klebsiella* spp.**	3	3.0	5	4.9
***Proteus* spp.**	10	10.1	3	2.9
***Serratia* spp.**	1	1.0	1	1.0
***Hafnia* spp.**	0	-	1	1.0
Other Enterobacteriaceae	1	1.0	4	3.9
Gram-neg. non-enterobacteriaceae	13	13.1	5	4.9
Acinetobacter baumannii	0	-	1	1.0
Pseudomonas aeruginosa	4	4.0	2	1.9
Stenotrophomonas maltophilia	1	1.0	0	-
Pseudomonadaceae family, other	4	4.0	1	1.0
***Haemophilus* spp.**	1	1.0	0	-
Other Non-enterobacteriaceae	3	3.0	1	1.0
Anaerobic Bacilli	10	10.1	17	16.7
Clostridium difficile	8	8.1	13	12.7
Other Anaerobes	2	2.0	4	3.9
Fungi	8	8.1	6	5.9
***Candida* spp.**	7	7.1	4	3.9
Other Parasites	1	1.0	2	2.0

5.2. Microbiology – Antimicrobial sensitivity

The number of reports for microorganisms of public health importance, as defined by European Centre for Disease Prevention and Control (ECDC), and their sensitivity to selected antimicrobials is shown in Table 21. Sensitivity data were reported for 16 *Staphylococcus aureus* isolates -13 meticillin sensitive (MSSA) and 3 meticillin resistant (MRSA). In total 36 Enterobacteriaceae isolates had sensitivity data reported. Of these sixteen were sensitive to both third generation cephalosporins and carbapenems; one was resistant to third generation cephalosporins but sensitive to carbapenems; none were identified as resistant to both third generation cephalosporins and carbapenems. Ten *Enterococcus* spp. isolates had

sensitivity data, four were glycopeptide sensitive but a further 4 were resistant, with two results unknown at the time of the survey. One *Acinetobacter baumannii* was recorded which was sensitive to carbapenem. Two *Pseudomonas* isolates were identified, but resistance results were not available for either of these.

Table 21 ECDC-defined antimicrobial resistance

Microorganism	Sensitivity	Number	%
Staphylococcus aureus	Meticillin or sensitive (MSSA)	13	81.2
	Meticillin or resistant (MRSA)	3	18.8
	Total	16	100%
***Enterococcus* spp.**	Glycopeptide sensitive	4	40.0
	Glycopeptide resistant	4	40.0
	Not recorded	2	20.0
	Total	10	100%
Enterobacteriaceae*	3rd generation cephalosporin sensitive + carbapenem sensitive	16	44.4
	3rd generation cephalosporin resistant + carbapenem sensitive	1	2.8
	3rd. generation cephalosporin resistant + carbapenem resistant	0	0.0
	Not recorded	19	52.8
	Total	36	100%
Acinetobacter baumannii	Carbapenem sensitive	1	100.0
	Carbapenem resistant	0	0.0
	Not recorded	0	0.0
	Total	1	100%

* Enterobacteriaceae: *Escherichia coli, Klebsiella* spp., *Enterobacter* spp., *Proteus* spp., *Citrobacter* spp., *Serratia* spp., *Morganella* spp.

6. Antimicrobial use

6.1. Antimicrobial use in Northern Ireland

A total of 1,385 patients were receiving 2,073 antimicrobials at the time of the survey. The overall prevalence of antimicrobial use was 36.3% (95%CI 34.8 – 37.9). Appendix B Table III shows a detailed breakdown of HAI and antimicrobial use by patient risk factors. Comparable rates of antimicrobial use in Europe and UK administrations are shown in Table 22.

Table 22 Prevalence of antimicrobial use for 2012 & 2017 PPS in Europe and UK

Country	AMU prevalence 2011/12	AMU prevalence 2016/17
Europe – ECDC PPS	35.0 (34.8 – 35.2)	To be published
England (Acute) (1)	34.3 (30.1 – 39.2)	To be published
Scotland (Acute) (2) (3)	32.3 (30.9 – 33.8)	35.3 (33.8 – 36.7)
Wales (Acute) (4) (5)	32.7 (31.6 – 33.9)	34.2 (33.0 – 35.3)
Northern Ireland	29.5 (28.1 – 30.9)	36.3 (34.8 – 37.9)

The number of antimicrobials prescribed per patient is shown in Table 23. A total of 127 patients were receiving three or more antimicrobials, i.e. 3.3% of the total hospital population and 9.2% of those receiving antimicrobials.

Table 23 Number of antimicrobials prescribed per patient in 2012 & 2017

Number of antimicrobials per patient	2012 Number of patients	% patients	2017 Number of patients	% patients
Zero	2,814	70.5	2428	63.7
One	744	18.6	851	22.3
Two	324	8.1	407	10.7
Three	84	2.1	102	2.7
Four	23	0.6	23	0.6
Five or more	3	0.1	2	0.1

Over one third of males (37.5%) received antimicrobials and the proportion for females was similar at 35.3%. The percentage of patients aged 0- 64 receiving antimicrobials was 32.3%, significantly lower ($p<0.01$) than those aged 65 or over (39.6%), see Table 24.

Table 24 Prevalence of antimicrobial use by age group 2012 & 2017

Age group	2012 Antimicrobial use prevalence % (95%CI)	2017 Number (n=3,813)	Number receiving antimicrobials	Antimicrobial use prevalence % (95%CI)
< 1 month	12.4 (8.4– 17.9)	168	33	19.6 (14.3-26.3)
1-23 months	28.1(20.1–37.8)	43	16	37.2(24.4-52.1)
2-15 years	36.6 (27.9–46.4)	115	31	27.0 (19.7-35.7)
16-29 years	23.4 (19.0–28.5)	242	79	32.6 (27.0-38.8)
30-49 years	25.3 (21.9–28.9)	487	154	31.6 (27.6-35.9)
50-64 years	32.9 (29.4–36.6)	640	234	36.6 (32.9-40.4)
65-79 years	34.5 (31.8–37.4)	1,116	452	40.5 (37.7-43.4)
80+ years	28.7 (26.0–31.7)	1,002	386	38.5 (35.6-41.6)

6.2. Antimicrobial use – Route of administration and reason in notes

Over six in ten of all antimicrobials were administered parenterally (62.4%), followed by oral (37.0%) – see Table 25. A larger proportion of those aged 0-65 years received antimicrobials parenterally compared with those aged over 65 years (68.7% and 58.3% respectively).

Table 25 Antimicrobial use – Route of administration 2012 & 2017

Route of administration	2012 - Number antimicrobials	2017 - Number antimicrobials	% of all antimicrobials (95%CI)
Parenteral	1,139 (65.2)	1,294	62.4 (60.3 – 64.6)
Oral	606 (34.6)	767	37.0 (34.9 – 39.2)
Inhalation	3 (0.2)	4	0.2 (0.0 - 2.4)
Unknown	3 (0.2)	8	0.4 (0.0 – 2.6)

Information was collected on whether the reason for prescribing was recorded in the medical notes or drug chart by a clinician. This was recorded for 1,941 antimicrobials (93.6% of the total), see Table 26.

Table 26 Antimicrobial use – Reason in notes 2012 & 2017

Reason in notes	2012 Number antimicrobials	% of all antimicrobials (95%CI)	2017 Number of antimicrobials	% of all antimicrobials (95%CI)
Yes	1,587	90.6 (89.2 – 91.9)	1,941	93.6 (92.7 - 94.6)
No	113	6.5 (5.4 – 7.7)	114	5.5 (4.5 - 6.5)
Notes not available	51	2.9 (2.2 – 3.8)	13	0.6 (0 - 1.6)

6.3. Antimicrobial use – Indication for prescribing

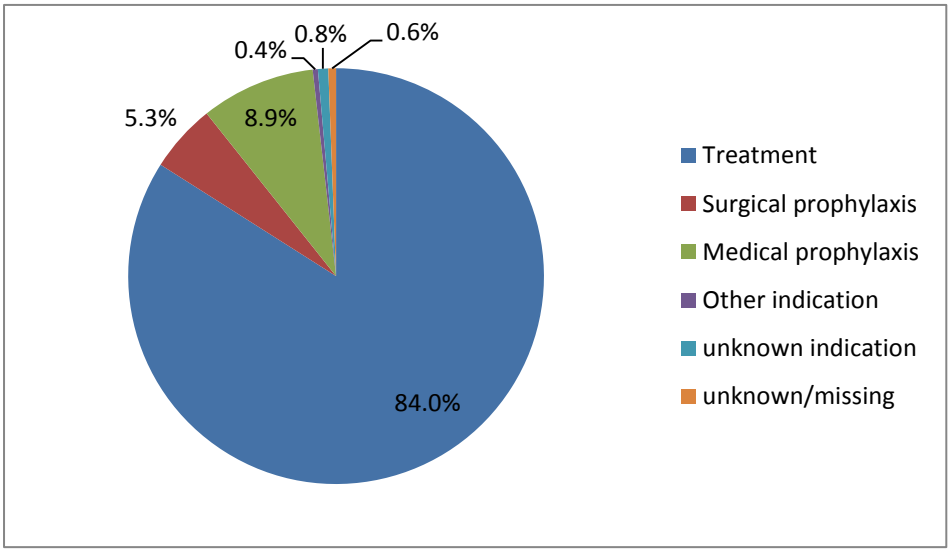
The most common reason for antimicrobial prescribing was for infections considered to be community acquired. There were 861 patients treated for community acquired infection or 22.6% of the hospital population. Treatment of community acquired infection accounted for 60.6% of all prescribed antimicrobials.

Surgical prophylaxis and medical prophylaxis accounted for 5.3% and 8.9% of all antimicrobials respectively, see Table 27 and Figure 7. Surgical prophylaxis continued for more than 24 hours in 23.3% of cases (20/86). Appendix B Table IV shows antimicrobial agents by indication for use.

Table 27 Antimicrobial use – Indication for prescribing

Indication for antimicrobial use	2012 Number of patients	2012 % antimicrobials (95%CI)	2017 Number patients	2017 Number antimicrobials	2017 % antimicrobials (95%CI)
Total	1,178	100%	1,385	2,073	100%
Treatment	940	80.5 (78.6 – 82.3)	1,183	1,741	84.0 (82.3 – 85.5)
Community infection	714	60.1 (57.8 – 62.4)	861	1,256	60.6 (58.5 - 62.7)
Hospital infection	201	18.3 (16.5 – 20.2)	307	445	21.5 (19.3 - 23.6)
Other HAI	25	2.1 (1.5 – 2.9)	28	40	1.9 (0 - 4.1)
Surgical prophylaxis	96	7.0 (5.9 – 8.3)	79	110	5.3 (4.4 – 6.4)
Single dose	65	5.0 (4.1 – 6.1)	36	47	2.3 (0.1 - 4.4)
One day	20	1.3 (0.8 – 1.9)	30	39	1.9 (0 - 4)
>1 day	11	0.7 (0.4 – 1.3)	20	24	1.2 (0 - 3.3)
Medical prophylaxis	77	6.6 (5.6 – 7.9)	152	184	8.9 (6.8 - 11)
Other indication	34	3.0 (2.3 – 3.9)	9	9	0.4 (0 - 2.6)
Unknown/missing	31	2.9 (2.2 – 3.8)	25	29	1.4 (1.0 – 2.0)

Figure 7 Antimicrobial indication as a proportion of all antimicrobials prescribed



6.4. Antimicrobial use – Treatment

A total of 1,741 antimicrobials were prescribed for treatment of active infection, acquired either in hospital, community or long term care, accounting for 84.0% of all antimicrobials. These were used to treat 1,183 patients. The vast majority of antimicrobials for treatment (92.3%) were for five system infection groups, i.e. respiratory, skin& soft tissue/bone/joint, urinary tract, systemic and gastrointestinal infections. The most common diagnosis for treatment of active infection was respiratory tract infection; accounting for 35.2% of treatment intentions, see Table 28 and Appendix B Table V.

Table 28 Antimicrobial treatment, diagnosis site by indication

Site of infection	Treatment of infection – 2017		
	Diagnoses Number	Community infection Number	Hospital infection Number
Total	1,746	1,235	444
Respiratory tract	614	435	163
Skin/soft tissue/bone/joint	254	174	71
Urinary tract	201	158	31
Systemic infections	257	171	66
Gastro-intestinal system	288	208	77
Eye/ear/nose/throat	57	32	22
Central nervous system	31	24	6
Cardiovascular system	17	13	1
Genito-urinary system	27	20	7

6.4.1. Treatment of infection – Antimicrobial agents

Table 29 shows that twenty antimicrobials accounted for 90% of antimicrobials prescribed for treatment of infection (n=1,564). The antimicrobials prescribed for treatment of infection in patients surveyed. The most commonly prescribed antimicrobial for management of infection was piperacillin and enzyme inhibitor (piperacillin-tazobactam), accounting for 18.2%, marginally lower than the 20.4% recorded in 2012. Amoxicillin in combination with an enzyme inhibitor (co-amoxiclav) was the second most commonly prescribed antimicrobial for treatment of infection (9.6%, similar to the 10.8% reported in 2012); followed by amoxicillin (8.6%, unchanged from 8.1% in 2012).

Ciprofloxacin and clindamycin accounted for 3.8% and 1%, respectively, of antimicrobials prescribed for the treatment of infection, virtually unchanged since 2012. Cephalosporins accounted for 2.6% of all antimicrobials for treatment of infection, slightly higher than the 2.1% seen in 2012. A detailed breakdown of antimicrobial agents for treatment of infection is shown in Appendix B Table IV.

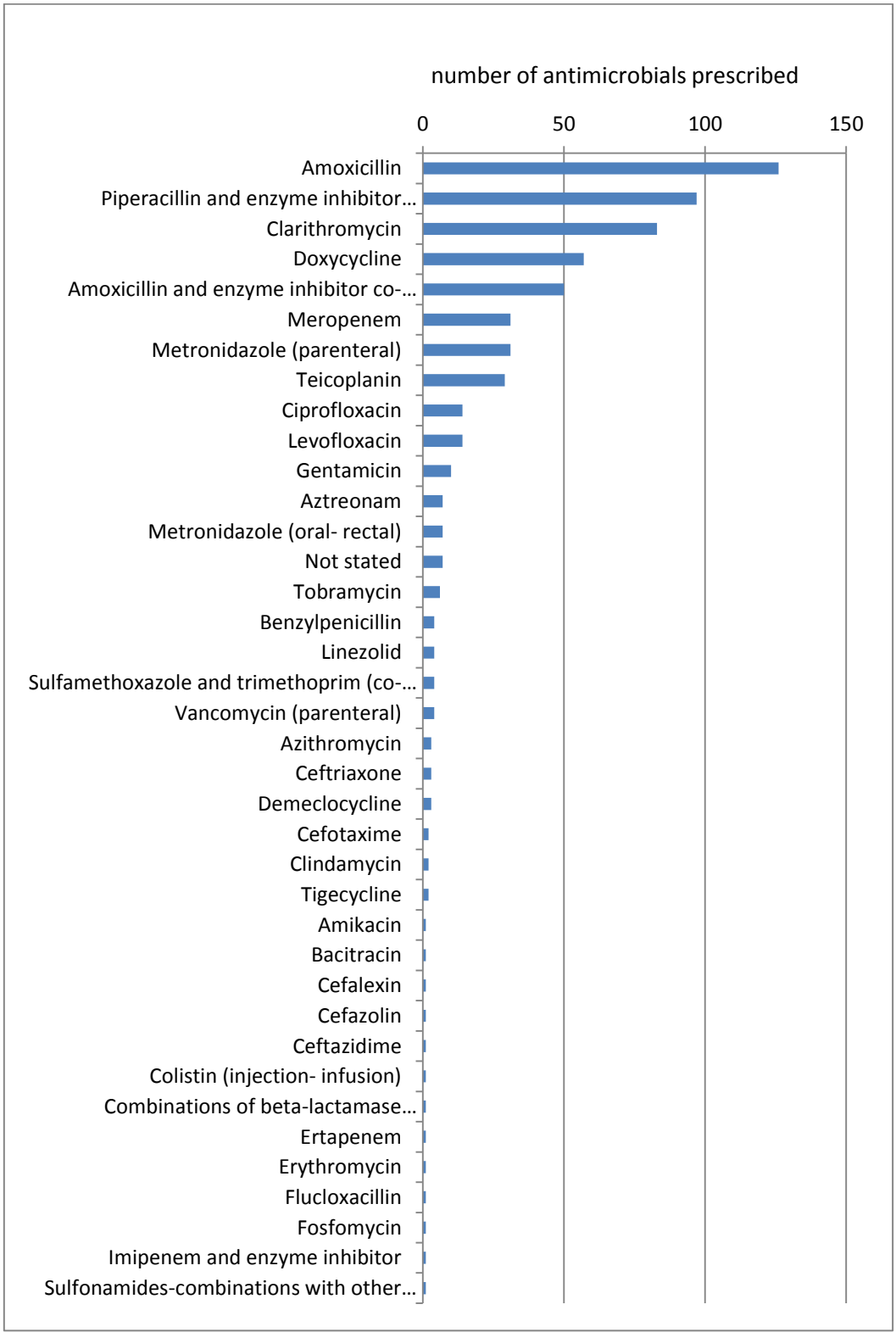
Table 29 – Antimicrobials for treatment of infection - 2017

Antimicrobial	Total number of antimicrobial agents for treatment	Proportion %
Total	1,741	100
Piperacillin and enzyme inhibitor	316	18.2
Amoxicillin	167	9.6
Amoxicillin and enzyme inhibitor	149	8.6
Gentamicin	115	6.6
Metronidazole (parenteral)	96	5.5
Clarithromycin	91	5.2
Teicoplanin	82	4.7
Flucloxacillin	80	4.6
Doxycycline	79	4.5
Meropenem	71	4.1
Ciprofloxacin	67	3.8
Metronidazole (oral- rectal)	45	2.6
Benzylpenicillin	43	2.5
Nystatin	34	2
Vancomycin (parenteral)	27	1.6
Ceftriaxone	25	1.4
Trimethoprim	24	1.4
Fluconazole	20	1.1
Clindamycin	17	1
Levofloxacin	16	0.9
Others	177	10.9

6.4.2. Treatment of respiratory infection – Antimicrobial agents

Figure 8 shows the distribution of antimicrobials prescribed for treatment of respiratory infections, i.e. pneumonia, acute bronchitis or exacerbations of chronic bronchitis (agents=39; prescriptions=614). Ten antimicrobials accounted for 86.7% of all antimicrobials prescribed for respiratory infections (prescriptions=614); the most common being amoxicillin, displacing piperacillin and enzyme inhibitor (piperacillin-tazobactam) since 2012 (prescriptions=126).

Figure 8 Antimicrobials prescribed for treatment of respiratory infections

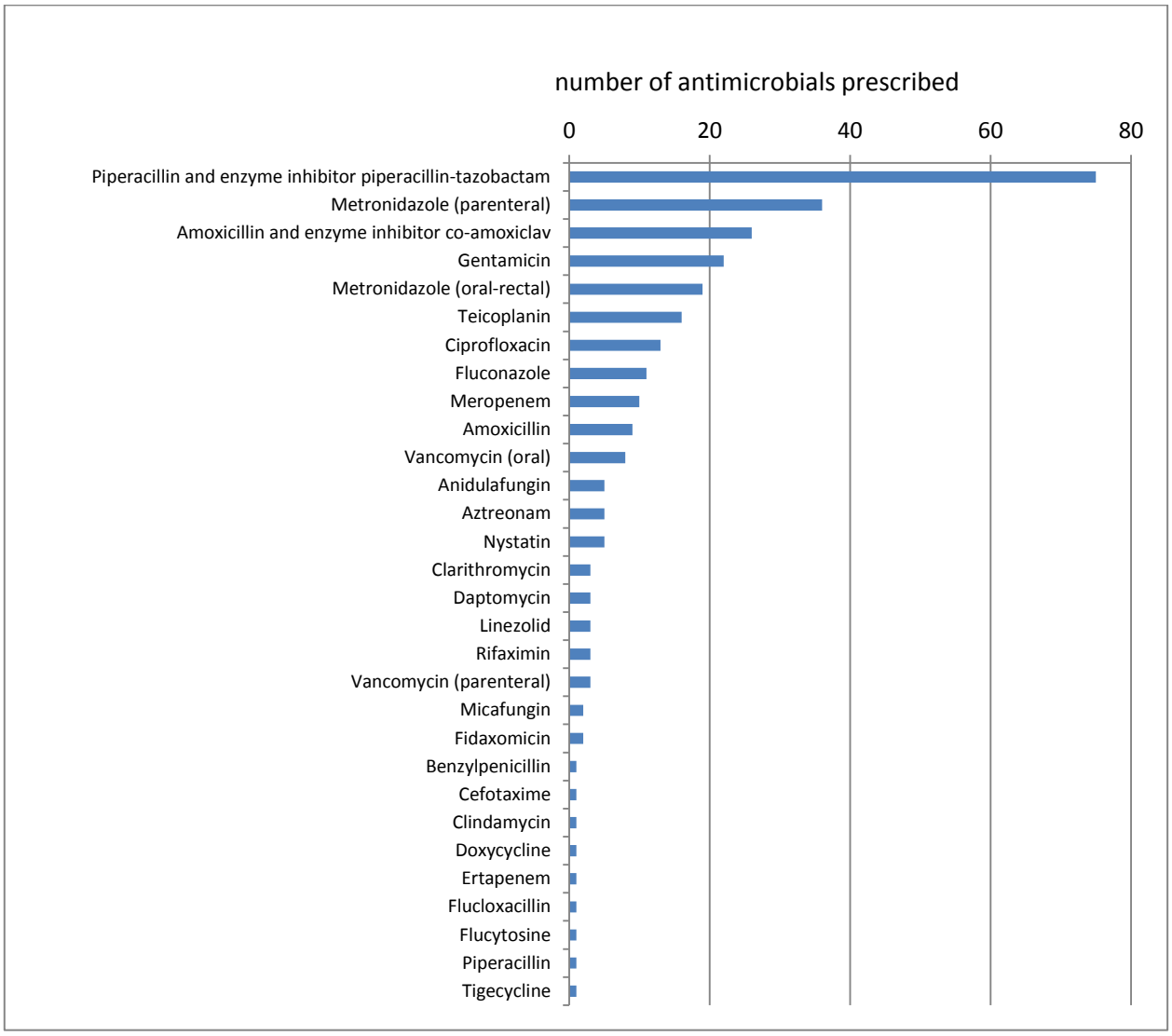


6.4.3. Treatment of gastrointestinal infections – Antimicrobial agents

Figure 9 illustrates the distribution of antimicrobials prescribed for treatment of gastrointestinal infections (agents=30; prescriptions=288). A total of 237 prescriptions were for treatment of intra-abdominal sepsis and 51 for treatment of gastroenteritis inclusive of *Clostridium difficile* infection. Three antimicrobials accounted for 47.6% of all antimicrobials prescribed in this category. As was the case in 2012, the most commonly prescribed antimicrobial

(prescriptions=75) was piperacillin and enzyme inhibitor (piperacillin-tazobactam) followed by metronidazole.

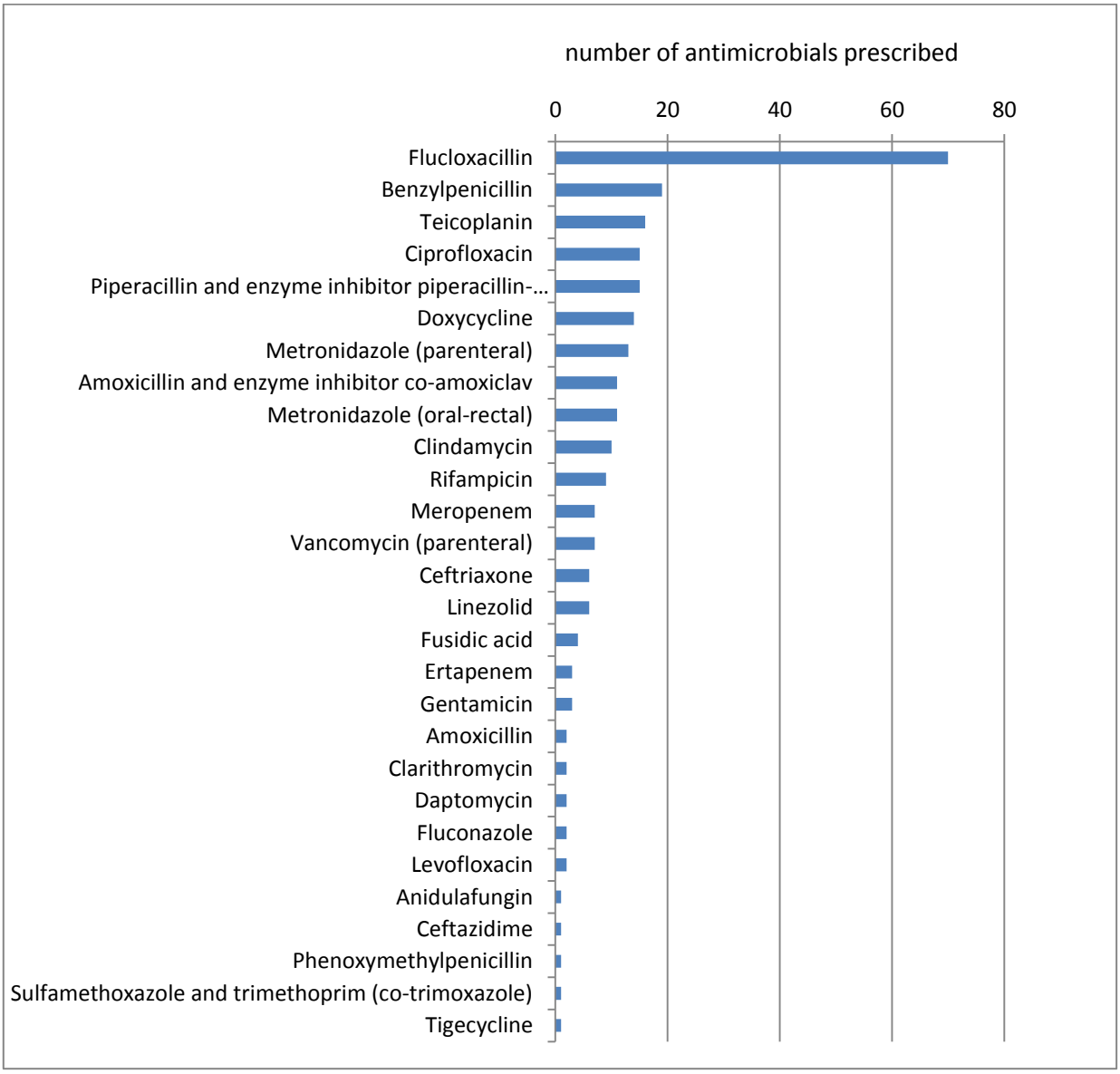
Figure 9 Antimicrobials prescribed for treatment of gastrointestinal infections



6.4.4. Treatment of skin & soft tissue/bone & joint infections – Antimicrobial agents

Figure 10 shows the distribution of antimicrobials prescribed for treatment of skin & soft tissue/bone & joint infections (agents= 28; prescriptions=254). Ten antimicrobials accounted for 76.3% of all antimicrobials prescribed in this category (prescriptions= 194). Since 2012, flucloxacillin remains the most commonly prescribed antimicrobial (prescriptions=70) accounting for 27.6% of all prescriptions.

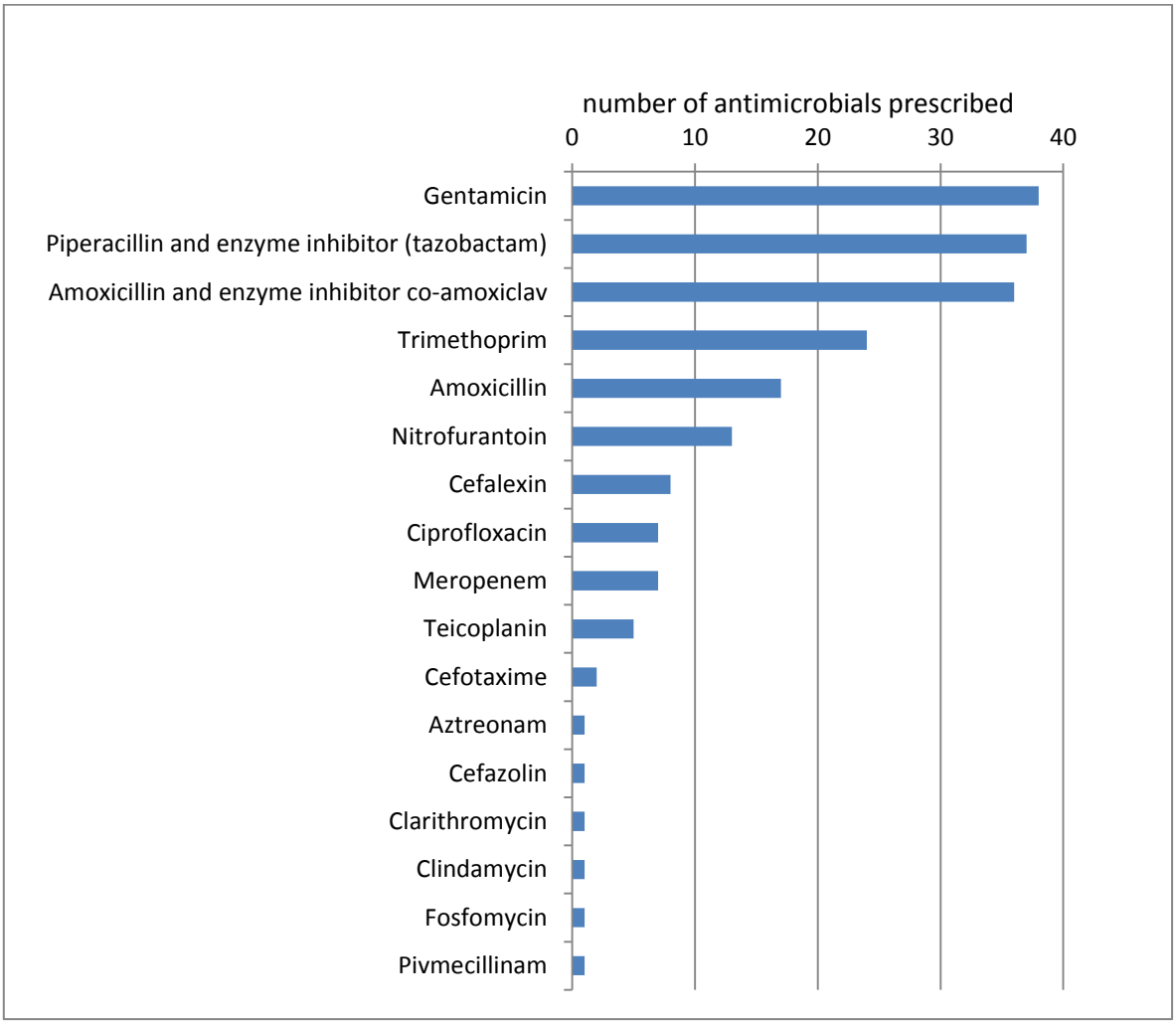
Figure 10 Antimicrobials prescribed for treatment of skin & soft tissue/bone & joint infections



6.4.5. Treatment of urinary tract infection (UTI) – Antimicrobial agents

Figure 11 shows the distribution of antimicrobials prescribed for the treatment of urinary tract infections (agents=18; prescriptions= 201). Five antimicrobials accounted for over 75% with gentamicin being the most commonly prescribed (prescriptions=38), closely followed by Piperacillin-Tazobactam.

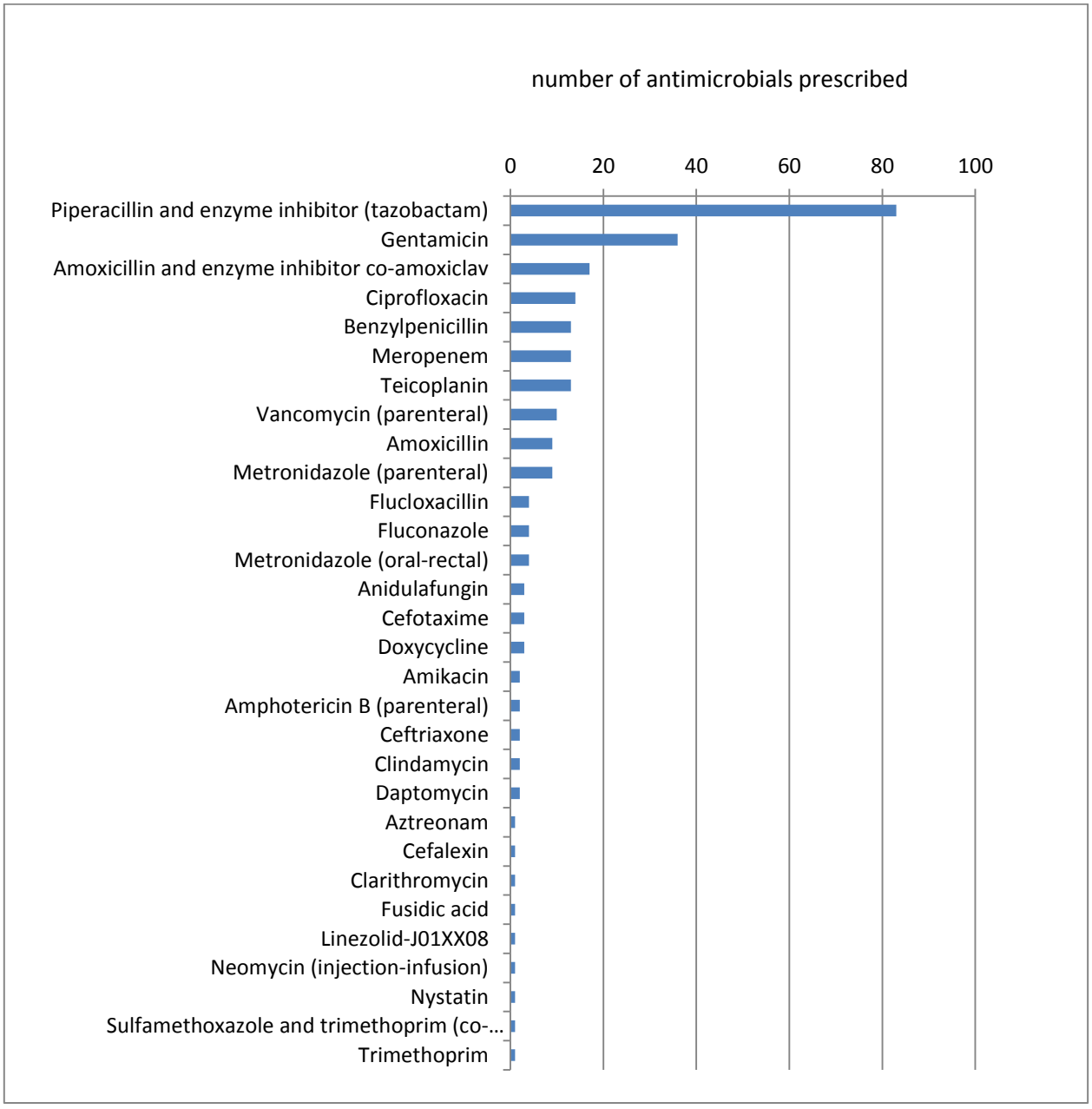
Figure 11 Antimicrobials prescribed for treatment of UTI



6.4.6. Treatment of systemic infection – Antimicrobial agents

Figure 12 shows the distribution of antimicrobials prescribed for treatment of systemic infections (agents= 30; prescriptions= 257). This diagnosis category included: laboratory-confirmed bacteraemia; clinical sepsis (suspected bloodstream infection without lab confirmation); febrile neutropenia or other manifestation of infection in an immunocompromised host; systemic inflammatory response with no clear anatomic site and undefined site with no systemic inflammation. Five antimicrobials accounted for 63.4% of antimicrobials prescribed in this diagnostic category (prescriptions=163). The most commonly prescribed antimicrobial for systemic infections (prescriptions=83) was piperacillin and enzyme inhibitor (piperacillin-tazobactam), remaining unchanged since 2012, and was over twice as likely to be prescribed as the next most frequently used antibiotic, gentamicin. Piperacillin-tazobactam and gentamicin accounted for 46.3% of antibiotics prescribed for systemic infection.

Figure 12 Antimicrobials prescribed for treatment of systemic infections



6.5. Antimicrobial use – Surgical prophylaxis

A total of 15 different antimicrobial agents were used for surgical prophylaxis; representing 110 prescriptions, i.e. 5.3% of all antimicrobials recorded (110/2073). The five most commonly used antimicrobials accounted for 83.6% of the total used for surgical prophylaxis. Cefuroxime was the most commonly prescribed agent in this category (23.6% of total), which was a move away from amoxicillin and enzyme inhibitor (co-amoxiclav) in 2012 - (Table 30). A detailed breakdown of antimicrobial agents for surgical prophylaxis is shown in Appendix B Table IV Overall, 23.3% of surgical prophylaxis was given for more than one-day.

Table 30 Surgical prophylaxis – Distribution of antimicrobials 2017

Antimicrobial name	Total number of antimicrobial agents	Proportion %
Total	110	100
Cefuroxime	26	23.6
Gentamicin	21	19.1
Amoxicillin and enzyme inhibitor co-amoxiclav	20	18.2
Flucloxacillin	14	12.7
Teicoplanin	11	10
Metronidazole (parenteral)	9	8.2
Amoxicillin	1	0.9
Clarithromycin	1	0.9
Clindamycin	1	0.9
Doxycycline	1	0.9
Fluconazole	1	0.9
Meropenem	1	0.9
Metronidazole (oral- rectal)	1	0.9
Piperacillin and enzyme inhibitor piperacillin-tazobactam	1	0.9
Not specified	1	0.9

6.6. Antimicrobial use – Medical prophylaxis

A total of 26 different antimicrobial agents were used for medical prophylaxis representing 184 prescriptions, i.e. 8.9% of all antimicrobials reported. The most prescribed antimicrobial for medical prophylaxis (27.7%) was sulfamethoxazole & trimethoprim (co-trimoxazole). Antifungal agents accounted for 20.6% of all medical prophylaxis, see Table 31. A detailed breakdown of antimicrobial agents for medical prophylaxis is shown in Appendix B Table IV.

Table 31 Medical prophylaxis – Distribution of antimicrobials 2017

Antimicrobial name	Total number of antimicrobial agents	Proportion %
Total	184	100%
Sulfamethoxazole and trimethoprim (co-trimoxazole)	51	27.7
Nystatin#	24	13
Azithromycin	16	8.7
Rifaximin	13	7.1
Cefalexin	12	6.5
Ciprofloxacin	7	3.8
Nitrofurantoin	7	3.8
Amoxicillin	6	3.3
Amphotericin B (parenteral)#	6	3.3
Doxycycline	6	3.3
Sulfonamides-combinations with other antibacterials (ex. trimethoprim)	6	3.3
Phenoxymethylpenicillin	4	2.2
Trimethoprim	4	2.2
Benzylpenicillin	3	1.6
Colistin (injection- infusion)	3	1.6
Gentamicin	3	1.6
Fluconazole#	2	1.1
Itraconazole#	2	1.1
Posaconazole#	2	1.1
Amoxicillin and enzyme inhibitor co-amoxiclav	1	0.5
Caspofungin#	1	0.5
Demeclocycline	1	0.5
Erythromycin	1	0.5
Voriconazole#	1	0.5
Piperacillin and enzyme inhibitor (Tazobactam)	1	0.5
Not specified	1	0.5
# antifungal agent		

6.7. Antimicrobial use by hospital type

The highest prevalence of antimicrobial prescribing was in ‘secondary’ level hospitals, with 39% of patients receiving antimicrobials, followed by ‘primary’ level hospitals with 38.5% of patients receiving antimicrobials (Table 32a), see Table 3 for hospital classification list.

There was a high degree of overlap in prevalence of antimicrobial use within hospital types, the only significant difference was in specialised hospitals, for example, antimicrobial use was higher in a children’s hospital compared to an orthopaedic hospital (Figure 13).

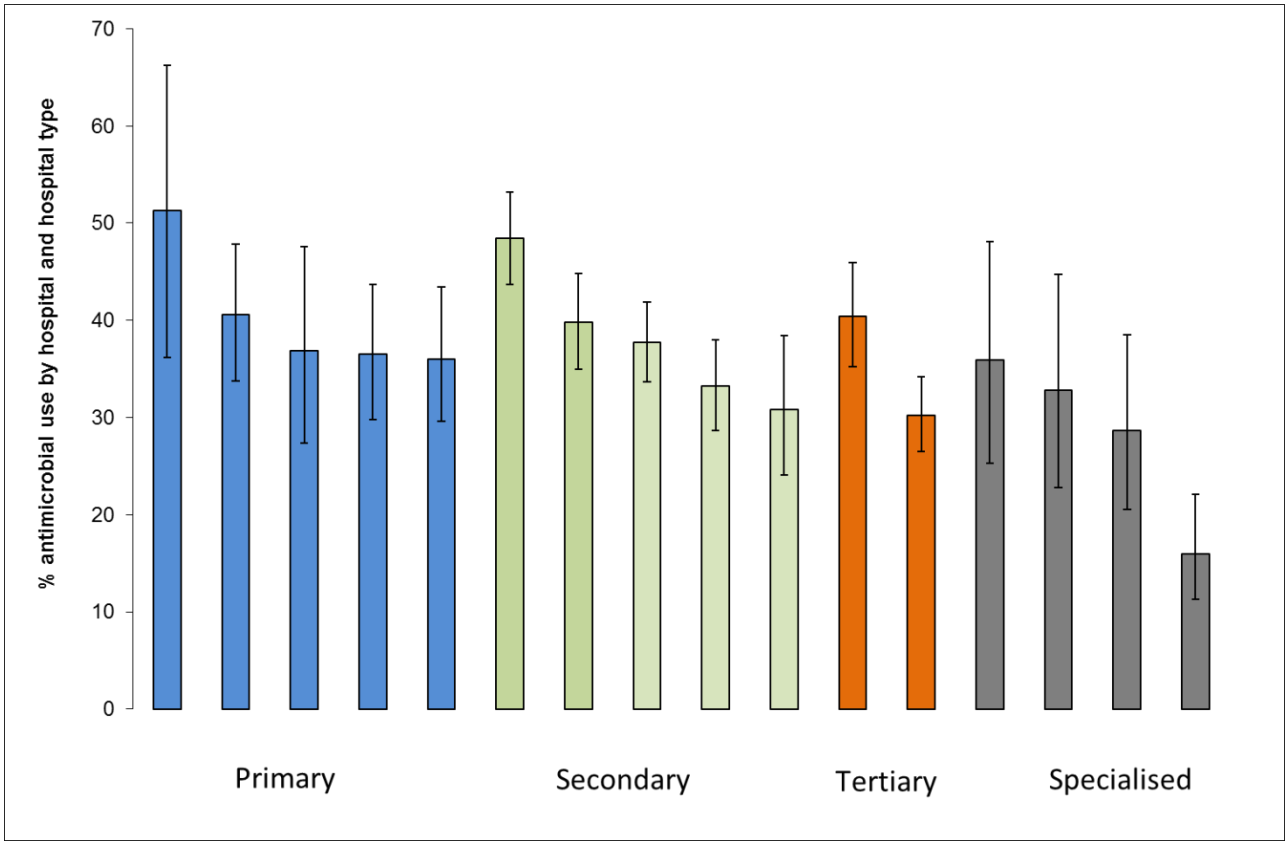
Table 32a Prevalence of antimicrobial use by hospital type

Hospital type	2012	2017		
	AMU prevalence % (95%CI)	Number of patients	Number of patients receiving AM	AMU prevalence % (95%CI)
Primary	31.5 (28.1 – 35.2)	663	255	38.5 (34.8 – 42.2)
Secondary	28.4 (26.4 – 30.4)	1892	738	39.0 (36.8 – 41.2)
Tertiary	32.9 (30.0 – 35.9)	858	292	34.0 (30.9 – 37.3)
Specialised	23.8 (19.9 – 28.0)	400	100	25.0 (21.0 – 29.5)

Table 32b Total volume of antimicrobials prescribed by hospital type

Hospital type	2017 Number of patients	2017 Number of prescriptions	Number of scripts per 100 patients
Total	3813	2073	54.37
Primary	663	361	54.45
Secondary	1892	1136	60.04
Tertiary	858	440	51.28
Specialised	400	136	34.00

Figure 13 Antimicrobial use prevalence for individual hospital by hospital type



6.8. Antimicrobial use by ward specialty

The highest prevalence of antimicrobial prescribing was in adult ICU, where 64.9% of patients received antimicrobials, an increase of almost ten percentage points since 2012 (Table 33). This was followed by mixed specialty wards and medical wards, where 50.8% and 40.6% of patients respectively received antimicrobials. The lowest prevalence of antimicrobial use was in Rehabilitation (7.5%).

Table 33 Prevalence of antimicrobial use by ward specialty 2017

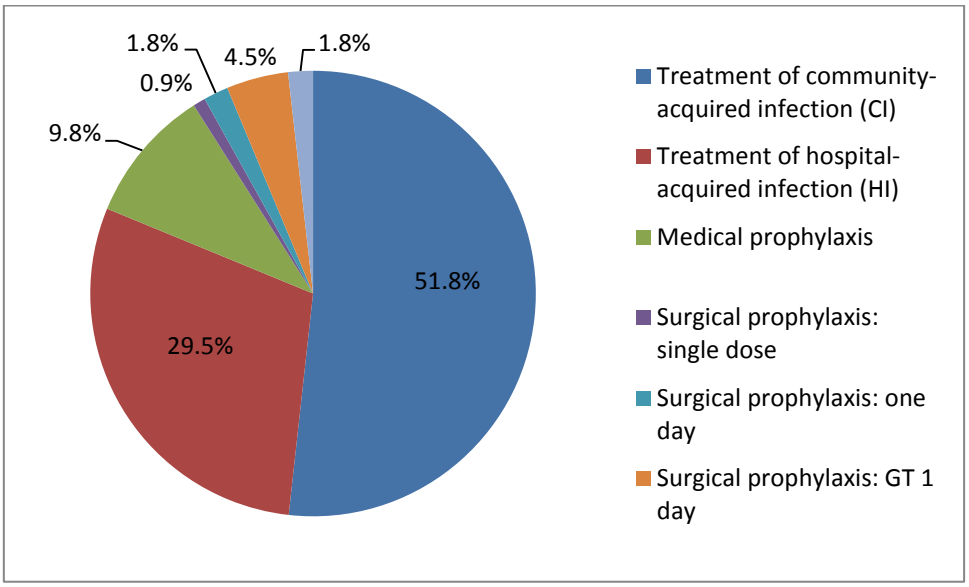
Ward specialty	Number of patients	Number receiving antimicrobials	Antimicrobial use prevalence percent (95%CI)
All specialties	3,813	1,385	36.3 (34.7 - 37.9)
Care of the elderly	371	125	33.7 (28.9 - 38.8)
Adult ICU	74	48	64.9 (52.9 - 75.6)
Medical	1597	649	40.6 (38.2 - 43.1)
Obstetrics/Gynae	329	69	21.0 (16.7 - 25.8)
Paediatrics	227	71	31.3 (25.6 - 37.6)
Surgical	988	331	33.5 (30.6 - 36.5)
Mixed specialty	132	67	50.8 (41.9 – 59.6)
Rehabilitation	40	3	7.5 (1.6 - 20.4)
Other	55	22	40.0 (27 - 54.1)

6.9. Antimicrobial use for paediatric patients

Paediatric patients were defined as those aged less than 16 years, whether found on an adult or paediatric ward. There were 326 paediatric patients and 80 (24.5%) (95%CI 20.2 – 29.5) were receiving antimicrobials. Neonates, on postnatal wards (n=84) 'well babies', had a low AMU prevalence (7.1%). The AMU prevalence in paediatric patients (0-15 years), excluding 'well babies', was 30.8% (95%CI 25.3 – 36.9).

Over eight in ten (80.5%) of antimicrobials administered to patients under 16-year old was for treatment of infection, Figure 14. The most common reason for antimicrobial prescribing in paediatrics was for infections reported as community acquired – 51.3%, followed by a hospital associated infection (29.2%). Surgical prophylaxis and medical prophylaxis accounted for 7.1% and 9.7% of all antimicrobials respectively.

Figure 14 Antimicrobial indication for paediatric patients



6.10. Antimicrobial use – Appropriateness of prescribing

All Health and Social Care Trusts in Northern Ireland have developed local guidelines addressing best practice for antimicrobial use in the hospital setting. Each prescription recorded during the survey was assessed as compliant or non-compliant with local guidelines. During the survey, 11.7% of all antimicrobials were noted as non-compliant with local guidelines and 14.4% were recorded as 'not assessable', i.e. antimicrobial administered for medical prophylaxis, or administered for treatment of infection in absence of local prescribing guideline, or antimicrobials administered for surgical prophylaxis in absence of local prescribing guideline, see Figure 15. Over a quarter (50/176; 28.4%) of amoxicillin and enzyme inhibitor (co-amoxiclav) prescriptions did not meet local prescribing guidelines, (Table 34)

Figure 15 Antimicrobials - Compliant with local guideline

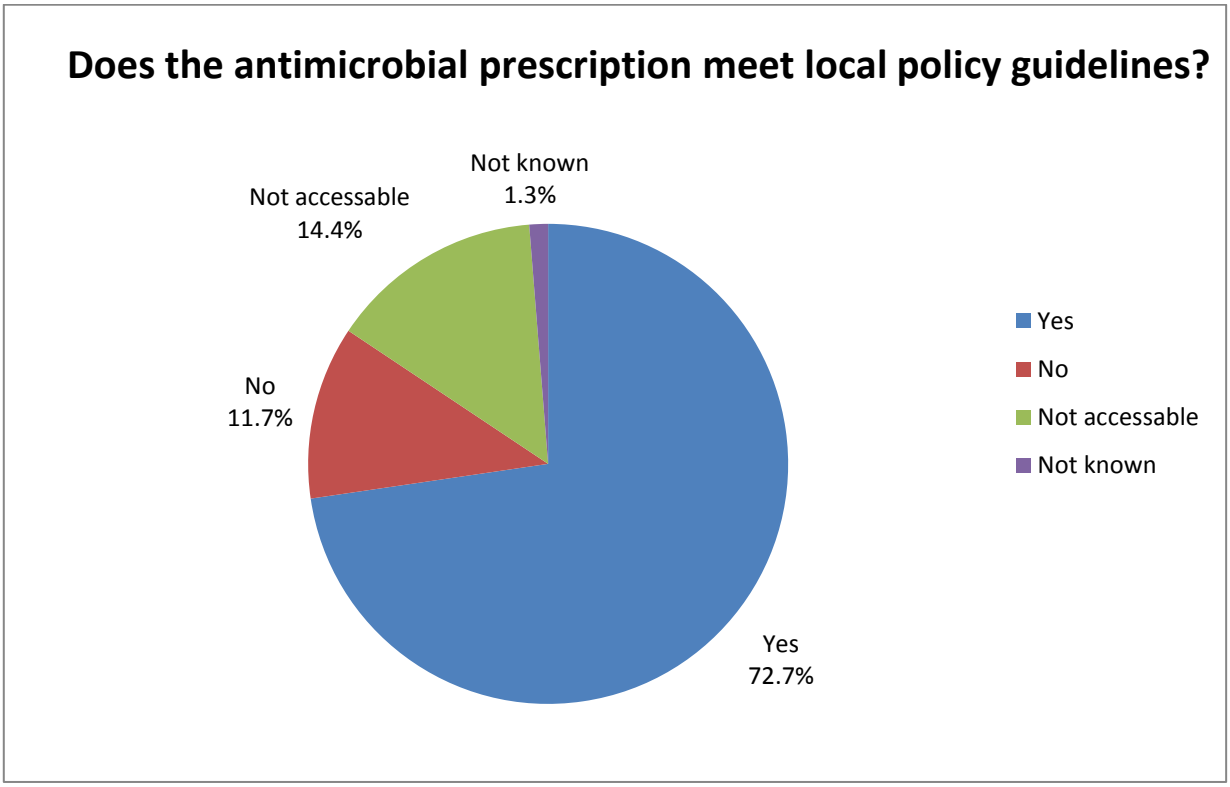


Table 34 Antimicrobials – Non-compliant antimicrobials (Top 10 named) 2017

Antimicrobial	Total antimicrobials	Number non-compliant	% non-compliant
Total	2073	241	11.6
Amoxicillin and enzyme inhibitor (co-amoxiclav)	176	50	28.4
Piperacillin and enzyme inhibitor (Pip Taz)	322	50	15.5
Amoxicillin	177	20	11.3
Clarithromycin	92	16	17.4
Metronidazole (parenteral)	105	15	14.3
Doxycycline	87	9	10.3
Gentamicin	139	9	6.5
Teicoplanin	93	9	9.7
Meropenem	75	8	10.7
Metronidazole (oral-rectal)	48	8	16.7
Other antimicrobials (agents = 22)	759	47	6.2

7. Infection, prevention and control and antimicrobial stewardship indicators

A summary of Infection prevention and control, antimicrobial stewardship structures and process indicator data are provided in Table 35. Hospital process and indicator data were collected for all participating hospitals. Data obtained at the time of the survey at the ward level were summed for each hospital. In wards where data were missing, their information was excluded from indicator calculations. Due to limited time and resource in collating and checking the indicator information, results should be treated with caution and will not be discussed further in the discussion section of the report.

Average length of stay in hospital was calculated by dividing the total number of bed days for the hospital by the total number of discharges. This figure represents the average length of stay for a patient from admission to a ward until discharge or transfer to another hospital. At the time of the last PPS in 2012 it was estimated that average length of stay across all hospital sites was 4.69, but this had reduced slightly to 4.49 days in 2017.

All of the hospitals had annual IPC plans and had produced an IPC report. There were approximately 2.3 IPCNs and 0.4 Infection Control doctors (ICD) per 250 beds. There were approximately 0.5 Whole Time Equivalent (WTE) staff with an antimicrobial stewardship role per 250 beds. One hospital reported a formal process to review the appropriateness of an antimicrobial order within 72 hours in all wards and a further 13 reported a review in a select group of wards (four hospitals indicated that this applied to ICU).

Table 35 Summary of infection prevention and control and antimicrobial stewardship structure and process indicator data in Northern Ireland 2017

	Indicator	Northern Ireland aggregate
Activity and bed occupancy	Number of discharges	296902
	Number of patient days	1333740
	Average length of stay	4.49
	Number acute beds	4331
Staffing	WTE nurses	9466.48
	WTE nurses/100 beds	218.57
	WTE nurse assistants	5400.97
	WTE nurse assistants/100 beds	124.70
	WTE infection control doctors	6.85
	WTE infection control doctors/250 beds	0.40
	WTE infection control nurses	39.79
	WTE infection control nurses/250 beds	2.30

	Indicator	Northern Ireland aggregate
Characteristics of IPC programmes	Availability of microbiology service on Saturdays, clinical samples	100% (16/16)
	Availability of microbiology service on Saturdays, screening samples	100% (16/16)
	Availability of microbiology service on Sundays, clinical samples	100% (16/16)
	Availability of microbiology service on Sundays, screening samples	100% (16/16)
	Number of blood culture sets received and incubated per 1000 patient days	58.43
	Number of in-patient stool tests performed for *Clostridium difficile* infection per 1000 patient days	11.44
Isolation capacity	Total number of single rooms in surveyed wards	1378
	Percentage of all beds in surveyed wards that were single rooms	31.82
	Total number single rooms with ensuite facilities	1130
	Percentage of single rooms that had ensuite facilities	82.0
Hand hygiene and availability of Alcohol Based Hand Rub (ABHR)	Total alcohol hand rub consumption (litres)	41493
	Total alcohol hand rub consumption per 1000 patient days	31.11
	Total number of observed hand hygiene opportunities in year	93652
Characteristics of antimicrobial stewardship programmes	Formal process to review the appropriateness of an antimicrobial within 72 hours of initial order	One hospital indicated 'yes to all wards', 13 hospitals indicated 'yes to selected wards only', 2 hospitals reported 'no review on any wards'

8. Discussion

This report presents the results of the 2017 point prevalence survey (PPS) of hospital – acquired infection (HAI) and antimicrobial use (AMU) in acute hospitals in Northern Ireland. The majority of face-to-face training sessions were undertaken in May 2017 and fieldwork was completed in June. The survey included 3,813 eligible patients in all 16 acute hospitals. Information was collected for patients in 89% of available acute beds; the remaining 11% of beds were not included either because the beds were not occupied or the patients were not eligible for inclusion in the survey, e.g. admitted after 8am or transferred to another ward after 8am on the day of the survey. The objectives of the survey were to determine the burden of HAI and AMU and to identify priorities areas for the future. Involvement in this PPS was on a voluntary basis, however, as in the previous PPS in 2012, all acute Health and Social Care Trusts participated, thus providing a robust data series for analysis and comparison in Northern Ireland.

This is the fifth time a point prevalence survey of healthcare associated infection (HAI) has been undertaken in Northern Ireland since 1994. Whilst there have been some changes to the definitions used for surveillance in the different years in which surveys have been completed, there has been greater consistency since 2012, meaning that comparisons between 2012 and 2017 have greater validity. This report has been presented to examine comparisons and contrasts between 2012 and 2017 so that a better insight into the pattern of infections and antimicrobial use affecting patients can be obtained.

8.1. Overall trends

The overall rate of healthcare associated infection in 2006 was 5.4% and this dropped to 4.2% in 2012. In 2017, the headline rate has increased to 6.1% (95% CI 5.4-6.9). As the definitions used have remained fairly static between 2012 and 2017, this increase in the overall infection rate is indicative of a rise in the proportion of patients who develop an HAI.

The proportion of inpatients in receipt of one or more antimicrobials in 2012 was 29.5% and the comparable figure for 2017 was higher at 36.3% (95% CI 34.8-37.9). This represents an increase in the prevalence of patients receiving antimicrobials.

The sample of eligible patients in 2017 was identical to that in 2012 except for those patients who were on acute psychiatric wards, who were excluded in 2017. To compare the overall HAI rate between 2012 and 2017, inpatients in acute psychiatric wards were removed from the sample in 2012 and the overall HAI rate was re-calculated. This change only increased the HAI rate by 0.1 percentage point, from 4.2% to 4.3% (95% CI 3.7-5.0). Removing acute psychiatry from those who received antimicrobials increased prevalence by 1.4 percentage points, from 29.5% to 30.9% (95% CI 29.4-32.4).

8.2. Changes to the composition of the inpatient population

In common with other parts of the UK, changes to demographic characteristics have influenced the patient population. The average age of inpatients has increased (median age increase from 66 to 68 years) and a higher proportion has multiple co-morbidities (increased proportion with

end of life prognosis, from 2.9% to 5.4%), which may have impacted on the number of inpatients who develop a healthcare associated infection. In order to assess if an older and more dependent patient population has led to an increase in the HAI rate, the sample was re-weighted to account for these changes. When the weights were applied to the 2017 data there was virtually no change to the HAI rate, in terms of the re-adjusted age distribution. The number of patients with an HAI remained the same at 6.1%, but there was a slight reduction in the AMU prevalence where the number of patients on antimicrobials reduced by 10 to 1,375 (36.1%) a small and non-significant reduction from 36.3%.

In terms of weights for the disease prognosis, when the sample was reweighted, the number of patients with an HAI dropped by just one to 233 and the headline rate remained at 6.1%. In terms of AM prevalence the number increased to 1,397 (36.7%) a small increase of 0.4%.

It would appear that the increase in HAI and AM prevalence in the acute PPS in 2017 is not driven by a change in the age distribution or disease prognosis of the patient population. This is an interesting finding taking into consideration the increasing susceptibility to infection of older and sicker patients. Further analysis of these increases showed that, rather than all hospital types registering a larger share of patients with HAI or in receipt of antimicrobials, the increases were concentrated in 'secondary' type hospitals and to a lesser extent in 'primary' type hospitals. There are multiple possible explanations for this change, which may reflect increasingly sick and dependent patients in these types of hospitals as well as increasing demand for services and patient turnover.

8.3. Validation study

In 2017 a comprehensive external validation was undertaken (blind and in parallel) alongside the internal data collection team at each hospital. No such validation survey took place in 2012. Approximately 520 inpatients were validated, or 14% of the total sample of 3,813 patients. While this showed a high level of consistency (with specificity for HAI at 98.6% and sensitivity at 86.1%, the comparable specificity for antimicrobial use was 98.4% and the sensitivity was 98.7%), it also revealed some false positives and false negatives. The validation study was used to produce an adjusted prevalence figure for Northern Ireland for both HAI and AMU. The adjusted HAI rate was 0.3 percentage points lower at 5.8% (95% CI 4.1-7.8). There was less impact on the overall prevalence of antimicrobial use which remained at 36.3% (95%CI 34.8-38.0). The PPS validation study supports the finding of the main PPS study for both HCAI and AMU.

8.4. HAI prevalence

Until relatively recently the proportion of HAI considered preventable was estimated to be 25 – 40% (23). More recent research suggests that up to 70% of all healthcare-associated infections are preventable using current evidence-based strategies (24).

The dynamic nature of healthcare delivery, the changing nature of the acute care population, adaptation of microorganisms, as well as the changing pattern of interventions are important factors influencing the prevalence of HAI and antimicrobial use. As it is not possible to maintain incidence surveillance across all specialist areas, consideration needs to be given to particular service areas and/or microorganisms for targeted surveillance. Previously it has been

determined that areas of high risk, high volume and high cost benefit most from HAI surveillance (25).

Findings arising from this PPS provide an opportunity to review changes in the epidemiology and burden of HAI and AMU in Northern Ireland. The changes highlighted will inform the development of policy and interventions aimed at reducing risk of infection, augmenting antimicrobial stewardship and targeting incidence surveillance programmes.

The overall prevalence of HAI in acute care in Northern Ireland hospitals surveyed was 6.1% (95%CI 5.4 – 6.9). This rate represents an increase in the prevalence since 2012, and also is higher than some other UK countries who have reported their 2017 results e.g. Scotland where the prevalence is 4.5% (95% CI 4.0-5.0) and Wales (5.5%; 95%CI 5.0-6.1) (1) (2) (4) (3) (5).

HAI prevalence in PPS 2017 was higher than that reported in PPS 2012. Following appropriate adjustments, HAI prevalence in PPS 2017 was approximately 1.5 percentage points higher than in PPS 2012. This finding is reflective of trends reported for HAI by incidence surveillance programmes across different countries (26) (27).

8.4.1. HAI prevalence – Population profile

In PPS 2006, a linear relationship between age and HAI prevalence was reported (11). This relationship was not observed for 2012 or 2017. In the adult population, the highest HAI prevalence occurred in 65-79 year old age group (7.6%), whereas in PPS 2012, the highest HAI prevalence occurred in 50-64 group (5.8%).

A number of demographic changes were seen between comparable survey populations in PPS 2017 and PPS 2012. In particular, the proportion of adult patients aged over 65 years was higher in 2017 compared to 2012 (56% compared to 52%). The proportion of patients recorded in Care of the Elderly was also higher in 2017 (9.7%) than in 2012 (7.1%). This suggests that older patients represent a larger proportion of inpatients in this survey compared to the previous PPS.

HAI prevalence in all hospital specialties increased. Between 2012 and 2017, the increases were greatest in Adult ICU (9.1% versus 17.6%); Care of the Elderly (5.7% versus 7.5%) and paediatrics (4.5% versus 7.0%). In 2017, analysis of wards which had ‘mixed’ specialty of inpatients also had an above average proportion of HAI at 7.6%. A renewed focus to target infection prevention and control activities in high prevalence wards is required in order to reduce HAI and specific attention is required to address the specific issue of complex patient needs in mixed specialty wards.

HAI was most frequently observed in the adult ICU setting with approximately 18% of patients being recorded with an HAI. This finding is in keeping with PPS findings reported in other UK administrations (1) (2) (4) (3) (5). ICU patients generally have more complex needs and greater susceptibility to infection as they often require many devices and antimicrobials to support delivery of care. The ICU population may also continue to have higher risks for infection when discharged to general wards, which may be related to on-going device use.

Device-associated incidence surveillance was introduced as a mandatory programme across critical care units in Northern Ireland during 2010, capturing three main categories of device-associated HAI. 'Wardwatcher' software is used in most units and the process of data collection, analysis and reporting has been simplified and streamlined. The proportion of ventilator associated pneumonia, catheter associated urinary tract infections and central line associated blood stream infections are measured per 1,000 device days. In December 2017 the relevant rates were 0.60, 0.10 and 0.41 infections per 1,000 device days respectively. While these rates may indicate the application of high standards, the rates are perhaps lower than what might be expected given data from other parts of the UK. A review of the impact of this surveillance programme is planned, to ensure that units are adhering to protocol and data are being recorded accurately.

The prevalence of HAI in the paediatric and child population (aged 0-15 years) in PPS 2012 was 3.4% (95%CI 2.0 – 5.7) and was 5.5% in 2017 (95% CI 3.5-8.6). Overall HAI prevalence in the paediatric population was reduced by the 'well baby' cohort – well babies nursed on postnatal wards with a short length of stay had a lower HAI prevalence at 2.3%.

8.4.2. HAI prevalence – Hospital type

In 2012 HAI prevalence was significantly higher in tertiary hospitals (6.8%) compared with the overall average, but in 2017 the difference between hospital types was considerably reduced – the rate for tertiary hospitals was 6.9%, followed by secondary hospitals 6.2%, specialised units 5.8% and primary hospitals 5.1%. This finding may represent a more complex case mix in hospitals below tertiary level, as well as greater specialisation of services being delivered. A detailed set of results has been issued to each hospital and discussions are ongoing about priorities for action in relation to infection reduction and antimicrobial stewardship. The results of this survey have also been used to help inform a regional strategy and action plan to reduce antimicrobial consumption (28).

8.4.3. HAI prevalence – Number and classification of infections

Overall, 234 patients were identified as having an active HAI in PPS 2017, only seven patients were identified with two HAIs. The most common types of HAI were: pneumonia (29.0%), followed by SSI (17.0%), gastrointestinal (10.4%), BSI (8.7%), eye/ENT or oral (6.6%), UTI (6.2%) and systemic infection - specifically clinical sepsis (6.2%). The overall pattern was similar to 2012, when pneumonia and SSI were the modal infections. In 2017, the proportion of UTI infections dropped compared with 2012, from 11.8% to 6.2%; and 2017 saw an increase in eye/ENT and oral infections compared with 2012, up from 1.2% to 6.6%.

Across the rest of the UK, the modal infections are: pneumonia, SSI and UTI. The drop in the proportion of UTIs in Northern Ireland contrasts with the situation elsewhere, for example, in the PPS in Scotland in 2017, the proportion of UTI infections was 24.5%. Feedback from infection control teams in local Trusts has outlined the preventative work they have undertaken in relation to the urinary catheter bundle across hospitals in Northern Ireland, and it would seem that this approach has avoided deterioration in infection rates for UTIs.

The majority of HAI (77.2%) identified during PPS 2017 developed during a patient's stay in the admitting hospital. Of those present on admission (n=55), just over half of the infections related

to the same hospital with the others relating to a stay in a different hospital or another healthcare environment.

For HAI not present at admission, approximately four in ten HAI (40.9%) were identified within the first seven days following admission. The majority of HAI (59.1%) were identified more than one week following admission to hospital, and 18.8 % of all HAIs were reported more than three weeks after admission.

8.4.4. HAI Prevalence – Devices in situ

Invasive devices were most prevalent in adult ICU, and across all specialties over six in ten (60.3%) inpatients (95% CI 58.7 – 61.8) had an invasive device *in situ* at the time of survey. This represented an increase from 2012 when the overall proportion was 51%. Peripheral vascular catheter (PVC), either arterial or venous, was the most common device present for over half (52.8%) of patients. The proportion of patients with a peripheral catheter was greater in Northern Ireland compared with other parts of the UK, where the comparable prevalence of peripheral catheter use was e.g. 36.3% in Scotland in PPS 2017 (3), 35.8% in Wales for acute patients in their 2017 PPS (5) and 38.6% in England in the PPS 2012. Infection prevention and control teams need to encourage appropriate use and review of peripheral catheters and attention could be focused on developing resources that can be used by clinical and ward staff for monitoring peripheral lines that are in place ensuring that these are regularly reviewed.

Urinary catheters were present for 17.8% of patients (95% CI 16.6 – 19.1) which was similar to the rate observed in 2012 (17.1%). It would seem that this rate is slightly lower than that observed in Scotland and slightly lower than that observed for acute patients in the 2017 PPS in Wales (19.2%). Ensuring consistent use of the catheter bundle is an essential component of avoiding UTIs. This requires an ongoing drive by infection prevention and control colleagues and ward staff with regular monitoring and feedback to ensure standards are maintained.

Pneumonia and lower respiratory tract infection

The prevalence of pneumonia in patients in 2012 was 1.0% (95% CI 0.8 - 1.4) and in 2017 had increased to 1.8% (95% CI 1.5 - 2.3) which is a significant rise. Hospital associated pneumonia is estimated to increase a hospital stay by about eight days and has a reported mortality rate ranging from 30–70%. There are variations in clinical management and outcomes across different parts of the UK (29).

The vast majority of pneumonias were clinically defined in both 2012 and 2017 (97% and 98% respectively) and microbiological confirmation of pneumonia was recorded for a small proportion of pneumonias in both surveys. The proportion of pneumonias which were assessed as ventilator associated (VAP) was 10.0% (7 out of 70). While the collection of surveillance data on ventilator and non-ventilator associated pneumonia is good in the context of ICU, there appears to be a gap in reporting of non-ventilator associated pneumonia in specialties other than ICU.

Respiratory tract infections (pneumonia and LRTI) were the most frequent HAI detected in PPS 2012 and 2017. As the proportion has increased in 2017, development of a protocol, checklist and monitoring system for pneumonia for patients in acute surgical and medical wards should be

a priority. Attention should be focused on implementation of a tool for possible intervention for specialties where there appears to be a heightened risk of pneumonia, such as general medicine and general surgery. Research indicates that a number of interventions have a positive impact on prevention of pneumonia, such as: hand hygiene, oral care with antiseptic, aspiration prevention, bed elevation and early mobilisation.

Surgical Site Infection (SSI)

The second most frequent HAI detected in this PPS was SSI. PHA currently oversees mandatory surveillance of surgical site infections following orthopaedic procedures, neurosurgery, cardiac surgery and caesarean section delivery. Deep incisional and organ/space SSI cause the greatest morbidity and mortality and accounted for almost three quarters (73%) of all SSIs recorded. Superficial site infections are less likely to result in death or injury and their identification may present challenges in terms of standardisation across hospitals.

A small but increasing burden of SSI was noted from 0.8% in 2012 (95% CI 0.6 – 1.1) to 1.1% in 2017 (95%CI 0.8–1.5). While the number of superficial incisional infections and deep incisional infections was similar between both surveys, the number of organ/space SSI more than doubled (n=8 in 2012, n=20 in 2017). This may indicate that SSI in the acute setting has increased because of the procedures being conducted and patient characteristics. The evolving nature of surgical intervention, advances in technology and changes to practice facilitate delivery of more complex care. This finding is likely to have significant implications for patients' quality of life and the future cost of healthcare delivery.

It is important to note that point prevalence surveys will only include SSI present in the hospital inpatient population. A number of factors are likely to impact on the proportion of SSI identified in the acute care setting, including higher patient turn-over and earlier discharge of patients who have undergone surgical procedure(s). These factors increase the likelihood that SSI will be seen and managed with increasing frequency in the post-acute setting, thus the current PHA incidence surveillance must include post-discharge follow-up. As a result, the SSI captured by this survey are likely to be an underestimation of the total burden of SSIs.

One quarter of SSIs (26.8%) reported in PPS 2017 were identified following general surgical procedures, followed by orthopaedics (19.5%) and obstetrics and gynaecology (17.1%). The incidence surveillance systems in place in Northern Ireland include: orthopaedic surveillance, caesarean section surveillance, cardiac and neurosurgery. Following the last PPS, a decision was made to take forward a pilot into surgical site infections following breast surgery, this programme has been ongoing for a year in one Trust and a review of the data collected is planned in order to assess if there is merit in rolling the programme out to other Trusts.

An increase in the rate of SSI observed in this PPS, when set against a reducing trend in the incidence programme of surveillance following orthopaedic surgery, suggests that the incidence survey is under reporting the true level of SSI. The incidence of SSI following orthopaedic surgery has significantly reduced since the introduction of mandatory orthopaedic SSI incidence surveillance in Northern Ireland. This reduction has been maintained between 2012 and 2017, with orthopaedic SSI rates currently standing at 0.28% (2017) (27). In 2014

PHA refreshed training on detection of SSI, and introduced light surveillance in a number of areas, so that the burden of completing forms for all procedures was removed. The impact of this change may mean that awareness about the surveillance has declined, so it is recommended that refresher training should take place and trusts should be notified about raising awareness so that reported rates of SSI are an accurate reflection of the total burden of SSI infections (30).

Two SSIs following caesarean section delivery were reported in PPS 2017 (survey included hospital in-patients only) one of these was a readmission and one was diagnosed on the ward following surgery. Currently mandatory incidence surveillance indicates that 90% of post-caesarean section SSI occurs following discharge from acute hospital care (31). It was therefore not unexpected that given the short length of stay for obstetric patients, few SSI were recorded following caesarean section in PPS 2017. Currently, the methodology used for caesarean section surveillance still relies on paper forms being completed on the ward and then following women once they are discharged into the community. Given that this approach is labour intensive, a scoping study is planned to investigate how administrative data might be adopted for use in providing a denominator for these procedures. This will allow for a more timely and efficient use of resources at the front line with emphasis on identifying SSIs which develop in the community, post discharge.

Urinary tracts infection (UTI)

While the proportion of symptomatic UTI in 2017 was half of that observed in 2012 (6% versus 12%), the prevalence showed a small downward shift from 0.5% in 2012 to 0.39% in 2017. Given a rising tide of other healthcare associated infections, the fact that an increase was not observed for UTIs is welcome.

Indications are that this is in contrast to the position in other parts of the UK, where UTI remains in the top three infections. In Northern Ireland it was ranked fifth after pneumonia, SSI, gastrointestinal and bloodstream infection. The proportion of patients with a urinary catheter in-situ at the time of the survey was broadly similar between both surveys (17.1% in 2012; 17.8% in 2017) as was the percentage of UTIs deemed catheter-related (35% in 2012; 33% in 2017). This finding suggests that ongoing vigilance in applying good catheter management remains a key component of achieving further improvement in UTI rates. Feedback from local trusts has re-confirmed the time and effort that has gone into training staff in the use of catheter bundles and its impact on avoiding infection.

Systemic infection

A new definition of clinical sepsis in adults and children was added to the systemic infection HAI group in 2012. This definition allowed data to be gathered, from both paediatric and adult populations, where there was clinical evidence of infection without positive microbiology confirmation.

In 2012, systemic infections (in effect clinical sepsis) accounted for 11.8% of all HAI. In 2017, the proportion of systemic infections was 6.2%, the majority of infections being clinical sepsis (n=13). Two were coded as a disseminated infection, involving multiple organs or systems but

without an apparent single site of infection. Early identification of sepsis is required in order to avoid potentially life threatening or life altering conditions. The Sepsis Six care bundle, when taken as a whole, has been shown to reduce the relative risk of death by almost half. More work needs to go into implementing the bundle in the acute setting and in raising awareness amongst staff for those patients who are at most risk (32).

Bloodstream infection (BSI)

The proportion of inpatients with a bloodstream infection in 2012 was 0.4% (95% CI, 0.2-0.7), whilst in 2017 the comparable proportion was 0.6% (95%CI, 0.4 – 0.9).

The survey confirms a general decline in the incidence of MRSA as the causative organism in bloodstream infections, with two out of eighteen infections being caused by MRSA (26).

Gastrointestinal infection

Prevalence of gastrointestinal infections increased slightly between 2012 when it was 0.4% (95% CI, 0.2 - 0.6) to 2017 when it was 0.7% (95% CI, 0.4 - 1.0) (26). The proportion of gastrointestinal infections where *Clostridium difficile* was diagnosed was just over half (n=14) in 2017, with an overall prevalence of 0.37 (95% CI, 0.2 - 0.6). This highlights the importance of focusing on infection prevention and control practices in reducing *Clostridium difficile* rates in acute settings.

Eye, ENT or mouth infection

Prevalence of infections of the eye, ENT or mouth increased from just 2 in 2012 to 16 infections in 2017. While the numbers are small, it is a significant increase in the prevalence of this type of infection to 0.4% (95%CI, 0.3-0.7). An investigation into these infections found that they were all oral cavity infections and the majority of patients (n=9) were aged over 79 years.

8.4.5. Summary of HAI priorities

1. Explore feasibility for scoping and implementing a project aimed at reducing the burden of non-ventilator associated pneumonia.
2. Continued emphasis on education and training of clinical staff on methods for improvement and prevention of HAI, with particular emphasis on learning tools for prevention of healthcare associated pneumonia and LRTI.
3. Consideration should be given to the development of methodologies to support standardised incidence surveillance of respiratory tract infections and clinical sepsis most commonly reported in the hospital context.
4. Continue to promote evidence based practice to reduce surgical site infection across surgical specialties (WHO bundle compliance, application of NICE and CDC guidelines as well as other relevant guidance).
5. Given an increased rate of surgical site infection observed in this survey, a review and validation of the case ascertainment and reporting arrangements in the current SSI surveillance programmes (caesarean section, orthopaedic, cardiac and neurosurgery) is recommended.

6. The future SSI surveillance arrangements should consider the need for improved methodology for the SSI incidence surveillance programme with a view to developing more efficient systems for data collection.
7. The requirement for potential extension of the SSI surveillance programme into other speciality/procedure areas should be taken forward in collaboration with relevant stakeholders.
8. Continue to focus on a programme to reduce overall use of urinary catheters and ensure best practice for management of catheters *in situ*.
9. Further investigation is required to examine the PPS findings related to increasing oral cavity infections, and infections in paediatrics and mixed specialty hospital wards.

8.5. Device use

Six in ten of all patients surveyed (60.3%, 95%CI 57.2-60.3) had an invasive device in situ at the time of survey which was an increase compared to 2012 when half of patients had a device in situ (50.1%, 95%CI 49.4-52.5).

The prevalence of central vascular catheter CVC use was 5.4%, which was similar to that recorded in 2012. However, use of CVC in the adult ICU setting increased from 42.4% in 2012 to 74.3% in 2017. The second largest proportion of patients with a CVC was in Paediatrics (10.3%), followed by mixed ward specialities (9.8%). The overall rate of CVC use recorded in other UK administrations was similar to that reported in Northern Ireland, although the overall proportion of patients with a CVC in ICU tended to be lower than that observed locally.

The prevalence of urinary catheters was 17.8% (95%CI, 16.6-19.1) which was similar to that observed in 2012 (17.1%). The proportion of patients with a urinary catheter in place was lower than in Scotland (20.8%) and slightly lower than that observed for acute patients in Wales (19.2%) (3) (5).

The prevalence of patients intubated (either with a tracheostomy or endotracheal tube) on the day of survey was 2.0%, similar to the prevalence in 2012 (2.4%). Similar rates of intubation were recorded in other UK countries.

Use of peripheral vascular catheters (PVCs), increased from 43.4% in 2012 to 52.8% in 2017. This represents a challenge given the correlation between higher prevalence of line use and increasing risk of HAI. Given that Northern Ireland had the highest prevalence in 2012, an increase in this proportion in 2017, when other parts of the UK continue to report lower rates, requires further examination and action.

8.5.1 Summary of Device use priorities

1. Continue to promote awareness of the presence of invasive devices as a significant risk factor for development of HAI in the hospital setting by strengthening the implementation of high impact interventions such as care bundles. Countinued emphasis on education and training of clinical staff responsible for insertion and maintenance of invasive devices, including the regular assessment of competency of clinical staff and the use of hand hygiene/care bundles.
2. Emphasis should be on maintaining the current ICU incidence surveillance programme, validating data reported on, Ventilator Associated Pneumonia (VAP), Central Line Associated Blood Stream Infection (CLABSI) and Catheter Associated Urinary Tract Infection (CAUTI), and continue to ensure that units are recording data accurately and using it for quality improvement and benchmarking against other regions.
3. In wards where the prevalence of patients with a peripheral vascular catheter was high, a review should be considered with a view to developing interventions that ensure appropriate use and maintenance of peripheral lines including line reviews.

8.6 Microbiology

The majority of infections reported in PPS can be identified using epidemiological case definitions of signs and symptoms, without microbiological confirmation. Overall one third of infections had positive microbiology (n=85), with approximately two thirds meeting the case definitions in terms of available clinical signs and symptoms. As microbiological findings were based on results which were available on the day the PPS was conducted, the distribution of microorganisms is unlikely to reflect the full breadth of pathogens involved in HAI and results should be treated with caution.

Gram-positive cocci accounted for the largest proportion of microorganism identified in PPS 2017 (37.3%) including *Staphylococcus aureus*, 18.6% and *Enterococcus* spp 9.8%. Gram-negative Enterobacteriaceae accounted for 35.2% of isolates, with the largest proportion being *Escherichia coli*, 20.6%.

There were similar proportions of Enterobacteriaceae reported in other parts of the UK. For example, in Scotland the proportion of *Escherichia coli* was 22.7%, and the proportion of *Staphylococcus aureus* was 20.2% (1) (3).

The emergence of Enterobacteriaceae as one of the most frequent microorganisms detected in relation to HAI requires action, especially as the proportion of *Escherichia coli*, microorganisms has more than doubled between 2012 and 2017. Further investigation of the circumstances and environments in which these infections have developed is required to inform appropriate prevention and control strategies.

In PPS 2017, less than 0.1% of the total survey population had an infection caused by MRSA, which is comparable to the 2012 survey. *Clostridium difficile* infection was detected in 0.3% of the hospital population in 2017 compared to 0.2% in 2012. These findings are in keeping with data reported through incidence surveillance of both MRSA and *Clostridium difficile* Infection in Northern Ireland over recent years (26).

8.6.1 Summary of microbiology priorities

1. Continued focus on the importance of developing appropriate regional and local capacity to monitor antimicrobial use and antimicrobial resistance across hospitals as well as the characteristics of patients affected and relevant risk factors. This should include capacity to monitor gram-negative infections.

8.7 Antimicrobial use

In total, 2073 antimicrobials were being given to 1,385 patients in this survey which equates to 1.5 antimicrobials per patient and is similar to that seen in PPS 2012. Of the 1,385 patients 39% received two or more antimicrobials (Table 23). This indicates that the overall prevalence of AMU in acute care hospitals in Northern Ireland was 36.3%, higher than that reported in 2012. The Northern Ireland antimicrobial prevalence is similar to the corresponding figure for acute care reported in Scotland (35.4%) and Wales (34.2%) for 2016/2017 (Table 22) (1) (2) (4). The highest prevalence of antimicrobial prescribing in Northern Ireland 2017 was reported by secondary acute hospitals (39%) followed by primary acute hospitals (38.5%). The prevalence of antimicrobial prescribing in tertiary and specialised acute hospitals was 34% and 25% respectively. These findings highlight that there is an increase in the prevalence of AMU in the secondary and primary hospitals whilst there is no change in the AMU in tertiary and specialised hospitals in 2017 compared to 2012 (Table 32a). The increased usage and higher prevalence reinforces the ongoing need for effective antimicrobial stewardship and monitoring of prescribing practices to drive quality improvement (33) (28) (34) (35).

Over six in ten (62.4%) of antimicrobials were administered parenterally and 37% were given orally (Table 25). Although there has been a decrease in the proportion of patients who were receiving antibiotics parenterally in Northern Ireland (62.4% in 2017 compared to 65.2% in 2012) this is still considerably higher when compared to Scotland and Wales where rates were ten percentage points lower (3) (5). This finding suggests there is a potential opportunity to further improve de-escalation in antimicrobial use by switching from parenteral to oral antimicrobials. Stewardship strategies should continue to ensure early switch from parenteral to oral agents where appropriate, conferring potential benefits of reducing the need for intravenous access and facilitating earlier hospital discharge.

The proportion of children aged between 2-15 years in receipt of antimicrobials has decreased from 36.6%, the highest group in 2012, to 27% the second lowest in 2017 whilst antimicrobial use in patients over 65 years has increased from the previous PPS. In 2017 40% of older patients (aged 65 years and over) received antibiotics (Table 24), an increase since 2012 (31.8%), with 58.3% being administered parenterally. Effective improvement and antimicrobial stewardship strategies should particularly address AMU in older patients (e.g. Care of the Elderly and medical services).

In PPS 2017, AMU was greatest in adult ICU at 64.9%, followed by mixed specialty wards where 50.8% of patients were in receipt of antimicrobials (Table 33). Whilst the greatest use of antimicrobials in the ICU setting is likely to reflect the complex patient group managed in this specialty, investigation into why mixed specialty wards have such high antimicrobial use is required.

8.7.1 Indications for Antimicrobial use

The most frequent indication for antimicrobial use (60.6%) was for treatment of community acquired infections (Table 27). This finding highlights the importance of infection control in the community, and ensuring effective antimicrobial stewardship across Northern Ireland. Guidelines for antimicrobial use in primary care in Northern Ireland (35) (36) (37) must be robustly implemented in healthcare settings as well as the acute hospital environment and

those prescribing in primary and community care settings must be guided by best practice guidance.

The majority of antimicrobials used for treatment of infection were prescribed for respiratory tract infections (35%) (Table 28). Pneumonia was the most commonly identified infection accounting for 29% of all HAI reported (Figure 5a). Preventing pneumonia in hospitals as well as other care settings, including care at home and in the community would reduce the need for antimicrobials. Consideration should be given to developing local guidelines for Hospital acquired pneumonia (HAP) and Community-acquired pneumonia (CAP).

Approximately one in seven antimicrobials prescribed in PPS 2017 was administered for prophylaxis, 5.3% for surgical prophylaxis and 8.9% for medical prophylaxis. Compared to 2012 there has been a decrease in surgical and an increase in medical prophylaxis. The proportion of surgical prophylaxis given for longer than 24 hours was 25.3% in PPS 2017 compared to 11% in 2012 (Table 27). This proportion was lower than the corresponding proportion reported in Wales (32.7%) but higher than reported by Scotland (19.8%) (38). Further work is therefore required to validate these finding and to inform future strategies for improvement in AMU this area.

8.7.2 Prescribed antimicrobials

A total of 69 different antimicrobial agents were recorded in this survey. Six antimicrobials comprised almost half of all antimicrobial use and the top 20 most commonly prescribed antimicrobials accounted for 86% of all AMU (Table 29). This finding shows that clinicians use a relatively narrow range of antimicrobials, similar to other UK administrations. Meropenem, a very broad spectrum beta-lactam and often regarded as the last resort beta-lactam agent, was the tenth most frequently prescribed antimicrobial overall (3.6% of all AMU) (Table 29).

8.7.3 Compliance with local guidelines and documentation

Rationale for treatment was recorded for 93.9% antimicrobials prescribed in this survey. Documentation of rationale for treatment varied from 87% to 100% across acute hospitals. This is in keeping with that reported by other UK administrations.

PPS 2017 also included an assessment of compliance with local prescribing guidelines that exists in in each Trust. The majority of prescriptions (72.7%) were reported as compliant with local guideline and over one in ten antimicrobials prescribed (11.7%) were not compliant with local guidelines (Figure 15).

Currently there are no regionally agreed performance targets associated with antimicrobial prescribing in the hospital setting in Northern Ireland.

8.7.4 Antimicrobial use – Broad Spectrum

In acute hospitals in Northern Ireland, 7.6% of patients were receiving broad spectrum antimicrobials cephalosporins, co-amoxiclav, quinolones, clindamycin) that are associated with a higher risk of CDI. Co-amoxiclav was the third most prescribed antimicrobial and, where reported, the proportion that was not compliant with local guideline was one third. Although the current finding is a snapshot of AMU, it does indicate that there is a substantial burden of

prescribing broad spectrum antimicrobials and there are opportunities for further improvement particularly in adherence to local prescribing guidelines.

8.7.5 Antimicrobial use – Very Broad Spectrum

This PPS identified that the most common causative organisms were Gram-negative organisms. These organisms are prone to drug resistance and when these organisms develop multi-drug resistance there are very limited treatment options. The carbapenems (meropenem, imipenem and enzyme inhibitor, ertapenem) and piperacillin/tazobactam (a penicillin/enzyme inhibitor combination) are considered 'critically important' and their effectiveness preserved to ensure that patients can be successfully treated in the future.

On the day of the survey, 8.4% of patients were receiving piperacillin/tazobactam, and 2.1% were receiving a carbapenem. This is over twice the rates reported by Scotland (3). While the use of antimicrobial agents associated with *Clostridium difficile* infection was relatively low in this survey, 4.1% of all antimicrobial were cephalosporins and 4.8% fluoroquinolones; the prevalence of meropenem use is of concern at 3.6% of all antimicrobials.

Overall, 9.9% of carbapenem prescriptions and 15.5% of piperacillin/tazobactam were recorded as not compliant with local guideline, compared to 20% and 25% reported by Scotland.

Meropenem was the most prescribed carbapenem (92.6%) with 10.7% of prescriptions recorded as not compliant with local guideline.

Inappropriate use of antimicrobials is regarded as a major driver for the development of resistance in micro-organisms (33) . Regional and local Trust guidelines on the use of meropenem should be agreed and robustly implemented with a view to reserving meropenem use for clinically appropriate cases and to prevent carbapenem resistant enterobacteriaceae (CRE). Continued improvement in prescribing of these broad and very broad spectrum antimicrobials is essential to ensure they are preserved and that inappropriate use does not drive antimicrobial resistance.

8.7.6 Summary of antimicrobial priorities

1. Continued focus on the development and importance of effective antimicrobial stewardship in the hospital, primary, and community care settings.
2. Further developments are required for accurate assessment and monitoring of antimicrobial use, and implementation of regional guidelines across all Trusts, addressing the appropriate use of broad spectrum antimicrobials e.g. meropenem and piperacillin-tazobactam.
3. A set of quality indicators relating to antimicrobial prescribing needs to be considered at a Trust and Northern Ireland level. These should include compliance with local policy, review of antimicrobial use within 72 hours, recording of indication for treatment and the reason for any departure. Monitoring of these quality indicators should be facilitated through ongoing surveillance and feedback by regular reporting.
4. Regular reporting and assessment of antimicrobial consumption data for each hospital, with case-mix stratification should be implemented.

5. Sustained emphasis on ensuring appropriate antimicrobial use and on promoting early switch from parenteral to oral agents as clinically appropriate.
6. Consideration of a targeted programme aimed at reducing antimicrobial requirements and ensuring appropriate antimicrobial use for infections of the respiratory system, particularly including the diagnosis and treatment of pneumonia across the region.
7. Ongoing monitoring in relation to antimicrobials used for prophylaxis, and in particular surgical prophylaxis lasting longer than 24 hours / or more than one dose administered.
8. Sustained emphasis on antimicrobial stewardship and prescribing competencies, with particular emphasis on leadership provided through multi-disciplinary team working

9 Conclusions

The data from this survey should be used to support HAI improvement across hospitals in Northern Ireland. It should facilitate benchmarking locally and nationally, with a view to supporting and continuing HAI improvements achieved to date. The experience from delivering this PPS should be used to inform future options for PPS in Northern Ireland.

Northern Ireland has benefited from the full participation of all hospitals providing acute care, which has given representative data across the entire acute care setting. The evidence from this survey points to a number of key priorities for infection prevention and control as well as for antimicrobial stewardship that need careful consideration by individual Trusts, PHA and Department of Health (see pages 11-13). Further prevalence surveys of both HAI and AMU will be important to measure the overall impact of new policies, guidance and interventions in future years.

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Appendices

Appendix A – PPS delivery group and fieldwork documents

A.1 Regional PPS Delivery Group members

A.2 Patient Information leaflet

A.3 Hospital staff information leaflet

A.4 Ward census

A.5 Patient form

A.6 Hospital form

A.7 Underlying disease prognosis

A.8 Algorithm for the definition of hospital associated infection

A.9 Key protocol changes 2017 vs 2012

Appendix B – ECDC tables

B.I Distribution of health care-associated infection sites

B.II Acute hospital SSI and related surgical procedure

B.III HAI and antimicrobial use by patient risk factors

B.IV Antimicrobial agents (ATC4 and ATC5) by indication

B.V Antimicrobial treatment diagnosis site by indication

B.VI Distribution of microorganisms isolated in HAI

Appendix C – Additional tables with comparison data between 2012 and 2017 PPS

C.I Device usage across ward specialities 2012 vs. 2017

C.II Distribution of HAI by Gender and Age Group 2012 vs. 2017

C.III Distribution of HAI by Hospital Type 2012 vs. 2017

C.IV Distribution of HAI by Risk Factors (Invasive device, Surgery, Underlying disease prognosis) 2012 vs. 2017

C.V Distribution of HAI by Ward Speciality 2012 vs. 2017

Appendix A.1 Regional PPS Delivery Group members

Name	Organisation
Dr. Muhammad Sartaj (Chair)	Consultant in Health Protection Public Health Agency
Mark McConaghy	Regional Surveillance Coordinator Public Health Agency
Gerard McIlvenny (until April 2017) Dr. Tony Crockford (from August 2017)	Surveillance Manager Public Health Agency
Caroline McGeary	Senior Infection Control Nurse Public Health Agency
Dr. Bronagh Clarke	Public Health Trainee Public Health Agency
Colin Clarke	Lead Nurse Infection Prevention & Control Southern Health and Social Care Trust
Dr. Naomi Baldwin	Lead Nurse Infection Prevention and Control Northern Health and Social Care Trust
Isobel King	Infection Prevention Lead South Eastern Health and Social Care Trust
Roisin Gillan	Senior Nurse, Infection Prevention and Control Belfast Health and Social Care Trust
Colin Lavelle	Senior Data Analyst Belfast Health and Social Care Trust
Cairine Gormley	Lead Antimicrobial Pharmacist Western Health and Social Care Trust
Clare Robertson	Infection Prevention & Control Nurse Western Health and Social Care Trust

Will patients benefit from the survey?

This hospital is taking part in the survey to learn more about hospital-acquired infections and antibiotic use in this hospital, in Northern Ireland and in Europe.

The results of the survey for this hospital will be used by nurses, doctors and managers to improve antibiotic use, reduce hospital-acquired infections and improve patient care.

Will I need to have extra tests?

No. The information for the survey will be taken from the results of previous tests. No extra tests will be needed.

Will my care be affected in any way?

No. Your normal care will not be affected in any way. All the information needed to complete the survey is already available in your notes or from the nurse or doctor who is looking after you.

Can I be identified by the data collected?

No. **There will be no personally-identifying information collected.** All data collected is anonymous. The information collected is: age, gender, the type of ward a patient is admitted to (i.e. medical ward, surgical ward or intensive care unit), whether or not a patient has a drip or urinary catheter, had recent surgery, receives antibiotics and if a hospital-acquired infection is present.

POINT PREVALENCE SURVEY (PPS) OF HOSPITAL-ACQUIRED INFECTIONS AND ANTIMICROBIAL USE IN NORTHERN IRELAND

Patient information

What is this survey about?

The European Centre for Disease Prevention and Control is overseeing a large survey across Europe, designed to answer two questions:

1. What percentage of patients develop an infection as a result of being admitted to hospital?
2. What percentage of patients in hospital receive antibiotics?

This is the second survey to be carried out across all European countries. The survey will take place in hospitals in Northern Ireland in May 2017.

Hospital-acquired infection

- Why does infection happen in a hospital environment?

Infection can happen anywhere, but patients in hospital are more prone to infection than people elsewhere. This is because they have either just had medical treatments or operations that make them more vulnerable, or because they are more elderly. Their natural defences are lowered and so they are more likely to be affected by bacteria that enter their system.

- What causes infection?

Infection can happen when bacteria enter part of the body at a place where they are not meant to be. For instance, they can enter:

- through a wound or cut (including a cut made during an operation)
- through a medical device that is inserted into the body – such as a drip into a vein or a catheter into the bladder
- when we breathe (in the same way as when you catch a cold)
- when we swallow them, if the bacteria are on our fingers or in food.

- How can I prevent it happening to me or others?

You can reduce the likelihood of getting a hospital-acquired infection by always checking that staff have washed their hands or used an antibacterial hand rub before they touch you. You can wash your own hands regularly (after contact with other patients or staff, after going to the toilet and before and after eating).

Why is information being collected on the use of antibiotics?

The survey will check the number of patients receiving antibiotics.

The information collected will help to identify areas where antibiotic use may be improved.

- Antibiotics are very important to treat infections
- Bacteria are always finding new ways to become resistant to antibiotics
- Infections that are caused by antibiotic-resistant bacteria, such as MRSA, are more difficult to treat
- Sometimes antibiotics are used unnecessarily, for example, on infections caused by viruses
- Unnecessary antibiotic use contributes to an increased risk of hospital-acquired infections

What happens during the survey?

- The hospital has a team of nurses and doctors who will go to every ward and check which patients have a hospital-acquired infection and which patients are receiving antibiotics.
- The survey team will also check notes, charts and laboratory results to decide if a patient has a hospital-acquired infection or is receiving antibiotics.

What will happen to the data collected during the PPS?

Your PPS team will send your hospital data to the Public Health Agency for analysis.

When all participating hospitals have submitted data, a hospital PPS report will be produced by the PHA. The PPS team leader should forward details of the report to healthcare workers and managers in your hospital. Your hospital's results can be compared with the overall Northern Ireland results.

All data collected from participating hospitals will be submitted by the PHA to European Centre for Disease Prevention and Control (ECDC) for inclusion in a European report. Results from Northern Ireland can be compared with those of other countries.

What will happen after the PPS?

Taking part in the PPS will provide information about hospital-acquired infections and antibiotic use in your hospital in Northern Ireland and in Europe.

The PPS results for your hospital should be used to inform interventions to reduce unnecessary antimicrobial use, reduce hospital-acquired infections and improve patient care.

The PPS results will be used to direct national and regional strategies for prudent antimicrobial use and work towards reduction of hospital-acquired infections.

THANK YOU FOR SUPPORTING THE PPS IN YOUR HOSPITAL

Further information and patient information leaflet are available from your local team.

ecdc
EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

POINT PREVALENCE SURVEY (PPS) OF HOSPITAL-ACQUIRED INFECTIONS AND ANTIMICROBIAL USE IN NORTHERN IRELAND

Healthcare staff information leaflet

HSC Public Health Agency

What is the point prevalence survey (PPS) about?

The European Centre for Disease Prevention and Control is overseeing a Europe-wide hospital point prevalence survey (PPS). A PPS provides a 'snapshot' of a particular issue at a fixed point in time. This PPS is designed to answer two questions:

1. What percentage of patients admitted to European hospitals develop a hospital-acquired infection (HAI)?
2. What percentage of patients admitted to European hospitals receive antimicrobials?

This is the second European PPS conducted using the same protocol. Up to 100,000 European patients will be surveyed. Our hospitals have been invited to participate in the PPS, which takes place in May 2017. The PPS in NI is coordinated by the Public Health Agency (PHA), the Agency is responsible for the monitoring of infectious diseases and antimicrobial use.

What data will be collected?

- Anonymous demographic data (age, gender, ward specialty) and risk factor data (recent surgery, presence of vascular catheters, urethral catheters, intubation and severity of underlying illness) will be collected on all eligible patients admitted to the hospital.
- Antimicrobial use data (systemic antibacterials and/or antifungals) for treatment of infection or prophylaxis will be collected on patients who receive antimicrobials (estimated at about one third).
- Hospital-acquired infection data will be collected on eligible patients meeting case definitions of a hospital-acquired infection (estimated at about one in twenty).

When and how will the PPS data be collected?

- This hospital will participate in the 2017 PPS and some of your colleagues have volunteered to act as the local data collection team. Members of the team will attend a one-day training course to learn about the protocol and the HAI definitions.
- The PPS team leader will plan the schedule for the hospital. All data for the hospital must be collected on weekdays during May 2017.
- The PPS team will visit every ward in the hospital, collecting data on all eligible patients in each ward within the same day. Performing the PPS for an entire hospital is a big undertaking for your local PPS team. Your support and cooperation is very important to ensure the survey is a success and provides accurate information on hospital-acquired infection and antimicrobial use in your hospital.
- Night-shift nursing or midwifery staff will be asked to help the PPS team by collecting demographic and risk factor data on each patient on the ward.
- Nursing/midwifery staff and medical staff who know the patients will be asked to help the PPS team by discussing clinical information, helping to decide the patient's underlying severity of illness and whether a patient meets case definitions for a HAI.
- **NO personally-identifying information will be collected.** Data collected is anonymous and will include: general demographic information, risk factors, antimicrobial use and HAI data.

Appendix A.4 Ward Census

Public Health Agency

Ward List A2

↓ **Ward details should be completed by Ward contact/manager and PPS team lead in advance of survey** ↓

Ward name ______________________

Hospital Code | | | | Ward code | | | Ward specialty | |

													COMPLETED BY PPS DATA TEAM	
↓ COMPLETED BY WARD STAFF FOR ALL PATIENTS ON THE WARD ↓														
		M/F	Years or Months	Neonate <4 weeks	DD/MM/YY	+	+	+	+	+	+	+	+	
Bed number	Patient name	Gender	Age Or month if <2 years old	Birth weight	Admission date	Surgery since admission	Surgery in last 24 hrs	Central vascular catheter	Peripheral vascular catheter	Urethral Catheter	Intubation	Patient on antimicrobial	Eligible patient	Patient Study Number
												Total		

Note: If there are more than 20 beds on ward please continue on another Ward List – Completed Ward Lists to be retained by the PPS team leader

Appendix A.5 Patient Form (page 1)

SURVEY OF HOSPITAL-ACQUIRED INFECTIONS & ANTIMICROBIAL USE

2017 PPS - PATIENT FORM C v2.1

1. Patient details *Hospital code* *Ward code* *Patient ID*

Unique identifier ☐☐ - ☐☐ - ☐☐

Consultant specialty [MIA PickList]

Age in years... If <2 enter '00' ☐☐☐ Age in months under 2-year old (neonates <4-weeks enter '00') ☐☐

Birth weight in grams if neonate <4-weeks old ☐☐☐☐ grams

Gender ☐ Male ☐ Female

Admission date to this hospital D D / M M / Y Y

2. Risk factors

Surgery since admission ☐ No ☐ Yes → [MIA PickList] *Surgical procedure*

Central vascular catheter ☐ No ☐ Yes

Peripheral vascular catheter ☐ No ☐ Yes

Uretheral catheter ☐ No ☐ Yes

Intubation ☐ No ☐ Yes

Underlying disease prognosis ☐ None/non-fatal diseas ☐ End of life prognosi ☐ Life limiting prognosi ☐ Not knowr

3. Condition of interest

Patient has active HAI ☐ No ☐ Yes Patient on antimicrobials ☐ No ☐ Yes

4. Hospital-acquired infection data (HAI) ...if more than 1 HAI use extension sheet Page 4

HAI 1

Infection [MIA PickList]

If SSI, record procedure [MIA PickList]

If BSI record source [MIA PickList]

Date admitted to current ward D D / M M / Y Y

Relevant device in situ before onset ☐ Yes ☐ No

HAI Present at admission ☐ Yes ☐ No

Origin of infection ☐ Current hospita ☐ Other acute hospita ☐ Other origin

Date of onset D D / M M / Y Y

Microorganism 1 [MIA PickList] Resistance 1 [MIA PickList]

Microorganism 2 [MIA PickList] Resistance 2 [MIA PickList]

Microorganism 3 [MIA PickList] Resistance 3 [MIA PickList]

Appendix A.5 Patient Form (page 2)

Hospital code Ward code Patient ID
☐☐ - ☐☐ - ☐☐

5. Antimicrobial use ... if more than 2 antimicrobials use extension sheet Page 3

First Antimicrobial MIA PickList

Route ☐ Parenteral ☐ Oral ☐ Rectal ☐ Inhalation

Doses per day ☐.☐☐ Note: alternate day dosing = 0.5; 2 doses per week = 0.29; 3 doses per week = 0.43

Strength of 1 dose ☐☐☐.☐ Unit of measurement ☐ grams ☐ mg ☐ Other

Indication for antimicrobial use MIA PickList

Diagnosis site code MIA PickList

Reason recorded in notes ☐ No ☐ Yes ☐ Notes not available

Meets local policy ☐ No ☐ Yes ☐ Not assessable ☐ Not known

Date started on current antimicrobial D D / M M / Y Y

Does current antimicrobial (choice or route) for this infection episode represent a change from what was originally prescribed? ☐ No ☐ Yes

Reason for change MIA PickList

If change, date antimicrobial started for infection/indication D D / M M / Y Y

Second Antimicrobial MIA PickList

Route ☐ Parenteral ☐ Oral ☐ Rectal ☐ Inhalation

Doses per day ☐.☐☐ Note: alternate day dosing = 0.5; 2 doses per week = 0.29; 3 doses per week = 0.43

Strength of 1 dose ☐☐☐.☐ Unit of measurement ☐ grams ☐ mg ☐ Other

Indication for antimicrobial use MIA PickList

Diagnosis site code MIA PickList

Reason recorded in notes ☐ No ☐ Yes ☐ Notes not available

Meets local policy ☐ No ☐ Yes ☐ Not assessable ☐ Not known

Date started on current antimicrobial D D / M M / Y Y

Does current antimicrobial (choice or route) for this infection episode represent a change from what was originally prescribed? ☐ No ☐ Yes

Reason for change MIA PickList

If change, date antimicrobial started for infection/indication D D / M M / Y Y

Appendix A.6 Hospital Form

HSC Public Health Agency | hpsc | HSE | Office of the Nursing & Midwifery Services Director

2017 SURVEY OF HOSPITAL-ACQUIRED INFECTIONS AND ANTIMICROBIAL USE

Hospital Form B

Page 1

Hospital

Survey dates *from* D D / M M / Y Y *to* D D / M M / Y Y

Hospital size (total number of beds)

Number of acute care beds

Number of ICU beds

Any exclusion of wards for PPS? Yes ☐ No ☐

If Yes, specify ward specialty of excluded wards

Year figures compiled Record calender year e.g. for 2016/17 enter 16

Number of admissions in year

Number of patient days in year

Number of WTE infection control nurses, e.g. 05.25

Number of WTE infection control doctors, e.g. 01.50

Number of WTE antimicrobial pharmacists, e.g. 01.50

Number of WTE registered nurses

Number of WTE nursing assistants

Number of WTE registered nurses in ICU

Number of WTE nursing assistants in ICU

Number of designated airborne isolation rooms

Alcohol hand rub consumption (litres)

Number of observed hand hygiene opportunities

Number of blood culture sets processed from inpatients

Number faeces specimens from inpatients tested for *C. difficile*

2017 SURVEY OF HOSPITAL-ACQUIRED INFECTIONS AND ANTIMICROBIAL USE

Hospital Form B

Page 2

Infection prevention and control (IPC) programme:

Is there an **annual IPC plan**, approved by the hospital CEO or a senior executive officer? Yes ☐ No ☐

Is there an **annual IPC report**, approved by the hospital CEO or a senior executive officer? Yes ☐ No ☐

Microbiology/diagnostic performance:

At weekends, can clinicians request routine microbiological tests and receive back results?

	Saturday	Sunday
Clinical tests	☐	☐
Screening tests	☐	☐

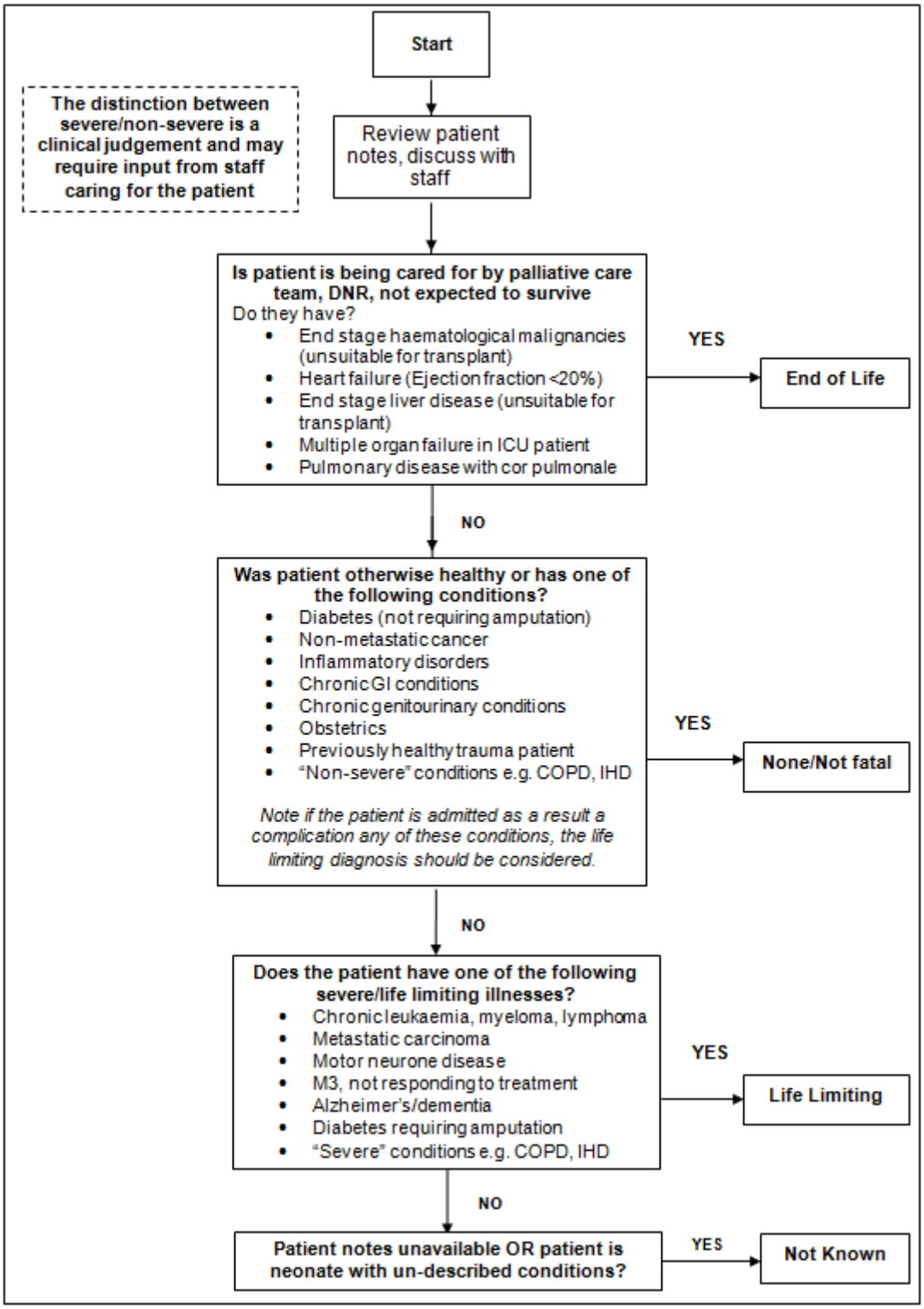
Does your ICU have the following in place for HAI prevention or antimicrobial stewardship?

	Guideline	Care bundle	Training	Checklist	Audit	Surveillance	Feedback
Pneumonia	☐	☐	☐	☐	☐	☐	☐
Blood stream infections	☐	☐	☐	☐	☐	☐	☐
Urinary tract infections	☐	☐	☐	☐	☐	☐	☐
Antimicrobial use	☐	☐	☐	☐	☐	☐	☐

Does your hospital (outside of ICU) have the following for HAI prevention or antimicrobial stewardship?

	Guideline	Care bundle	Training	Checklist	Audit	Surveillance	Feedback
Pneumonia	☐	☐	☐	☐	☐	☐	☐
Blood stream infections	☐	☐	☐	☐	☐	☐	☐
Surgical site infections	☐	☐	☐	☐	☐	☐	☐
Urinary tract infections	☐	☐	☐	☐	☐	☐	☐
Antimicrobial use	☐	☐	☐	☐	☐	☐	☐

Appendix A.7 Underlying disease prognosis



Appendix A.8 Algorithm for the definition of Hospital associated Infection

Onset of HAI		Case Definition
All HAI types *Day 3 onwards*	***AND***	Meets the case definition on the day of survey
OR		
All HAI types *Admission, day 1 or day 2 AND patient discharged from hospital, acute or non-acute, in preceding 48 hours*		
OR		OR
Surgical Site Infection *Admission, day 1 or day 2* *An SSI is defined as any SSI type which occurs within 30 days of infection of the operation date. In the case of surgery involving an implant, deep or organ space SSI arising up to 90 days after surgery is also considered and the patient either has symptoms that meet the case definition and/or is on antimicrobial treatment for infection.*		Patient is receiving antimicrobials **AND** HAI has previously met the case definition between day 1 of antimicrobial treatment and survey day
OR		
***Clostridium difficile* infection** *Admission, day 1 or day 2 AND patient discharged from hospital, acute or non-acute, in preceding 28 days*		
OR		
Device associated infection *Relevant device in situ prior to onset*		
OR		
Neonatal infection *Count any active infection arising after birth while infant remains in hospital*		

Appendix A.9 Key Protocol Changes 2017 versus 2012

- Inclusion criteria now *include* chronic care wards in acute care hospitals.
- Inclusion of new structure and process indicators for HAI and AMR prevention at hospital and ward level. Requirement for the local PPS team to gather ward level process indicators for inclusion on each ward list
- Hospital level:
    - Hospital ownership, more details on administrative hospital groups
    - Hospital size = total beds minus exclusive day beds. Day beds were not excluded from hospital size in 2012 PPS
    - Hospital level data on blood culture sets and faeces specimens tested for *C. difficile* processed on inpatients in previous year
    - IPC plan and report, participation in surveillance programmes, weekend access to microbiology tests and results, availability of multi-modal strategies in hospital and ICU(s) for prevention of certain HAI types and for antimicrobial stewardship
- Ward data: Simplified ward specialty variable
- Patient data:
    - Birth weight for neonates <4-weeks old by PPS date
- Antimicrobial use data:
    - Date of start of the antimicrobial; was the antimicrobial changed and if so, what was the reason for change of the antimicrobial and what was the date of start of the first antimicrobial given for this indication. Information on changing antimicrobials (+reason) will allow evaluating actual efforts to improve antimicrobial prescribing and adds local value to the PPS for the hospitals. The start dates serve as proxy indicator of the validity (sensitivity and specificity) of the prevalence of HAIs and will be used to estimate the burden antimicrobial use (prevalence to incidence conversion); as indicator of data validity, this variable needs to be interpreted together with the validation studies performed during the national PPS.
    - Dosage per day (number, strength and unit if doses per day): for EU/US comparisons and to enable DDD updates.

- HAI and AMR data:
    - HAI associated to current ward, or another ward since admission.
    - AMR marker data collected as S/I/R/UNK rather than as susceptible/non-susceptible.
- Codebook:
    - Specialty list: new ward specialty code list (with only main specialties), added consultant/patient specialty codes for healthy neonates
    - Diagnosis (site) code list for antimicrobial use: surgical site infection (SSI) was added as a subcategory of both SST and BJ; addition of cystic fibrosis (CF) as a separate entry
    - Antimicrobial ATC codes: updated with new codes added since 2011
    - HAI case definitions:
        - Surgical site infection (SSI): follow-up period of deep and organ/space SSIs after implant surgery changed from one year to 90 days.
        - Pneumonia (PN): note added indicating that one definitive chest X-ray or CT-scan for the current pneumonia episode may be sufficient in patients with underlying cardiac or pulmonary disease if comparison with previous X-rays is possible.
        - *Clostridium difficile* infection (GI-CDI): definition aligned to the case definition in the CDI surveillance protocol, to account for other methods to detect toxin-producing C. difficile organism in stool.
        - SYS-CSEP: no change in the definition, but change of the name from ‘clinical sepsis’ to ‘treated unidentified severe infection’ in adults and children, to differentiate this ‘last resort’ HAI case definition from the modern concept of sepsis based on organ dysfunction.

Appendix B Table I (2017)

Table I. Distribution of healthcare-associated infection sites	Total UK-NI (n=16)			
	N pts (1)	Pr% (95%CI) (2)	N HAI (3)	Rel% (4)
Total	**234**	**6.1% (5.4-6.9)**	**241**	**100%**
Pneumonia	71	1.9% (1.5-2.3)	71	29.5%
PN1 (Pneumonia, clinical + positive quantitative culture from minimally contaminated lower respiratory tract specimen)	1	0.0% (0.0-0.1)	1	0.4%
PN4 (Pneumonia, clinical + positive sputum culture or non-quantitative culture from lower respiratory tract specimen)	6	0.2% (0.1-0.3)	6	2.5%
PN5 (Pneumonia - Clinical signs of pneumonia without positive microbiology)	63	1.7% (1.3-2.1)	63	26.1%
NEO-PNEU (Pneumonia in neonates)	1	0.0% (0.0-0.1)	1	0.4%
Other lower respiratory tract inf.	6	0.2% (0.1-0.3)	6	2.5%
LRI-BRON (Bronchitis, tracheobronchitis, bronchiolitis, tracheitis, without evidence of pneumonia)	6	0.2% (0.1-0.3)	6	2.5%
Surgical site infections	41	1.1% (0.8-1.5)	41	17.0%
SSI-S (Surgical site infection, Superficial incisional)	11	0.3% (0.1-0.5)	11	4.6%
SSI-D (Surgical site infection, Deep incisional)	10	0.3% (0.1-0.5)	10	4.1%
SSI-O (Surgical site infection, Organ/Space)	20	0.5% (0.3-0.8)	20	8.3%
Urinary tract infections	15	0.4% (0.2-0.6)	15	6.2%
UTI-A (symptomatic urinary tract infection, microbiologically confirmed)	9	0.2% (0.1-0.4)	9	3.7%
UTI-B (symptomatic urinary tract infection, not microbiologically confirmed)	6	0.2% (0.1-0.3)	6	2.5%
Bloodstream infections	24	0.6% (0.4-0.9)	24	10.0%
BSI (Bloodstream infection (laboratory-confirmed) , other than CRI3)	20	0.5% (0.3-0.8)	20	8.3%
CRI3-CVC (Microbiologically confirmed CVC-related bloodstream infection)	1	0.0% (0.0-0.1)	1	0.4%
NEO-LCBI (Laboratory-confirmed bloodstream infection in neonates, non-CNS)	2	0.1% (0.0-0.2)	2	0.8%
NEO-CNSB (Laboratory-confirmed bloodstream infection with coagulase-negative staphylococci in neonates)	1	0.0% (0.0-0.1)	1	0.4%
Cardiovascular system infections	1	0.0% (0.0-0.1)	1	0.4%
CVS-ENDO (Endocarditis)	1	0.0% (0.0-0.1)	1	0.4%
Gastro-intestinal system infections	26	0.7% (0.4-1.0)	26	10.8%
GI-CDI (Clostridium difficile infection)	14	0.4% (0.2-0.6)	14	5.8%
GI-GIT (Gastrointestinal tract (esophagus, stomach, small and large bowel, and rectum), excl. GE, CDI)	5	0.1% (0.0-0.3)	5	2.1%
GI-IAB (Intraabdominal infection, not specified elsewhere)	6	0.2% (0.1-0.3)	6	2.5%
NEO-NEC (Necrotising enterocolitis)	1	0.0% (0.0-0.1)	1	0.4%
Skin and soft tissue infections	11	0.3% (0.1-0.5)	11	4.6%
SST-SKIN (Skin infection)	10	0.3% (0.1-0.5)	10	4.1%
SST-ST (Soft tissue (necrotizing fascitis, infectious gangrene, necrotizing cellulitis, infectious myositis, lymphadenitis, or lymphangitis))	1	0.0% (0.0-0.1)	1	0.4%
Bone and joint infections	3	0.1% (0.0-0.2)	3	1.2%
BJ-BONE (Osteomyelitis)	2	0.1% (0.0-0.2)	2	0.8%
BJ-DISC (Disc space infection)	1	0.0% (0.0-0.1)	1	0.4%
Central nervous system infections	2	0.1% (0.0-0.2)	2	0.8%
CNS-IC (Intracranial infection)	1	0.0% (0.0-0.1)	1	0.4%
CNS-MEN (Meningitis or ventriculitis)	1	0.0% (0.0-0.1)	1	0.4%
Eye, Ear, Nose or Mouth infection	16	0.4% (0.2-0.7)	16	6.6%
EENT-ORAL (Oral cavity (mouth, tongue, or gums))	16	0.4% (0.2-0.7)	16	6.6%
Systemic infections	25	0.7% (0.4-1.0)	25	10.4%
SYS-DI (Disseminated infection)	2	0.1% (0.0-0.2)	2	0.8%
SYS-CSEP (Treated unidentified severe infection in adults and children)	13	0.3% (0.2-0.6)	13	5.4%
NEO-CSEP (Clinical sepsis in neonates)	10	0.3% (0.1-0.5)	10	4.1%
LEGEND:				
(1,2) number and % of infected patients (site-specific prevalence)				
(3,4) number of HAI and percentage of total HAI (relative frequency)				

Appendix B Table II (2017)

Table II. List of surgical procedures with associated HAI and AM use

	Total UK-NI (n=16)					
	N (1)	% tot (2)	n HAI	% HAI (3)	n AM	% AM (3)
AAA-Abdominal aortic aneurysm repair	7	0.2%	0	0.0%	3	42.9%
AMP-Limb amputation	7	0.2%	0	0.0%	0	0.0%
APPY-Appendix surgery	6	0.2%	0	0.0%	4	66.7%
AVSD-Shunt for dialysis	0	0.0%	0	.%	0	.%
BILI-Bile duct, liver or pancreatic surgery	5	0.1%	0	0.0%	1	20.0%
BRST-Breast surgery	10	0.3%	1	10.0%	5	50.0%
CARD-Cardiac surgery	18	0.5%	3	16.7%	9	50.0%
CBGB-Coronary artery bypass graft with both chest and donor site incisions	2	0.1%	2	100.0%	2	100.0%
CBGC-Coronary artery bypass graft with chest incision only	7	0.2%	1	14.3%	6	85.7%
CEA-Carotid endarterectomy	0	0.0%	0	.%	0	.%
CHOL-Gallbladder surgery	11	0.3%	2	18.2%	4	36.4%
COLO-Colon surgery	48	1.3%	6	12.5%	18	37.5%
CRAN-Craniotomy	16	0.4%	0	0.0%	2	12.5%
CSEC-Cesarean section	31	0.8%	1	3.2%	14	45.2%
FUSN-Spinal fusion	3	0.1%	0	0.0%	0	0.0%
FX-Open reduction of fracture	44	1.2%	4	9.1%	8	18.2%
GAST-Gastric surgery	8	0.2%	1	12.5%	3	37.5%
HER-Herniorrhaphy	7	0.2%	1	14.3%	2	28.6%
HPRO-Hip prosthesis	54	1.4%	7	13.0%	18	33.3%
HTP-Heart transplant	0	0.0%	0	.%	0	.%
HYST-Abdominal hysterectomy	3	0.1%	1	33.3%	1	33.3%
KPRO-Knee prosthesis	30	0.8%	4	13.3%	10	33.3%
KTP-Kidney transplant	2	0.1%	0	0.0%	0	0.0%
LAM-Laminectomy	11	0.3%	1	9.1%	1	9.1%
LTP-Liver transplant	2	0.1%	1	50.0%	1	50.0%
NECK-Neck surgery	0	0.0%	0	.%	0	.%
NEPH-Kidney surgery	13	0.3%	2	15.4%	6	46.2%
OVRY-Ovarian surgery	16	0.4%	2	12.5%	4	25.0%
PACE-Pacemaker surgery	5	0.1%	0	0.0%	0	0.0%
PRST-Prostate surgery	0	0.0%	0	.%	0	.%
PVBY-Peripheral vascular bypass surgery	6	0.2%	2	33.3%	2	33.3%
REC-Rectal surgery	3	0.1%	0	0.0%	0	0.0%
RFUSN-Refusion of spine	1	0.0%	0	0.0%	0	0.0%
SB-Small bowel surgery	19	0.5%	4	21.1%	7	36.8%
SPLE-Spleen surgery	2	0.1%	1	50.0%	2	100.0%
THOR-Thoracic surgery	8	0.2%	0	0.0%	1	12.5%
THYR-Thyroid and/or parathyroid surgery	4	0.1%	1	25.0%	1	25.0%
VHYS-Vaginal hysterectomy	6	0.2%	0	0.0%	0	0.0%
VSHN-Ventricular shunt	5	0.1%	1	20.0%	2	40.0%
XLAP-Exploratory laparotomy	0	0.0%	0	.%	0	.%

LEGEND:

(1) total number of patients in category

(2) percentage of total (column percent), (3) percentage of category total (row percent)

HAI: patients with >=1 healthcare-associated infection, AM: patients receiving >=1 antimicobial agent

Appendix B Table III (2017)

Table III. HAI and antimicrobial use by patient risk factors (standard protocol only)

	Total UK-NI (n=16)					
	N (1)	% tot (2)	n HAI	% HAI (3)	n AM	% AM (3)
All patients	3813	100.0%	234	6.1%	1385	36.3%
Age						
<1y	153	4.0%	13	8.5%	30	19.6%
1-4y	93	2.4%	5	5.4%	30	32.3%
5-14y	68	1.8%	0	0.0%	17	25.0%
15-24y	123	3.2%	2	1.6%	43	35.0%
25-34y	258	6.8%	6	2.3%	72	27.9%
35-44y	208	5.5%	13	6.3%	74	35.6%
45-54y	315	8.3%	24	7.6%	110	34.9%
55-64y	477	12.5%	23	4.8%	171	35.8%
65-74y	654	17.2%	44	6.7%	270	41.3%
75-84y	912	23.9%	71	7.8%	344	37.7%
>=85y	552	14.5%	33	6.0%	224	40.6%
Gender						
F	2050	53.8%	99	4.8%	724	35.3%
M	1763	46.2%	135	7.7%	661	37.5%
Length of stay (7)						
1-3d	1301	34.1%	29	2.2%	409	31.4%
4-7d	971	25.5%	74	7.6%	454	46.8%
8-14d	739	19.4%	58	7.8%	287	38.8%
>2w	792	20.8%	73	9.2%	232	29.3%
Missing/Unk	10	0.3%	0	0.0%	3	30.0%
Surgery since admission						
No surgey	3181	83.4%	163	5.1%	1149	36.1%
NHSN surgery	482	12.6%	58	12.0%	164	34.0%
Non-NHSN/minimal surgery	123	3.2%	12	9.8%	61	49.6%
Missing/Unk	27	0.7%	1	3.7%	11	40.7%
McCabe score						
Non fatal disease	2477	65.0%	139	5.6%	836	33.8%
Ultimately fatal disease	735	19.3%	57	7.8%	359	48.8%
Rapidly fatal disease	182	4.8%	15	8.2%	78	42.9%
Missing/Unk	419	11.0%	23	5.5%	112	26.7%
Central vascular catheter						
No	3606	94.6%	203	5.6%	1251	34.7%
Yes	207	5.4%	31	15.0%	134	64.7%
Missing/Unk	0	0.0%	0	.%	0	.%
Peripheral vascular catheter						
No	1800	47.2%	60	3.3%	365	20.3%
Yes	2013	52.8%	174	8.6%	1020	50.7%
Missing/Unk	0	0.0%	0	.%	0	.%
Urinary catheter						
No	3134	82.2%	149	4.8%	1053	33.6%
Yes	679	17.8%	85	12.5%	332	48.9%
Missing/Unk	0	0.0%	0	.%	0	.%
Intubation						
No	3735	98.0%	225	6.0%	1349	36.1%
Yes	78	2.0%	9	11.5%	36	46.2%
Missing/Unk	0	0.0%	0	.%	0	.%
Birthweight						
>=2500g	103	2.7%	7	6.8%	18	17.5%
<2500g	42	1.1%	6	14.3%	10	23.8%
NA/Missing/Unk	3668	96.2%	221	6.0%	1357	37.0%

LEGEND:
(1)total number of patients in category
(2) percentage of total (column percent), (3)percentage of category total (row percent)
HAI: patients with >=1 healthcare-associated infection, AM: patients receiving >=1 antimicobial agent
(7) Length of stay until date of onset HAI if HAI during current hospital stay

Appendix B Table IV (part 1) 2017

Table IV. Antimicrobial agents (ATC4 and ATC5) by indication								
Page 1 of 2	Total UK-NI (n=16)							
	Total	%	Trt	%	SP	%	MP	%
Total N of antimicrobial agents	2072	100.0%	1742	100.0%	111	100.0%	184	100.0%
A07AA (Intestinal antiinfectives, antibiotics)	89	4.3%	47	2.7%	0	0.0%	37	20.1%
A07AA02 (Nystatin)	60	2.9%	33	1.9%	0	0.0%	24	13.0%
A07AA07 (Amphotericin B (oral))	1	0.0%	1	0.1%	0	0.0%	0	0.0%
A07AA09 (Vancomycin (oral))	8	0.4%	8	0.5%	0	0.0%	0	0.0%
A07AA10 (Colistin (oral))	1	0.0%	1	0.1%	0	0.0%	0	0.0%
A07AA11 (Rifaximin)	17	0.8%	2	0.1%	0	0.0%	13	7.1%
A07AA12 (Fidaxomicin)	2	0.1%	2	0.1%	0	0.0%	0	0.0%
D01BA (Antifungals for systemic use)	1	0.0%	0	0.0%	0	0.0%	0	0.0%
D01BA02 (Terbinafine)	1	0.0%	0	0.0%	0	0.0%	0	0.0%
J01AA (Tetracyclines)	98	4.7%	86	4.9%	1	0.9%	7	3.8%
J01AA01 (Demeclocycline)	6	0.3%	3	0.2%	0	0.0%	1	0.5%
J01AA02 (Doxycycline)	87	4.2%	79	4.5%	1	0.9%	6	3.3%
J01AA06 (Oxytetracycline)	1	0.0%	0	0.0%	0	0.0%	0	0.0%
J01AA12 (Tigecycline)	4	0.2%	4	0.2%	0	0.0%	0	0.0%
J01CA (Penicillins, extended spectrum without anti-pseudomonal activity)	181	8.7%	170	9.8%	1	0.9%	7	3.8%
J01CA04 (Amoxicillin)	177	8.5%	167	9.6%	1	0.9%	6	3.3%
J01CA08 (Pivmecillinam)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J01CA12 (Piperacillin)	2	0.1%	1	0.1%	0	0.0%	1	0.5%
J01CA17 (Temocillin)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J01CE (Beta-lactamase sensitive penicillins)	52	2.5%	45	2.6%	0	0.0%	7	3.8%
J01CE01 (Benzylpenicillin)	46	2.2%	43	2.5%	0	0.0%	3	1.6%
J01CE02 (Phenoxymethylpenicillin)	5	0.2%	1	0.1%	0	0.0%	4	2.2%
J01CE30 (Combinations of beta-lactamase sensitive penicillins)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J01CF (Beta-lactamase resistant penicillins)	94	4.5%	80	4.6%	14	12.6%	0	0.0%
J01CF05 (Flucloxacillin)	94	4.5%	80	4.6%	14	12.6%	0	0.0%
J01CG (Beta-lactamase inhibitors)	10	0.5%	9	0.5%	1	0.9%	0	0.0%
J01CG02 (Tazobactam)	10	0.5%	9	0.5%	1	0.9%	0	0.0%
J01CR (Combinations of penicillins, incl. beta-lactamase inhibitors)	497	24.0%	464	26.6%	21	18.9%	2	1.1%
J01CR02 (Amoxicillin and enzyme inhibitor)	176	8.5%	150	8.6%	20	18.0%	1	0.5%
J01CR05 (Piperacillin and enzyme inhibitor)	321	15.5%	314	18.0%	1	0.9%	1	0.5%
J01DB (First-generation cephalosporins)	21	1.0%	9	0.5%	0	0.0%	12	6.5%
J01DB01 (Cefalexin)	19	0.9%	7	0.4%	0	0.0%	12	6.5%
J01DB04 (Cefazolin)	2	0.1%	2	0.1%	0	0.0%	0	0.0%
J01DC (Second-generation cephalosporins)	28	1.4%	1	0.1%	27	24.3%	0	0.0%
J01DC02 (Cefuroxime)	28	1.4%	1	0.1%	27	24.3%	0	0.0%
J01DD (Third-generation cephalosporins)	36	1.7%	35	2.0%	0	0.0%	0	0.0%
J01DD01 (Cefotaxime)	8	0.4%	8	0.5%	0	0.0%	0	0.0%
J01DD02 (Ceftazidime)	2	0.1%	2	0.1%	0	0.0%	0	0.0%
J01DD04 (Ceftriaxone)	25	1.2%	25	1.4%	0	0.0%	0	0.0%
J01DD08 (Cefixime)	1	0.0%	0	0.0%	0	0.0%	0	0.0%
J01DF (Monobactams)	16	0.8%	16	0.9%	0	0.0%	0	0.0%
J01DF01 (Aztreonam)	16	0.8%	16	0.9%	0	0.0%	0	0.0%
J01DH (Carbapenems)	81	3.9%	78	4.5%	1	0.9%	0	0.0%
J01DH02 (Meropenem)	75	3.6%	72	4.1%	1	0.9%	0	0.0%
J01DH03 (Ertapenem)	5	0.2%	5	0.3%	0	0.0%	0	0.0%
J01DH51 (Imipenem and enzyme inhibitor)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J01EA (Trimethoprim and derivatives)	28	1.4%	24	1.4%	0	0.0%	4	2.2%
J01EA01 (Trimethoprim)	28	1.4%	24	1.4%	0	0.0%	4	2.2%
J01EC (Intermediate-acting sulfonamides)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J01EC02 (Sulfadiazine)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J01EE (Combinations of sulfonamides and trimethoprim, incl. derivatives)	58	2.8%	5	0.3%	0	0.0%	51	27.7%
J01EE01 (Sulfamethoxazole and trimethoprim)	58	2.8%	5	0.3%	0	0.0%	51	27.7%

Appendix B Table IV (part 2) 2017

Table IV. Antimicrobial agents (ATC4 and ATC5) by indication								
Page 2 of 2	Total UK-NI (n=16)							
	Total	%	Trt	%	SP	%	MP	%
J01FA (Macrolides)	117	5.6%	95	5.5%	1	0.9%	17	9.2%
J01FA01 (Erythromycin)	6	0.3%	1	0.1%	0	0.0%	1	0.5%
J01FA09 (Clarithromycin)	92	4.4%	91	5.2%	1	0.9%	0	0.0%
J01FA10 (Azithromycin)	19	0.9%	3	0.2%	0	0.0%	16	8.7%
J01FF (Lincosamides)	19	0.9%	18	1.0%	1	0.9%	0	0.0%
J01FF01 (Clindamycin)	19	0.9%	18	1.0%	1	0.9%	0	0.0%
J01GB (Aminoglycosides)	153	7.4%	129	7.4%	21	18.9%	3	1.6%
J01GB01 (Tobramycin)	10	0.5%	10	0.6%	0	0.0%	0	0.0%
J01GB03 (Gentamicin)	139	6.7%	115	6.6%	21	18.9%	3	1.6%
J01GB05 (Neomycin (injection, infusion))	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J01GB06 (Amikacin)	3	0.1%	3	0.2%	0	0.0%	0	0.0%
J01MA (Fluoroquinolones)	91	4.4%	84	4.8%	0	0.0%	7	3.8%
J01MA02 (Ciprofloxacin)	75	3.6%	68	3.9%	0	0.0%	7	3.8%
J01MA12 (Levofloxacin)	16	0.8%	16	0.9%	0	0.0%	0	0.0%
J01RA (Combinations of antibacterials)	7	0.3%	1	0.1%	0	0.0%	6	3.3%
J01RA02 (Sulfonamides, combinations with other antibacterials (excl. trimethoprim)	7	0.3%	1	0.1%	0	0.0%	6	3.3%
J01XA (Glycopeptide antibacterials)	120	5.8%	109	6.3%	11	9.9%	0	0.0%
J01XA01 (Vancomycin (parenteral))	27	1.3%	27	1.5%	0	0.0%	0	0.0%
J01XA02 (Teicoplanin)	93	4.5%	82	4.7%	11	9.9%	0	0.0%
J01XB (Polymyxins)	6	0.3%	3	0.2%	0	0.0%	3	1.6%
J01XB01 (Colistin (injection, infusion))	6	0.3%	3	0.2%	0	0.0%	3	1.6%
J01XC (Steroid antibacterials)	5	0.2%	5	0.3%	0	0.0%	0	0.0%
J01XC01 (Fusidic acid)	5	0.2%	5	0.3%	0	0.0%	0	0.0%
J01XD (Imidazole derivatives)	105	5.1%	96	5.5%	9	8.1%	0	0.0%
J01XD01 (Metronidazole (parenteral))	105	5.1%	96	5.5%	9	8.1%	0	0.0%
J01XE (Nitrofuran derivatives)	20	1.0%	13	0.7%	0	0.0%	7	3.8%
J01XE01 (Nitrofurantoin)	20	1.0%	13	0.7%	0	0.0%	7	3.8%
J01XX (Other antibacterials)	26	1.3%	26	1.5%	0	0.0%	0	0.0%
J01XX01 (Fosfomycin)	2	0.1%	2	0.1%	0	0.0%	0	0.0%
J01XX08 (Linezolid)	14	0.7%	14	0.8%	0	0.0%	0	0.0%
J01XX09 (Daptomycin)	8	0.4%	8	0.5%	0	0.0%	0	0.0%
J01XX10 (Bacitracin)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J01XX11 (Tedizolid)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J02AA (Antimycotics, antibiotics)	9	0.4%	3	0.2%	0	0.0%	6	3.3%
J02AA01 (Amphotericin B (parenteral))	9	0.4%	3	0.2%	0	0.0%	6	3.3%
J02AC (Triazole derivatives)	28	1.4%	20	1.1%	1	0.9%	7	3.8%
J02AC01 (Fluconazole)	23	1.1%	20	1.1%	1	0.9%	2	1.1%
J02AC02 (Itraconazole)	2	0.1%	0	0.0%	0	0.0%	2	1.1%
J02AC03 (Voriconazole)	1	0.0%	0	0.0%	0	0.0%	1	0.5%
J02AC04 (Posaconazole)	2	0.1%	0	0.0%	0	0.0%	2	1.1%
J02AX (Other antimycotics for systemic use)	16	0.8%	14	0.8%	0	0.0%	1	0.5%
J02AX01 (Flucytosine)	1	0.0%	1	0.1%	0	0.0%	0	0.0%
J02AX04 (Caspofungin)	1	0.0%	0	0.0%	0	0.0%	1	0.5%
J02AX05 (Micafungin)	2	0.1%	2	0.1%	0	0.0%	0	0.0%
J02AX06 (Anidulafungin)	12	0.6%	11	0.6%	0	0.0%	0	0.0%
J04AB (Antimycobacterials, antibiotics)	11	0.5%	11	0.6%	0	0.0%	0	0.0%
J04AB02 (Rifampicin)	11	0.5%	11	0.6%	0	0.0%	0	0.0%
P01AB (Nitroimidazole derivatives)	48	2.3%	45	2.6%	1	0.9%	0	0.0%
P01AB01 (Metronidazole (oral, rectal))	48	2.3%	45	2.6%	1	0.9%	0	0.0%
LEGEND:								
Trt: treatment intention, SP: surgical prophylaxis, MP: medical prophylaxis								

Appendix B Table V (2017)

Table V. Antimicrobial treatment diagnosis site by indication								
	Total UK-NI (n=16)							
	Total	%	CI	%	HI	%	LI	%
Total N of diagnoses (N of infections)	1249	100.0%	895	100.0%	326	100.0%	28	100.0%
Respiratory tract	446	35.7%	312	34.9%	124	38.0%	10	35.7%
PNEU (Pneumonia)	343	27.5%	222	24.8%	113	34.7%	8	28.6%
BRON (Acute bronchitis or exacerberations of chronic bronchitis)	94	7.5%	81	9.1%	11	3.4%	2	7.1%
CF (Cystic Fibrosis)	9	0.7%	9	1.0%	0	0.0%	0	0.0%
Urinary tract	179	14.3%	143	16.0%	30	9.2%	6	21.4%
CYS (Symptomatic Lower UTI)	109	8.7%	85	9.5%	18	5.5%	6	21.4%
PYE (Symptomatic Upper UTI)	68	5.4%	57	6.4%	11	3.4%	0	0.0%
ASB (Asymptomatic bactreriuria)	2	0.2%	1	0.1%	1	0.3%	0	0.0%
Systemic infections	180	14.4%	126	14.1%	48	14.7%	6	21.4%
BAC (Lab-confirmed bacteraemia)	57	4.6%	39	4.4%	17	5.2%	1	3.6%
CSEP (Clinical sepsis (suspected bloodstream infections without lab confirmation=result not yet available, no blood cultures collect	52	4.2%	34	3.8%	17	5.2%	1	3.6%
FN (Febrile Neutropaenia or other form of manifestation of infection in immunocompromised host (e.g., HIV, chemotherapy etc)	29	2.3%	26	2.9%	3	0.9%	0	0.0%
SIRS (Systematic inflammatory response with no clear anatomic site)	27	2.2%	16	1.8%	9	2.8%	2	7.1%
UND (Completely undefined, site with no systemic inflammation)	15	1.2%	11	1.2%	2	0.6%	2	7.1%
Cardiovascular system	11	0.9%	9	1.0%	1	0.3%	1	3.6%
Gastro-intestinal system	179	14.3%	133	14.9%	45	13.8%	1	3.6%
GI (GI Infections (salmonellosis, antibiotic associated diarrhoea))	36	2.9%	13	1.5%	23	7.1%	0	0.0%
IA (Intra abdominal sepsis including hepatobiliary)	143	11.4%	120	13.4%	22	6.7%	1	3.6%
Skin/soft tissue/bone/joint - SSI	41	3.3%	9	1.0%	32	9.8%	0	0.0%
SST-SSI (Surgical site infection involving skin or soft tissue but not bone)	27	2.2%	3	0.3%	24	7.4%	0	0.0%
BJ-SSI (Septic arthritis, osteomyelitis of surgical site)	14	1.1%	6	0.7%	8	2.5%	0	0.0%
Skin/soft tissue/bone/joint - other	128	10.2%	106	11.8%	18	5.5%	4	14.3%
SST-O (Cellulitis, wound, deep soft tissue not involving bone, not related to surgery)	103	8.2%	84	9.4%	17	5.2%	2	7.1%
BJ-O (Septic arthritis, osteomyelitis, not related to surgery)	25	2.0%	22	2.5%	1	0.3%	2	7.1%
Central nervous system	21	1.7%	17	1.9%	4	1.2%	0	0.0%
Eye/ear/nose/throat	51	4.1%	30	3.4%	21	6.4%	0	0.0%
Genito-urinary system/obs.	13	1.0%	10	1.1%	3	0.9%	0	0.0%
OBGY (Obstetric or gynaelogical infections, STD in women)	9	0.7%	6	0.7%	3	0.9%	0	0.0%
GUM (Prostatitis, epididymoorchitis, STD in men)	4	0.3%	4	0.4%	0	0.0%	0	0.0%
Missing/Unknown	0	0.0%	0	0.0%	0	0.0%	0	0.0%
LEGEND:								
CI: treatment intention for community-acquired infection								
HI: treatment intention for hospital-acquired infection								
LI: treatment intention for long-term care-acquired infection								

Appendix B Table VI (2017)

Table VI. Distribution of microorganisms isolated in HAI

	Total		PN/LRI(1)		SSI		UTI		BSI(2)		GI(3)	
N of HAI, all	241		77		41		15		24		26	
N of HAI with microorganisms, all	85	35.3%	8	10.4%	16	39.0%	9	60.0%	22	91.7%	20	76.9%
N of microorganisms	99	100.0%	9	100.0%	21	100.0%	10	100.0%	22	100.0%	25	100.0%
GRAM-POSITIVE COCCI	38	38.4%	2	22.2%	12	57.1%	1	10.0%	11	50.0%	5	20.0%
STAPHYLOCOCCUS AUREUS	19	19.2%	2	22.2%	8	38.1%	0	0.0%	6	27.3%	0	0.0%
COAG.-NEG. STAPHYLOCOCCI	5	5.1%	0	0.0%	2	9.5%	0	0.0%	2	9.1%	1	4.0%
STREPTOCOCCUS SPP.	3	3.0%	0	0.0%	1	4.8%	0	0.0%	0	0.0%	1	4.0%
ENTEROCOCCUS SPP.	10	10.1%	0	0.0%	1	4.8%	1	10.0%	2	9.1%	3	12.0%
OTHER GRAM POSITIVE COCCI	1	1.0%	0	0.0%	0	0.0%	0	0.0%	1	4.5%	0	0.0%
ENTEROBACTERIACEAE	31	31.3%	5	55.6%	6	28.6%	8	80.0%	8	36.4%	3	12.0%
ENTEROBACTER SPP.	1	1.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
ESCHERICHIA COLI	21	21.2%	3	33.3%	3	14.3%	7	70.0%	6	27.3%	2	8.0%
KLEBSIELLA SPP.	5	5.1%	1	11.1%	1	4.8%	1	10.0%	1	4.5%	1	4.0%
PROTEUS SPP.	3	3.0%	0	0.0%	2	9.5%	0	0.0%	1	4.5%	0	0.0%
SERRATIA SPP.	1	1.0%	1	11.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
GRAM-NEG., NON-ENTEROBACTERIACEAE	4	4.0%	0	0.0%	1	4.8%	0	0.0%	1	4.5%	0	0.0%
ACINETOBACTER SPP.	1	1.0%	0	0.0%	0	0.0%	0	0.0%	1	4.5%	0	0.0%
PSEUDOMONAS AERUGINOSA	2	2.0%	0	0.0%	1	4.8%	0	0.0%	0	0.0%	0	0.0%
PSEUDOMONADACEAE FAMILY, OTHER	1	1.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
ANAEROBIC BACILLI	19	19.2%	1	11.1%	1	4.8%	1	10.0%	0	0.0%	16	64.0%
BACTEROIDES SPP.	2	2.0%	0	0.0%	1	4.8%	0	0.0%	0	0.0%	1	4.0%
CLOSTRIDIUM DIFFICILE	15	15.2%	0	0.0%	0	0.0%	1	10.0%	0	0.0%	14	56.0%
OTHER ANAEROBES	2	2.0%	1	11.1%	0	0.0%	0	0.0%	0	0.0%	1	4.0%
OTHER BACTERIA	1	1.0%	0	0.0%	1	4.8%	0	0.0%	0	0.0%	0	0.0%
FUNGI	6	6.1%	1	11.1%	0	0.0%	0	0.0%	2	9.1%	1	4.0%
CANDIDA SPP.	4	4.0%	0	0.0%	0	0.0%	0	0.0%	2	9.1%	1	4.0%
OTHER FUNGI OR PARASITES	2	2.0%	1	11.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
NEGATIVE CODES(4)	156	64.7%	69	89.6%	25	61.0%	6	40.0%	2	8.3%	6	23.1%
MICRO-ORGANISM NOT IDENTIFIED	18	7.5%	11	14.3%	3	7.3%	0	0.0%	0	0.0%	1	3.8%
EXAMINATION NOT DONE	72	29.9%	28	36.4%	12	29.3%	4	26.7%	0	0.0%	2	7.7%
STERILE EXAMINATION	1	0.4%	0	0.0%	1	2.4%	0	0.0%	0	0.0%	0	0.0%
NOT (YET) AVAILABLE/MISSING	65	27.0%	30	39.0%	9	22.0%	2	13.3%	2	8.3%	3	11.5%

LEGEND:

(1) PN/LRI: pneumonia and other lower respiratory tract infections (incl. PN1-PN5, PN-Nos, NEO-PNEU, LRI-BRON, LRI-LUNG)

(2) BSI: bloodstream infections (incl. BSI, CRI3, NEO-LCBI, NEO-CNSB, NEO-CSEP)

(3) GI: gastro-intestinal infections (incl. GI-CDI, GI-GE, GI-GIT, GI-IAB, GI-Nos, NEO-NEC)

(4) Negative codes: percentage of total HAI

Appendix C Table I (2017)

Device usage across ward specialities 2012 vs. 2017

Ward Speciality	CVC				PVC				UC				Intubated			
	2012		2017		2012		2017		2012		2017		2012		2017	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
All Specialties	200	5	207	5.4	1733	43.4	2013	52.8	681	17.1	679	17.8	97	2.4	78	2
Care of the Elderly	3	1.1	2	0.5	74	26.2	123	33.2	47	16.7	54	14.6	0	-	0	0
Adult ICU	42	42.4	55	74.3	68	68.7	57	77	71	71.7	73	98.6	42	42.4	36	48.6
Medical	77	4.6	65	4.1	833	49.4	919	57.5	281	16.7	271	17	10	0.6	2	0.1
Obstetrics/Gynaecology	1	0.3	3	0.9	86	22.3	103	31.3	27	7	37	11.2	5	1.3	0	0
Paediatrics (inc. paediatric & neonatal ICU)	17	9.6	23	20	63	35.4	96	79.8	10	5.6	8	5.2	13	7.3	8	5.9
Surgical	55	5.3	44	4.5	552	53	603	61	226	21.7	203	20.5	27	2.6	29	2.9
Other	5	1.6	15	13.4	57	17.8	112	129.1	19	5.9	33	39.8	0	-	3	4.4
N = number of devices																
% = percentage of patients																

Appendix C Table II (2017)

Distribution of HAI by Gender and Age Group 2012 vs. 2017

Risk Factors	Number of Patients		Number of Patients with HAI		HAI prevalence %(95% CI)	
	2012 (n=3992)	2017 (n=3813)	2012	2017	2012	2017
Gender						
Male	1823	1763	85	135	4.7 (3.8-5.8)	7.7 (6.5-9.0)
Female	2169	2050	81	99	3.7 (3.0-4.6)	4.8 (4.0-5.8)
Age Group						
< 1 month	186	168	3	14	1.6 (1.6-4.6)	8.3 (5.0-13.5)
1-23 months	96	43	8	4	8.3 (4.3-15.6)	9.3 (3.7-21.6)
2-15 years	101	115	2	0	2.0 (0.5-6.9)	0.0 (0.0-3.2)
16-29 years	299	242	6	4	2.0 (0.9-4.3)	1.7 (0.6-4.2)
30-49 years	590	487	18	29	3.1 (1.9-4.8)	6.0 (4.2-8.4)
50-64 years	654	640	38	35	5.8 (4.3-7.9)	5.5 (4.0-7.5)
65-79 years	1092	1116	47	85	4.3 (3.3-5.7)	7.6 (6.2-9.3)
80+ years	974	1002	44	63	4.5 (3.4-6.0)	6.3 (4.9-8.0)

Appendix C Table III (2017)

Distribution of HAI by Hospital Type 2012 vs. 2017

Hospital types	Number of Patients		Number of Patients with HAI		HAI prevalence %(95% CI)	
	2012	2017	2012	2017	2012	2017
Primary	672	663	15	34	2.2 (1.4-3.7)	5.1 (3.7-7.1)
Secondary	1947	1892	62	118	3.2 (2.6-4.2)	6.2 (5.2-7.4)
Tertiary	952	858	65	59	6.8 (5.8-9.2)	6.9 (5.4-8.8)
Specialised	421	400	24	23	5.7 (4.1-8.8)	5.8 (3.9-8.5)

Appendix C Table IV (2017)

Distribution of HAI by Risk Factors (Invasive device, Surgery, Underlying disease prognosis) 2012 vs. 2017

Risk Factors	Number of Patients		Number of Patients with HAI		HAI prevalence %(95% CI)	
	2012 (n=3992)	2017 (n=3813)	2012	2017	2012	2017
Invasive device in situ						
Any device - Yes	2034	2298	145	194	7.1 (6.1-8.3)	8.4 (7.4-9.6)
Any device - No	1958	1515	21	40	1.1 (0.7-1.6)	2.6 (1.9-3.6)
CVC	200	207	41	31	20.5 (15.5-26.6)	14.9 (10.8-20.5)
PVC	1733	2013	110	174	6.3 (5.3-7.6)	8.6 (7.5-10.0)
Urinary Catheter	681	679	64	85	9.4 (7.4-11.8)	12.5 (10.2-15.2)
Intubulation	97	78	16	9	16.5 (10.4-25.1)	11.5 (6.2-20.5)
Surgery Since Admission						
Yes	706	632	55	71	7.8 (6.0-10.0)	11.2 (9.0-13.9)
No	3286	3181	111	163	3.4 (2.8-4.1)	5.1 (4.4-5.9)
Underlying Disease Prognosis						
None/Non-fatal	2792	2477	83	139	3.0 (2.4-3.7)	5.6 (4.8-6.6)
Life Limiting Prognosis	844	735	59	57	7.0 (5.5-8.9)	7.8 (6.0-9.9)
End of life Prognosis	109	182	9	15	8.3 (4.4 - 15.0)	8.2 (5.1-13.2)
Not Known	247	419	15	23	6.1 (3.7-9.8)	5.5 (3.7-8.1)

Appendix C Table V (2017)

Distribution of HAI by Ward Speciality 2012 vs. 2017

Ward Specialty	Number		% Total Patients		Number with HAI		HAI Prevalence %(95% CI)	
	2012	2017	2012	2017	2012	2017	2012	2017
All Ward Specialities	3992	3813	100	100	166	234	4.2 (3.6-4.8)	6.14 (5.4-6.9)
Adult ICU	99	74	2.5	1.9	9	13	9.1 (4.7-16.4)	17.6 (10.6-27.8)
Care of the Elderly	282	371	7.1	9.7	16	28	5.7 (3.5-9.0)	7.5 (5.3-10.7)
Surgical	1041	988	26.1	25.9	54	65	5.2 (4.0-6.7)	6.6 (5.2-8.3)
Paediatrics (Inc. pardiatric & neonatal ICUs)	178	227	4.5	5.6	8	16	4.5 (2.3-8.6)	7.0 (4.4-11.1)
Medical	1687	1597	42.3	41.9	67	87	4.0 (3.1-5.0)	5.4 (4.4-6.7)
Other	320	227	8	5.6	9	10	2.8 (1.5-5.3)	4.4 (2.4-7.9)
Obstetrics/Gynaecology	385	329	9.6	8.6	3	15	0.8 (0.3-2.3)	4.6 (2.8-7.4)

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