Northern Ireland Point Prevalence Survey of Hospital-acquired Infections and Antimicrobial Use 2012

Preliminary Report
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HSC Public Health Agency

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Summary

Background

'Changing the Culture 2010' [1], the DHSSPS strategic action plan for healthcare-associated infections, recommended that Public Health Agency (PHA) should co-ordinate a repeat of the 2006 Point Prevalence Survey (PPS) across acute hospitals in Northern Ireland during 2012.

Findings arising from the 2012 PPS provide a comprehensive summary of the burden and nature of hospital-acquired infection (a subset of all healthcare–associated infections) in Northern Ireland. Outputs from PPS 2012 will be used to track progress in achieving the Health and Social Care Board's objective to "*ensure high quality, safe and accessible health and social care services, and performance manage delivery to achieve quality outcomes*". [2]

The Public Health Agency (PHA) coordinated the PPS on hospital-acquired infection (HAI) and antimicrobial use (AMU) in Northern Ireland. This followed a recommendation from the Council of the European Union that separate point prevalence surveys of hospital-acquired infection and antibiotic use in hospitals should be combined into one survey.

Each Trust indicated their agreement to participate in PPS 2012 and identified a local coordinator who was responsible for liaising with PHA and completion of PPS in their Trust.

Aims and objectives

- Estimate the burden (prevalence) of HAI and AMU in acute care.
- Measure the overall prevalence of antimicrobial prescribing, types of antimicrobials and compliance with local policy.
- Identify priority areas for future interventions to prevent and control HAI, for antimicrobial stewardship and for future targeted incidence surveillance of HAI.
- Disseminate PPS results to those who need to know at local, regional, national and EU level to identify problems and determine priorities accordingly.

Methods

The methodology used for PPS 2012 in Northern Ireland followed the European Centre for Disease Prevention and Control (ECDC) protocol for 'Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals'. Extra data items were collected to reflect local needs and facilitate comparison across UK countries and Ireland.

PPS data were collected by participating acute hospitals. All PPS training materials were based on those provided by ECDC. Data collection protocol, codebook and case studies were provided to PPS Teams in each acute site. Electronic data capture was facilitated using 'WebForms' software, which included facilities for data checking and validation.

The PPS was completed between June and September 2012 in Northern Ireland. The survey included all acute care beds in Tertiary, Secondary, Primary and Specialised hospitals.

Key results

Prevalence of HAI

PPS 2012 was the second national survey of HAI prevalence and the first national survey of AMU prevalence in Northern Ireland and included all sixteen acute hospitals and 3,992 patients. The overall HAI prevalence was 4·2% (95%CI 3·6 – 4·8).

Comparable rates of hospital acquired infections in Europe and UK		
Country	**Prevalence %**	**95%CI**
Europe – ECDC PPS 2011/12	6·2	6·1 – 6·3
England (Acute NHS) 2011 [3]	6·5	4·8 – 8·8
Scotland (Acute NHS) 2011 [4]	4·9	4·4 – 5·4
Wales (Acute NHS) 2011 [5]	4·3	3·8 – 4·8
Northern Ireland 2012	4·2	3·6 – 4·8

The most commonly identified HAIs were pneumonia (24% of all HAI), followed by surgical site infection (19%), urinary tract infection (12%), systemic infection (12%), gastrointestinal infection (9%) and bloodstream infections (9%).

Overall the prevalence of urinary catheter and central vascular catheter use has not changed since 2006. However, when similar survey populations were compared, the use of peripheral vascular catheters was significantly higher in 2012 than in 2006 (used for 48% of patients in 2012 and 39% of patients in 2006).

Gram-negative organisms were the most commonly identified organisms accounting for almost four in every ten microorganisms. *Staphylococcus aureus* remains an infection risk in hospitals, accounting for 14% of all available microbiology reports in this survey.

The prevalence of MRSA decreased by over 80% from PPS 2006 and PPS 2012. *Clostridium difficile* accounted for 8% of all microorganisms reported. When similar survey populations were compared, *Clostridium difficile* prevalence decreased from 1% of the patient population surveyed in 2006 to 0·2% in 2012.

Prevalence of antimicrobial use

The overall prevalence of antimicrobial use was 29·5% (95%CI 28·1 – 30·9). The highest antimicrobial use (56%) was reported in adult intensive care units (ICUs) followed by medical wards (34%). The prevalence of antimicrobial use in the paediatric population (29%) was similar to that reported for the overall survey population.

The most common indication for antimicrobial prescribing was infections deemed to be community acquired (18% of all patients; 60% of all prescribed antimicrobials). One in twenty patients was prescribed antimicrobials specifically for hospital-acquired infection. Prophylaxis accounted for 14% of all antimicrobials (7% surgical prophylaxis, 6·6% medical prophylaxis).

Comparable rates of antimicrobial use in Europe and UK		
Country	**Prevalence %**	**95%CI**
Europe – ECDC PPS 2011/12	36·3	36·1 – 36·5
England (Acute NHS) 2011 [3]	34·3	30·1 – 39·2
Scotland (Acute NHS) 2011 [4]	32·3	30·9 – 33·8
Wales (Acute NHS) 2011 [5]	32·7	31·6 – 33·9
Northern Ireland 2012	29·5	28·1 – 30·9

Priorities

Hospital-acquired infection

1. Continued focus on HAI prevention and control in ICU settings.

2. Consideration should be given to reviewing HAI incidence surveillance programmes as currently established.

3. Realignment of surgical site infection (SSI) surveillance to include surgical specialties, for which a high prevalence rate was reported.

4. Development of methodologies to support standardised incidence surveillance of HAI most commonly reported in the hospital context.

5. Validation of PPS findings relating to reduced prevalence of symptomatic urinary tract infections in the hospital setting.

6. Sustained emphasis on education and training of clinical staff on methods for improvement and prevention of HAI.

Device use

1. Continued focus on presence of invasive devices as a significant risk factor for development of HAI in the hospital setting.
2. Sustained emphasis on education and training of clinical staff responsible for insertion and maintenance of invasive devices.
3. Consideration of reporting device prevalence across services and organisations, with a view to assisting with reduction of device use and shortening duration of use.

Priorities

Antimicrobial use

1 Continued focus on the critical importance of effective antimicrobial stewardship in the hospital context and across the whole health economy.

2 Development, and robust implementation across all Trusts of, local guidelines addressing appropriate use of important broad spectrum antimicrobials e.g. meropenem.

3 Development of regionally agreed quality indicators for AMU to assist with benchmarking across organisations.

4 Regular reporting and assessment of antimicrobial consumption data for each hospital, with case-mix stratification.

5 Sustained emphasis on ensuring appropriate antimicrobial use.

6 Consideration of targeted programme aimed at reducing antimicrobial requirements and ensuring appropriate antimicrobial use for infections of the respiratory system.

7 Validation of survey findings relating to antimicrobials used for prophylaxis, and in particular surgical prophylaxis lasting longer than 24 hours.

8 Development of antimicrobial stewardship and prescribing competencies.

Microbiology

1 Continued focus on the importance of developing appropriate regional and local capacity to monitor ‘drug-bug’ combinations across the health economy

2 Development of guidance on the prevention and control of Enterobacteriaceae in hospital and healthcare settings.

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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
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 Chemotherapy
ESBL	Extended spectrum beta-lactamase
GI	Gastrointestinal infection
HELICS	Hospitals in Europe Link for Infection Control through Surveillance
HAI	Hospital-acquired 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

1 Introduction

Hospital-acquired infections (HAI) occur when patients admitted to hospital develop illness as a result of the treatment they receive. HAI are a recognised public health problem worldwide and contribute significantly to morbidity and mortality in the hospital population. [(6)] Additional costs arising from treatment of HAI place a significant burden on healthcare resources. [(7)]

Significant progress has been made in recent years to implement effective infection prevention and control strategies in hospitals and healthcare facilities across Northern Ireland – thus reducing the burden of HAI.

There are two approaches to assessing the burden of HAI – continuous (incidence) surveillance and/or point prevalence surveys (PPS). HAI surveillance, i.e. the collection of standardised data, its dissemination and the subsequent action accruing from the results, is a key component of effective infection prevention and control.

HAI surveillance at a national level requires a balance between the collection of complex and detailed information and the need to minimise the load on infection control and prevention teams, while continuing to maintain a focus on data accuracy and completeness. [(8)]

Mandatory incidence surveillance has been introduced for a number of HAIs in Northern Ireland. These include MRSA, *Clostridium difficile*, surgical site infections (orthopaedics and caesarean section) and device-associated infections in the adult critical care setting). These surveillance programmes continue to report a decrease in related infection rates over recent years. [(9)]

Point prevalence surveys (PPS) have value in determining the overall burden of HAI and in highlighting areas that need further attention. [(10)] [(11)] [(12)] [(13)] [(14)] [(15)] [(16)] Prevalence surveys can support identification of areas requiring more detailed audit and assessment. PPS may also demonstrate differences between hospitals and/or healthcare systems. [(17)]

The Council of the European Union has advised that comprehensive HAI surveillance should be improved by organising surveys to agreed timescales and by following a harmonised protocol. Coordination would promote comparisons over time and across different geographies.

The protocol for the ECDC point prevalence survey of HAI and antimicrobial use in acute sector hospitals in 2011/12 was used by all countries participating in this survey. It is important to note that the definition of infection used in this PPS is narrower than the more general definition of healthcare associated infections (HCAI) used in Northern Ireland. The focus in this PPS is on infections likely to be attributable to the hospital environment, excluding infections likely to have originated within the wider community setting.

2 Background

In its strategic regional action plan for HCAI, '*Changing the Culture 2010*', DHSSPS advised that; *'by October 2011 the Agency [PHA] will complete a repeat of the 2006 HCAI Prevalence Survey'.* [(1)] On behalf of DHSSPS, PHA was mandated to develop and implement the ECDC point prevalence survey of hospital-acquired infection and antimicrobial prescribing in acute hospitals in Northern Ireland during 2012.

A follow-up to the most recent PPS completed in 2006 was considered necessary due to the changing epidemiology of HAI in Northern Ireland; for example, *Staphylococcus aureus* and *Clostridium difficile* were identified as the most prevalent HAIs in the 2006 PPS. Both organisms have since been the focus of local and national infection prevention and control interventions and both are the subject of performance reduction targets. Mandatory surveillance programmes for *Staphylococcus aureus* and *Clostridium difficile* have reported statistically significant reductions in the incidence of these infections in Northern Ireland over recent years. [(9)]

2.1 Previous prevalence studies of HAI across UK and Ireland

Northern Ireland has participated in previous HAI prevalence surveys undertaken in the United Kingdom during 1993/94 and 2006 (Table 1).

Table 1 Northern Ireland, UK & Ireland prevalence of HAI

Prevalence survey	Patients surveyed	Number with HAI	Prevalence	95%CI
Northern Ireland 2006	3,644	198	5·4	4·7 – 6·2
UK* & Ireland 2006 [(10)]	75,856	5,773	7·6	7·4 – 7·8
UK 1993/94 [(18)]	37,111	3,353	9·0	8·8 – 9·3

* Scotland not included

The definitions used in the 2006 survey differ from the definitions used in the current PPS, so care must be taken with interpretation of results, outlined above. In 2006, prevalence of hospital acquired infection in the United Kingdom and Ireland was 7·6% (95%CI: 7·40 – 7·78); in England 8·2%, Wales 6·4%, Ireland 4·9% and Northern Ireland 5·4%.

The most common HAI system infections identified for Northern Ireland in 2006 were: gastrointestinal (20·6% of all infections), urinary tract (19·9%), surgical site (14·5%), pneumonia (14·1%), skin and soft tissue (10·4%) and primary bloodstream (7·0%). Prevalence of MRSA was 1·2% with MRSA being the causative organism in 15·8% of all systemic infections. Prevalence of *Clostridium difficile* was also reported at 1·2%.

More recently, in 2009, five acute hospitals in Northern Ireland participated in the European Surveillance of Antimicrobial Consumption Point Prevalence Survey (ESAC) and reported an overall prevalence of antimicrobial use of 27·8%.

3 Methodology

3.1 Aims and objectives of 2012 PPS

The aims of this PPS were to determine the burden of hospital-acquired infection (HAI) and antimicrobial use (AMU) and to identify priority areas for future attention.

The specific objectives were to:

- Estimate the total burden (prevalence) of HAI and AMU in acute care hospitals in Northern Ireland.
- Describe HAI and AMU by types of patients, specialties, and healthcare facilities.
- Describe the sites, micro-organisms and markers of resistance for HAIs identified.
- Describe the antimicrobial compounds prescribed, indications for their use and quality indicators relating to their use.
- Report and disseminate PPS findings at local, regional and national level.
- Inform local and national priorities for HAI and AMU policy intervention, surveillance, improvement, and research going forward.
- Inform local and national priorities for quality indicators relating to AMU in line with relevant antimicrobial stewardship programmes.

3.2 Timetable and organisation

The Public Health Agency for Northern Ireland (PHA) coordinated the 2012 Point Prevalence Survey (PPS) of hospital acquired infection (HAI) and antimicrobial use (AMU) in Northern Ireland.

In March 2012, the Director of Public Health wrote to each HAI Trust Lead inviting their participation in PPS 2012. All acute hospitals in Northern Ireland were encouraged to participate in the survey. All Trusts replied indicating their willingness to participate and identified a local coordinator, who would be responsible for liaising with PHA and completing PPS in their Trust.

HCAI surveillance staff in PHA established working arrangements with colleagues in Health Protection Surveillance Centre (HPSC) in Ireland. Joint working with HPSC included planning and preparation of survey materials, delivery of survey-specific training, and cleaning, analysis and reporting of PPS data.

3.3 Study design

A rolling point prevalence survey was carried out in Northern Ireland hospitals between May and September 2012. The Northern Ireland protocol was developed in collaboration with colleagues in HPSC using the ECDC protocol for PPS. [19] [20] Ethical approval was not required as the study was not deemed to be research. A PPS Delivery Group was established to oversee the survey – membership of this group is attached in Appendix A.1.

3.4 Training and support

Eight training sessions were delivered by PHA to members of multidisciplinary PPS Teams in the five Health and Social Care (HSC) Trusts. One additional session was provided to Trust antimicrobial pharmacists. Training sessions were delivered in two parts, (i) why the PPS was being undertaken, methodology and patient eligibility; (ii) training on definitions of hospital-acquired infection (targeted at infection prevention and control teams and pharmacy staff).

A total of 197 staff received PPS-specific training. Feedback on training was positive. Participants requested additional case studies to assist with assignment of survey definitions in advance of PPS commencement. In collaboration with HPSC, a set of case studies were 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. Questions regarding data collection, including application of the protocol of definitions, were answered promptly by the PHA Prevalence Team. 'Frequently Asked Questions' were drafted and shared with Trust PPS Teams

3.5 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 surveillance 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. All wards, with the exception of day units and long term care facilities within acute hospitals were included. Patients admitted to the ward at 8 a.m. on the morning of the survey, excluding day patients, were eligible for inclusion. Patients admitted to or transferred into the ward after 8 a.m. on the day of the survey were excluded. Patients who left the ward before the survey data collection team arrived were also excluded.

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

Data was collected on data collection forms (Appendix A4 – A6). After completing the forms, data was entered into a specifically designed web entry programme. Data entry was the responsibility of participating hospitals.

3.6 Data Management

Data capture was facilitated over the web using Web Forms software [21] which included internal data checking and validation rules. Data analysis was undertaken using PASW Statistics 18.0 and data were further quality checked using specifically designed validation routines. A series of predefined reports were generated using PASW Web reports for surveys (Version 5.6). These reports were made available to participating hospitals within four weeks of the last date of data entry, see Appendix A.7.

This report presents the results of the 2012 PPS in Northern Ireland and includes all hospitals providing acute inpatient services. Figures from the Department of Health, Social Services and Public Safety indicate that in 2010/11 the average occupied beds in acute hospitals were 3,921 [22].The PPS provided information on 3,992 patients.

3.7 Data Definitions

3.7.1 Hospital Type

Each hospital in Northern Ireland self-defined their hospital type using ECDC definitions [20]:

Primary – often referred to as 'district hospital', few specialities and limited laboratory services.

Secondary – referred to as 'general hospital with a teaching function', highly differentiated by function with five to ten specialties. Takes referrals from Primary hospitals.

Tertiary – referred to as a 'regional' or 'Tertiary-level' hospital with highly specialised and technical equipment and often classified as a university or university associated hospital. Clinical services are highly differentiated by function. Provides regional services and regularly takes referrals from other Primary and Secondary hospitals.

Specialised – generally a single clinical specialty with the possibility of sub-specialties with highly specialised staff and technical equipment.

3.7.2 Risk factors

Risk factor data were collected including underlying disease prognosis and National Healthcare Safety Network (NHSN) operative procedure categories [23] used to categorise patients who had undergone minimally invasive or invasive surgery since admission to hospital. Each patient was surveyed 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 – In order 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. As a consequence a considerable proportion of patients (35%) included in the ECDC pilot survey did not have a McCabe Score recorded (see Appendix A.8).

3.7.3 HAI definitions

The 2012 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).

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

- Surgical site infection [24]
- Pneumonia [25]
- Bloodstream infection [25]
- Central vascular catheter related infection [25]
- Urinary tract infections [25]
- *Clostridium difficile* infection [26]
- Specific neonatal definitions – established by the KISS network [27] [28]
- All other case definitions used were CDC/NHSN definitions of infection [23]

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 1 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.

3.7.4 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 prescription was recorded as either treatment of infection (community acquired; hospital acquired; 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 acquired infection used when describing the indication for prescription was: an infection that the prescribing clinician considered to be a hospital acquired 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 two quality indicators for prescribing: (i) if the reason for prescription was recorded in the medical notes and (ii) if empirical prescriptions for infection or surgical prophylaxis prescriptions were compliant with local prescribing policy.

Compliance with local prescribing policy was assessed by Trust antimicrobial pharmacists. Each was required to assess the type of antimicrobial (route, dose and duration were not required to be assessed). If the guideline recommended a combination of two or more antibiotics, compliance was met if all relevant antimicrobials were prescribed. Antimicrobials were recorded as ‘not assessable’ for three reasons: (i) if administered for medical prophylaxis, (ii) if administered for treatment of infection in absence of local prescribing policy or (iii) if administered for surgical prophylaxis in absence of local prescribing policy.

3.7.5 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* (meticillin), *Enterococcus* spp. (glycopeptides), *Enterobacteriaceae* (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 3,992 eligible patients were surveyed. Based on returns from each hospital this represented 88·5% of available beds. The largest proportion of eligible patients recorded was from Belfast HSC Trust (40·5% of all patients); followed by South-Eastern HSC Trust (16·9%), Southern HSC Trust (17·7%), Western HSC Trust (13·9%) and Northern HSC Trust (13·3%), see Table 2. The largest proportion of patients (48·8%) was in a Secondary level hospital, see Table 3.

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

Trust	Number of hospitals	Number of beds (Included Wards)	Number eligible patients surveyed	% of all beds
Total	16	4,510	3,992	88·5
Belfast HSC	7	1,779	1,617	90·1
South-Eastern HSC	3	820	675	82·3
Southern HSC	2	646	614	95·0
Western HSC	2	672	556	82·7
Northern HSC	2	593	530	89·4

Table 3 Hospitals by Type and numbers of patients surveyed

Hospital type	Hospitals	Number	% of patients surveyed
Primary	Causeway Hospital Daisy Hill Hospital Downe Hospital Lagan Valley Hospital South West Acute Hospital	672	16·8
Secondary	Altnagelvin Hospital Antrim Area Hospital Craigavon Area Hospital Mater Infirmorum Ulster Hospital	1,947	48·8
Tertiary	Belfast City Hospital Royal Victoria Hospital	952	23·8
Specialised	Belvoir Park Hospital Musgrave Park Hospital Royal Belfast Hospital for Sick Children Royal Jubilee Maternity Service	421	10·5

4.1.2 Ward specialty

Ward specialties were grouped into seven categories, the largest proportion of patients were on medical wards (42·3%). There were 99 (2·5%) patients in Adult ICU. Three patients were resident in paediatric ICU and 30 were in neonatal ICU, Table 4.

Table 4 Ward specialty

Ward specialty	Number of patients (n=3,992)	% of patients surveyed (95%CI)
Care of the Elderly	282	7·1 (6·3–7·9)
Adult ICU	99	2·5 (2·0–3·0)
Medical	1,687	42·3 (40·7– 43·8)
Obstetrics/Gynaecology	385	9·6 (8·8–10·6)
Paediatrics (Inc. paediatric and neonatal ICU)	178	4·5 (3·9 – 5·1)
Surgical	1,041	26·1 (24·7– 27·5)
Other	320	8·0 (7·2–8·9)

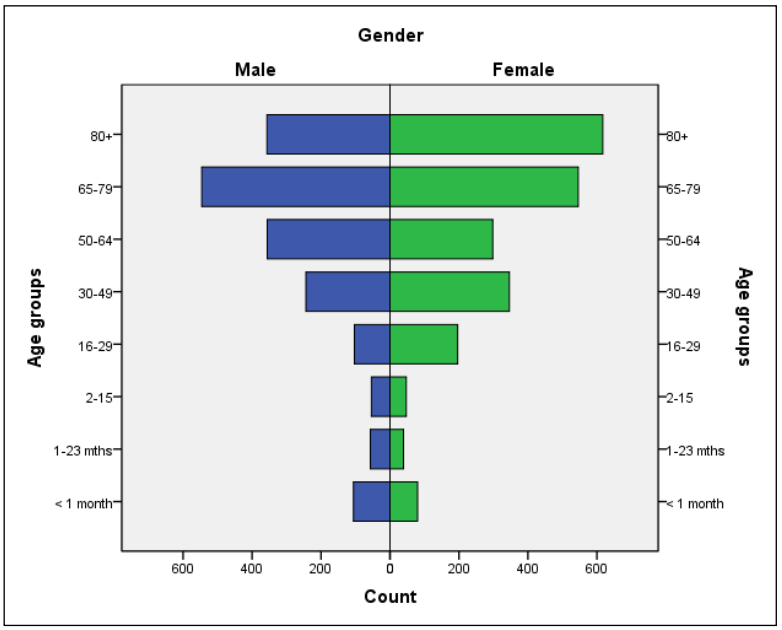
4.2 Patient demographics

Females represented 54·3% of the survey population and males accounted for 45·7%. The median age was 66 years (IQR 41 – 79; range 0 –105). The proportion of the population aged less than one month was 4·7%, the combined population under age 16 was 9·6%; the proportion aged 16-64 years was 38·7% and aged 65 and over 51·8%, see Table 5 and Figure 1.

Table 5 Demographic characteristics of survey population

Risk factors	Number of patients (n=3,992)	% of patients surveyed (95%CI)
Gender		
Male	1,823	45·7 (44·1 – 47·2)
Female	2,169	54·3 (52·8 – 55·9)
Age Group		
< 1 month	186	4·7 (4·1 – 5·4)
1-23 months	96	2·4 (2·0 – 2·9)
2-15 years	101	2·5 (2·1 – 3·1)
16-29 years	299	7·5 (6·7 – 8·4)
30-49 years	590	14·8 (13·7 – 15·9)
50-64 years	654	16·4 (15·3 – 17·6)
65-79 years	1,092	27·4 (26·0 – 28·8)
80+ years	974	24·4 (23·1 – 25·8)

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



4.3 Device usage

Over half of patients (51%) 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 (43·4%), see Figure 2. The ECDC definition of intubation was 'Patient was under intubation with or without mechanical ventilation (endotracheal tube or tracheostomy)'. Lung expansion devices such as intermittent positive-pressure breathing (IPPB); nasal positive end-expiratory pressure (PEEP); and continuous nasal positive airway pressure (CPAP) were not considered unless delivered via tracheostomy or endotracheal intubation. The use of devices (CVC, PVC, urinary catheter and intubation) varied across ward specialties; the highest utilisation was in Adult ICU, Table 6.

Figure 2 Proportion of patients with invasive device *in situ*

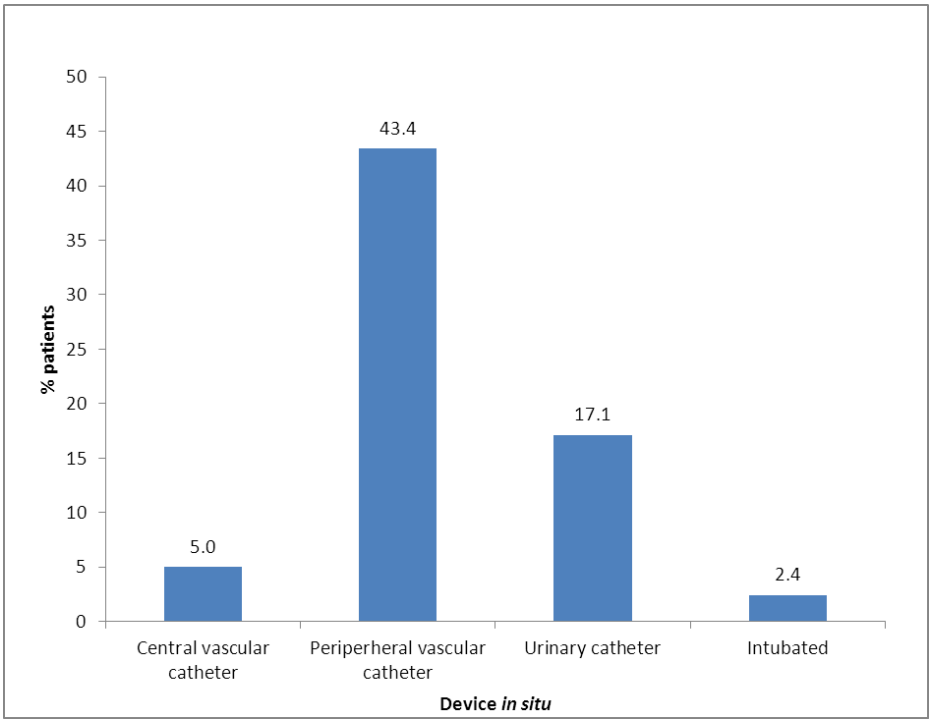


Table 6 Ward specialty and invasive devices *in situ*

Ward specialty	CVC		PVC		UC		Intubated	
	N	%	N	%	N	%	N	%
All specialties	200	5·0	1,733	43·4	681	17·1	97	2·4
Care of the Elderly	3	1·1	74	26·2	47	16·7	0	-
Adult ICU	42	42·4	68	68·7	71	71·7	42	42·4
Medical	77	4·6	833	49·4	281	16·7	10	0·6
Obstetrics/Gynaecology	1	0·3	86	22·3	27	7·0	5	1·3
Paediatrics (Inc. paediatric & neonatal ICU)	17	9·6	63	35·4	10	5·6	13	7·3
Surgical	55	5·3	552	53·0	226	21·7	27	2·6
Other	5	1·6	57	17·8	19	5·9	0	-

4.4 Intrinsic risk factors – Surgery and underlying disease prognosis

Overall, the proportion of patients who had surgery since admission was 16·7%, of these 13·4% had an NHSN operative procedure and the remaining 3·3% had minimally invasive surgery, see Table 7.

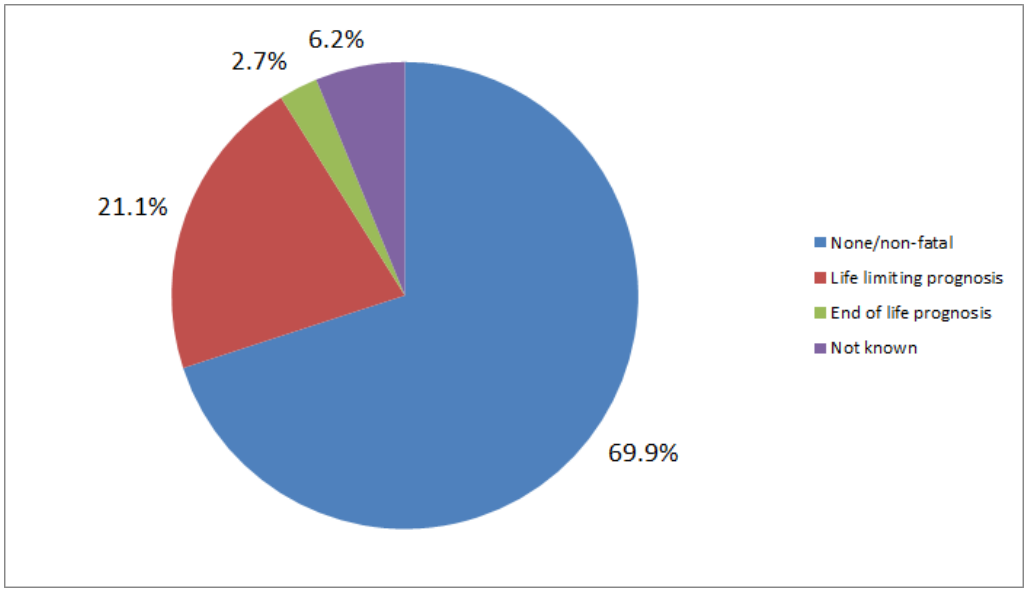
> Definition of NHSN operative procedure is a procedure:
>
> Takes place during an operation defined as a single trip to the theatre where a surgeon makes at least one incision through the skin or mucous membrane, including laparoscopic approach, and closes the incision before the patient leaves the theatre.

Table 7 Intrinsic risk factors

Risk factors	Number of patients (n=3,992)	% (95%CI)
Surgery Since Admission		
Yes (NHSN)	533	13·4 (12·3–14·4)
Yes (Non-NHSN)	131	3·3 (2·8–3·9)
No	3,286	82·3 (81·1–83·5)
Not known	42	1·1 (0·8–1·4)
Underlying Disease Prognosis		
None/Non-fatal	2,792	69·9 (68·5– 71·3)
Life limiting prognosis	844	21·1 (19·9–22·4)
End of life prognosis	109	2·7 (2·3–3·3)
Not Known	247	6·2 (5·5–7·0)

Underlying disease prognosis was provided for over nine in ten patients. The majority of patients (69·9%) had a non-fatal disease prognosis. A further 21·1% were considered to have a life limiting prognosis and 2·7% of patients had an end-of-life prognosis, see Figure 3. Over seventy per cent (71·6%) of those with end-of-life prognosis had a device *in situ* compared to 46% with a non-fatal prognosis.

Figure 3 Underlying disease prognosis



4.5 Hospital-acquired infection (HAI)

4.5.1 HAI prevalence in Northern Ireland

The overall HAI prevalence in Northern Ireland acute care hospitals was 4·2% (95%CI 3·6%-4·8%). When sampling error was taken into consideration, this was in line with the rate observed in England, Scotland and Wales. This is lower than the aggregate rate reported across participating European countries. A total of 166 patients had 169 infections, the vast majority were identified as having one HAI and only three patients had two infections reported. Comparable rates of HAI for 2011/12 PPS in Europe and UK administrations are shown in Table 8.

Table 8 Prevalence of HAI PPS for Europe and UK 2011/12

Country	Prevalence %	95%CI
Europe – ECDC PPS 2011/12	6·2	6·1 – 6·3
England (Acute NHS) [3]	6·5	4·8 – 8·8
Scotland (Acute NHS) [4]	4·9	4·4 – 5·4
Wales (Acute NHS) [5]	4·3	3·8 – 4·8
Northern Ireland	4·2	3·6 – 4·8

4.5.2 HAI prevalence by gender and age

The HAI prevalence for males was 4·7% compared with 3·7% for females, although this difference was not statistically significant, Table 9. The prevalence of HAI was highest for those aged 1-23 months (8·3%) and HAI prevalence, for these patients was 8·2% in England, 5·5% in Scotland and 5·6% in Wales. [3] [4] [5]

Table 9 Distribution of HAI by gender and age group

Risk factors	Number of patients (n=3,992)	Number of patients with HAI	HAI prevalence % (95%CI)
Gender			
Male	1,823	85	4·7 (3·8-5·8)
Female	2,169	81	3·7 (3·0-4·6)
Age Group			
< 1 month	186	3	1·6 (0·6-4·6)
1-23 months	96	8	8·3 (4·3-15·6)
2-15 years	101	2	2·0 (0·5-6·9)
16-29 years	299	6	2·0 (0·9-4·3)
30-49 years	590	18	3·1 (1·9-4·8)
50-64 years	654	38	5·8 (4·3-7·9)
65-79 years	1,092	47	4·3 (3·3-5·7)
80+ years	974	44	4·5 (3·4-6·0)

4.5.3 HAI prevalence by hospital type

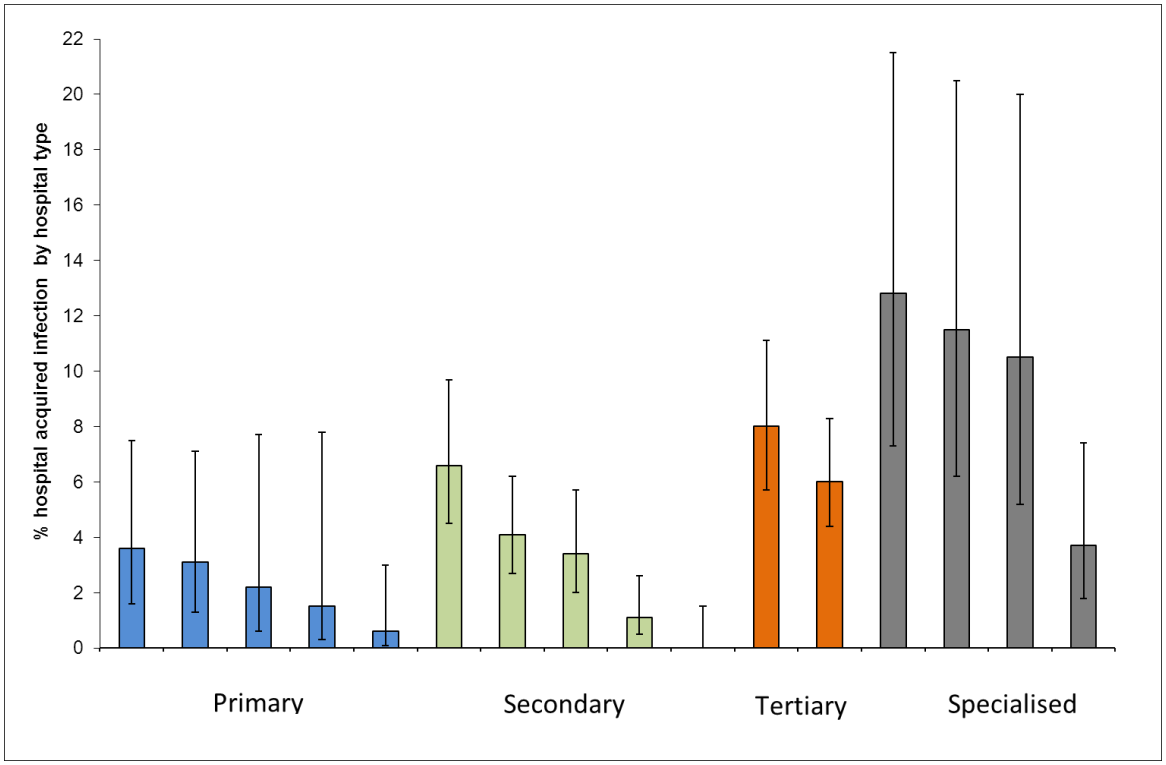
In terms of hospital type, there was a significant difference in the HAI prevalence, with Tertiary hospitals having over twice as many infections as Secondary level hospitals (6·8% versus 3·2%; p<0.01). The lowest prevalence of 2·2% was found in Primary hospitals and the HAI prevalence in Specialised hospitals was 5·7%, see Table 10.

Table 10 Distribution of HAI by hospital type

Hospital type	Number of patients	Number of HAI	HAI prevalence % (95%CI)
Primary	672	15	2·2 (1·4 – 3·7)
Secondary	1,947	62	3·2 (2·6 – 4·2)
Tertiary	952	65	6·8 (5·8 – 9·2)
Specialised	421	24	5·7 (4·1 – 8·8)

When HAI prevalence was compared for individual hospitals within each hospital type, i.e. Tertiary, Secondary, Primary and Specialised, there were no significant differences observed, see Figure 4.

Figure 4 HAI prevalence for individual hospitals by hospital type



4.5.4 HAI prevalence by risk factors

While the overall HAI prevalence was 4·2%, if a patient had a device *in situ* the HAI prevalence was significantly higher (7·1%, p < 0·01). The presence of specific devices was associated with higher HAI prevalence: central vascular catheter (HAI prevalence 20·5%, p < 0·01), peripheral vascular catheter (HAI prevalence 6·3%, p < 0·01), urinary catheter (HAI prevalence 9·4%, p < 0·01) and intubation (HAI prevalence 16·5%, p < 0·01), see Table 11.

The proportion of patients who had some form of surgery (operative procedure or minimally invasive procedure) since admission was 706 (17·7%). Prevalence of HAI was higher for patients undergoing surgery than for those who did not have surgery (7·8% versus 3·4%; p<0.01). Higher HAI prevalence was observed in patients with a life-limiting prognosis (7·0%) or end-of-life prognosis (8·3%) compared with those with non-fatal prognosis (3·0%), p<0.01.

Table 11 Distribution of HAI by intrinsic risk factors

Risk factors	Number of patients (n=3,992)	Number with HAI	HAI prevalence % (95%CI)
Invasive device *in situ*			
Any device - Yes	2,034	145	7·1(6·1 – 8·3)
Any device - No	1,958	21	1·1 (0·7 – 1·6)
CVC	200	41	20·5 (15·5 – 26·6)
PVC	1733	110	6·3 (5·3 – 7·6)
Urinary catheter	681	64	9·4 (7·4 – 11·8)
Intubation	97	16	16·5 (10·4 – 25·1)
Surgery Since Admission			
Yes	706	55	7·8 (6·0 – 10·0)
No	3,286	111	3·4 (2·8 – 4·1)
Underlying Disease Prognosis			
None/Non-fatal	2,792	83	3·0 (2·4 – 3·7)
Life limiting prognosis	844	59	7·0 (5·5 – 8·9)
End of life prognosis	109	9	8·3 (4·4 – 15·0)
Not Known	247	15	6·1 (3·7 – 9·8)

4.5.5 HAI prevalence by ward specialty

HAI prevalence varied across ward specialties, with the highest prevalence in adult intensive care (9·1%) followed by Care of the Elderly (5·7%) and surgical wards (5·2%). The lowest HAI prevalence was found in obstetrics/gynaecology wards (0·8%), see Table 12.

Table 12 Distribution of HAI by ward specialty

Ward specialty	Number	% total patients	Number with HAI	HAI prevalence % (95%CI)
All ward specialties	3,992	100·0	166	4·2 (3·6 – 4·8)
Adult ICU	99	2·5	9	9·1 (4·7 – 16·4)
Care of the Elderly	282	7·1	16	5·7 (3·5 – 9·0)
Surgical	1,041	26·1	54	5·2 (4·0 – 6·7)
Paediatrics (Inc. paediatric and neonatal ICUs)	178	4·5	8	4·5 (2·3 – 8·6)
Medical	1,687	42·3	67	4·0 (3·1 – 5·0)
Other	320	8·0	9	2·8 (1·5 – 5·3)
Obstetrics/Gynaecology	385	9·6	3	0·8 (0·3 – 2·3)

4.5.6 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 383 paediatric patients surveyed with 12 on adult wards. There were 13 patients with HAI, the most prevalent HAI was skin & soft tissue infection (n=4; 30·8% of paediatric HAI), see Table 13.

The prevalence of HAI in the paediatric population was 3·4% (95%CI 2·0 – 5·7). Neonates on postnatal wards, 'well babies' (n=128) had a low HAI prevalence (0·8%). HAI prevalence in paediatric patients, excluding 'well babies', was 4·7% (95%CI 2·7 – 8·0). HAI prevalence in Paediatric ICU was 45.5%, in paediatric Haematology & Bone Marrow Transplant Unit 40% and in Neonatal ICU HAI prevalence was 18·2% Table 14.

Table 13 Distribution of paediatric HAI types

HAI groups	Number of HAI	% of paediatric HAI
Skin & soft tissue infection	4	30·8
Pneumonia	2	15·4
Bloodstream infection	2	15·4
Systemic infection	2	15·4
Lower respiratory tract infection	1	7·7
Central nervous system infection	1	7·7
Catheter-related infection	1	7·7

Table 14 Distribution of Paediatric HAI by ward specialty

Ward specialty	Total patients	Number with HAI	HAI prevalence % (95%CI)
Total paediatric	383	13	3·4 (2·0 – 5·7)
Paediatric ICU	11	5	45·5 (21·3 – 72·0)
Neonatal ICU	30	2	18·2 (5·1 – 47·7)
Haematology/BMT	5	2	40·0 (11·8 – 77·0)
Mixed specialty	15	2	13·3 (3·7 – 37·9)
Neonatology	46	1	2·2 (0·4 – 11·3)
Maternity	128	1	0·8 (0·1 – 4·4)

4.5.7 HAI categories

The number, proportion and prevalence of HAI by infection category are shown in Table 15 and by HAI type in Appendix B, Table I. The most common HAI category was pneumonia (24·3%), followed by surgical site infection (18·9%), UTI (11·8%) and systemic infection (11·8%). There were no infections reported of either reproductive tract infections or neonatal specific infections.

Table 15 Distribution of HAI categories

HAI category	Number of HAI	% of all HAI	HAI prevalence % (95%CI)
Pneumonia	41	24·3	1·0 (0·8 – 1·4)
Surgical site infection	32	18·9	0·8 (0·6 – 1·1)
Urinary tract infection	20	11·8	0·5 (0·3 – 0·8)
Systemic infection	20	11·8	0·5 (0·3 – 0·8)
Bloodstream infection	15	8·9	0·4 (0·2 – 0·6)
Gastrointestinal system infection	15	8·9	0·4 (0·2 – 0·6)
Skin & soft tissue infection	10	5·9	0·3 (0·1 – 0·5)
Lower respiratory tract infection, other than pneumonia	6	3·6	0·2 (0·1 – 0·3)
Central nervous system infection	3	1·8	0·1 (0·0 – 0·2)
Catheter-related infection	2	1·2	0·1 (0·0 – 0·2)
Bone and joint infection	2	1·2	0·1 (0·0 – 0·2)
Eye, ENT or mouth infection	2	1·2	0·1 (0·0 – 0·2)
Cardiovascular system infection	1	0·6	<0·1 (0·0 – 0·1)

Pneumonia

A total of 41 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=12) or PN5 (n=28). The one remaining pneumonia was recorded as a PN1.

Surgical site infection (SSI)

A total of 32 SSI were identified, more than two thirds were deep or organ space infections (n=22).The surgical site procedure categories that were linked with SSI are shown in Table 16 and the specific procedures are shown in Appendix B, Table II. Almost half of SSI followed general surgery (46·9%), almost three quarters of these were deep or organ space infections (n=11). One fifth of SSI occurred following orthopaedic surgery, of these 85·7% were deep or organ space infections (n=6).

Table 16 Prevalence of surgical site infection by surgical procedure category

Surgical category	Number	% of SSI	% Superficial	% Deep/Organ space
Total	32	100·0	31·3	68·7
General surgery	15	46·9	26·7	73·3
Orthopaedics	7	21·9	14·3	85·7
Thoracic surgery	2	6·3	0·0	100·0
ENT/Neck surgery	2	6·3	100	0·0
Vascular surgery	2	6·3	50·0	50·0
Urology/kidney transplant	1	3·1	100	0·0
Not recorded	3	9·4	33·3	66·6

Urinary tract infection (UTI)

A total of 20 UTI were recorded. Almost equal numbers were identified as either microbiologically confirmed (n=11) or not microbiologically confirmed (n=9) symptomatic UTI. Seven of the patients with a UTI (35%) 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 20 systemic infections identified. All 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.

Bloodstream infection (BSI)

Table 17, provides information on the source of bloodstream infections (BSI). There were fifteen BSIs identified, of these 80% were primary BSIs (nine of unknown origin; three CVC related) and the remaining 20% were classified as secondary to other infections.

Table 17 Source of bloodstream infections

Source of BSI	Number	% of BSI
Total BSI	15	100%
Primary BSI	12	80·0
BSI of unknown origin	9	60·0
Central Vascular Catheter related	3	20·0
Secondary BSI	3	20·0
Secondary to urinary tract infection	2	13·0
Secondary to digestive tract infection	1	7·0

Gastrointestinal system infections (GI)

The number of gastrointestinal system infections identified was 15. Seven of eight *Clostridium difficile* infections were found in patients aged over 80 years. Six intra-abdominal GI infections were recorded relating either to gall bladder, bile ducts, liver, spleen, pancreas, peritoneum or sub phrenic/sub diaphragmatic space. All of these patients were aged between 40-69 years. The one remaining GI infection was classified as gastroenteritis (not *Clostridium difficile).*

4.5.8 HAI onset and origin

More than 80% of HAI (136 of 169) developed following admission to the survey hospital; the remaining 33 (19·5%) were present on admission to the survey hospital. Of the 33 HAI present on admission, 23 were readmissions to the survey hospital; the remaining 10 infections were related to another hospital. The median time from admission to onset of infection was 9 days (IQR 2 – 18 days). HAI onset occurred more than 2 weeks after admission for over 30% of patients, see Table 18.

Table 18 Onset of HAI

Onset (admission to infection date)	Number	% of total HAI
Less than a week	75	46·3
7-13 days	38	23·5
14-20 days	15	9·3
21 days or more	34	21·0

5 Antimicrobial use

5.1 Antimicrobial use prevalence in Northern Ireland

A total of 1,178 patients were receiving 1,751 antimicrobials at the time of the survey. The overall prevalence of antimicrobial use was 29·5% (95%CI 28·1 – 30·9). 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 19.

Table 19 Prevalence of antimicrobial use for 2011/12 PPS in Europe and UK

Country	Prevalence %	95%CI
Europe – ECDC PPS 2011/12	36·3	36·1 – 36·5
England (Acute NHS) [3]	34·3	30·1 – 39·2
Scotland (Acute NHS) [4]	32·3	30·9 – 33·8
Wales (Acute NHS) [5]	32·7	31·6 – 33·9
Northern Ireland 2012	29·5	28·1 – 30·9

The number of antimicrobials prescribed per patient is shown in Table 20. A total of 110 patients were receiving three or more antimicrobials, i.e. 2·8% of the total hospital population and 9·3% of those receiving antimicrobials.

Table 20 Number of antimicrobials prescribed per patient

Number of antimicrobials per patient	Number of patients	% of patients
Zero	2,814	70·5
One	744	18·6
Two	324	8·1
Three	84	2·1
Four	23	0·6
Five or more	3	0·1

Almost one third of males (32·2%) received antimicrobials which was significantly more than females receiving antimicrobials (27·2%) (p<0·01). The percentage of patients aged 0- 64 receiving antimicrobials was 27·1%, this was significantly lower (p<0·01) than those aged 65 or over 31·8% receiving antimicrobials, see Table 21.

Table 21 Prevalence of antimicrobial use by age group

Age group	Number (n=3,992)	Number receiving antimicrobials	Antimicrobial use prevalence % (95%CI)
< 1 month	186	23	12·4 (8·4– 17·9)
1-23 months	96	27	28·1(20·1–37·8)
2-15 years	101	37	36·6 (27·9–46·4)
16-29 years	299	70	23·4 (19·0–28·5)
30-49 years	590	149	25·3 (21·9–28·9)
50-64 years	654	215	32·9 (29·4–36·6)
65-79 years	1,092	377	34·5 (31·8–37·4)
80+ years	974	280	28·7 (26·0–31·7)

5.2 Antimicrobial use – Route of administration and reason in notes

Almost a fifth of all patients were administered antimicrobials parenterally (18·4%) which represented 65·2% of all antimicrobials administered, Table 22.

Table 22 Antimicrobial use – Route of administration

Route of administration	Patients on antimicrobials	% of all patients (95%CI)	Number of antimicrobials	% of all antimicrobials (95%CI)
Parenteral	736	18·4 (17·2–19·7)	1,142	65·2 (63·0 – 67·4)
Oral	441	11·0 (10·1–12·1)	606	34·6 (32·4 – 36·9)
Other/unknown	1	0·0 (0·0–0·1)	3	0·2 (0·1– 0·5)

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 1,587 antimicrobials (90·6% of the total), see Table 23.

Table 23 Antimicrobial use – Reason in notes

Reason in notes	Patients on antimicrobials	% of patients on antimicrobials (95%CI)	Number of antimicrobials	% of all antimicrobials (95%CI)
Yes	1,074	91·2 (89·4 – 92·7)	1,587	90·6 (89·2 – 91·9)
No	76	6·5 (5·2 – 8·0)	113	6·5 (5·4 – 7·7)
Unknown	28	2·4 (1·7 – 3·4)	51	2·9 (2·2 – 3·8)

5.3 Antimicrobial use – Indication for prescribing

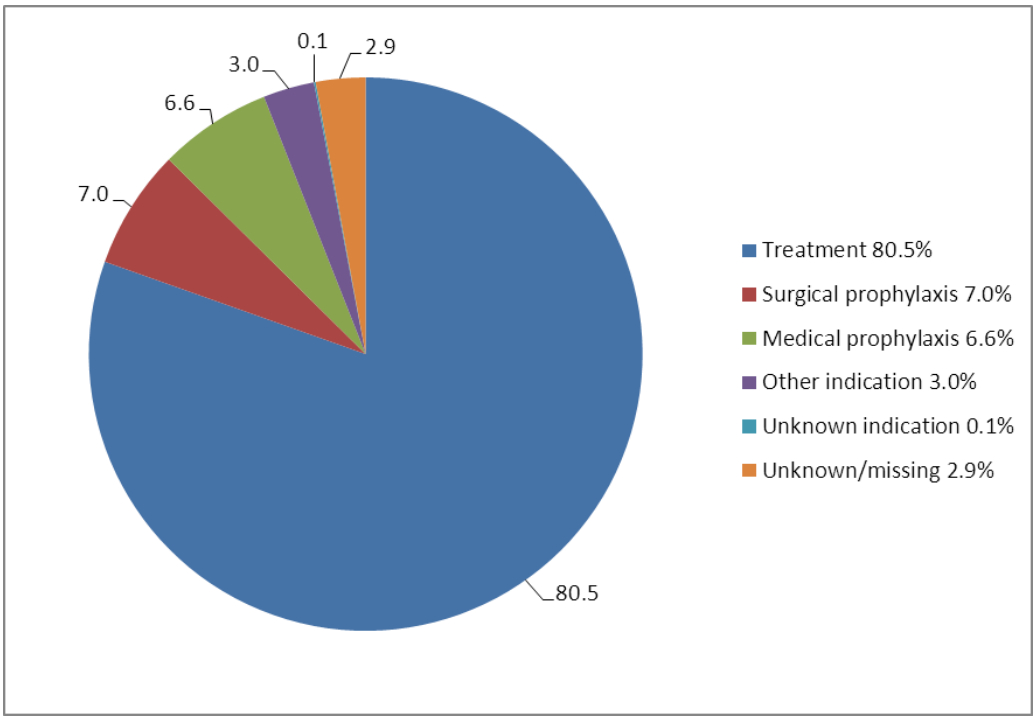
The most common reason for antimicrobial prescribing was for infections considered to be community acquired. There were 714 patients treated for community acquired infection or 17·9% of the hospital population. Treatment of community acquired infection accounted for 60·1% of all prescribed antimicrobials.

Surgical prophylaxis and medical prophylaxis accounted for 7·0% and 6·6% of all antimicrobials respectively, Table 24 and Figure 5. Surgical prophylaxis continued for more than 24 hours in 11·5% of cases (11/96). Appendix B Table IV shows antimicrobial agents by indication for use.

Table 24 Antimicrobial use – Indication for prescribing

Indication for antimicrobial use	Number of patients	% of all patients (95%CI)	Number of antimicrobials	% all antimicrobials (95%CI)
Total	**1,178**	**29•5 (28•1-31•0)**	**1,751**	**100%**
Treatment	**940**	**23·5 (22·2-24·9)**	**1,410**	**80·5 (78·6 – 82·3)**
Community infection	714	17·9 (16·7-19·1)	1,053	60·1 (57·8 – 62·4)
Hospital infection	201	5·0 (4·4-5·8)	320	18·3 (16·5 – 20·2)
Other HAI	25	0·6 (0·4-0·9)	37	2·1 (1·5 – 2·9)
Surgical prophylaxis	**96**	**2·4 (2·0-2·9)**	**122**	**7·0 (5·9 – 8·3)**
Single dose	65	1·6 (1·3-2·1)	87	5·0 (4·1 – 6·1)
One day	20	0·5 (0·3-0·8)	22	1·3 (0·8 – 1·9)
>1 day	11	0·3 (0·1-0·5)	13	0·7 (0·4 – 1·3)
Medical prophylaxis	**77**	**1·9 (1·5-2·4)**	**116**	**6·6 (5·6 – 7·9)**
Other indication	34	0·9 (0·6-1·2)	52	3·0 92·3 – 3·9)
Unknown/missing	31	0·8 (0·6-1·1)	51	2·9 (2·2 – 3·8)

Figure 5 Antimicrobial indication as a proportion of all antimicrobials prescribed



5.4 Antimicrobial use – Treatment

A total of 1,410 antimicrobials were prescribed for treatment of active infection, acquired either in hospital, community or long term care, accounting for 80·5% of all antimicrobials. These were used to treat 940 patients for 971 infection diagnoses. The vast majority of antimicrobials for treatment (95·8%) were for five system infection groups, i.e. respiratory, skin & soft tissue, urinary tract, systemic and gastrointestinal infections. The most common diagnosis for treatment of active infection was respiratory tract infection; accounting for 38·6% of treatment intentions, Table 25 and Appendix B Table V.

Table 25 Antimicrobial treatment, diagnosis site by indication

Site of infection	Treatment		
	Diagnoses Number (%)	Community infection Number (%)	Hospital infection Number (%)
Total	971 (100)	731 (100)	213 (100)
Respiratory tract	375 (38·6)	277 (37·9)	84 (39·4)
Skin/soft tissue/bone/joint	143 (14·7)	105 (14·4)	35 (16·4)
Urinary tract	140 (14·4)	112 (15·3)	23 (10·8)
Systemic infections	140 (14·4)	99 (13·5)	36 (16·9)
Gastro-intestinal system	132 (13·6)	105 (14·4)	27 (12·7)
Eye/ear/nose/throat	14 (1·4)	11 (1·5)	3 (1·4)
Central nervous system	13 (1·3)	11 (1·5)	2 (0·9)
Cardiovascular system	10 (1·0)	8 (1·1)	2 (0·9)
Genito-urinary system	4 (0·4)	3 (0·4)	1 (0·5)

5.4.1 Treatment of infection – Antimicrobial agents

Table 26 shows the antimicrobials prescribed for treatment of infection in patients surveyed. Twenty antimicrobials accounted for 91% of antimicrobials prescribed for treatment of infection (n=1,281). The most commonly prescribed antimicrobial for management of infection was piperacillin and enzyme inhibitor accounting for 20·4% of these antimicrobials. Amoxicillin in combination with an enzyme inhibitor (co-amoxiclav) was the second most commonly prescribed antimicrobial for treatment of infection (10·8%); followed by amoxicillin (8·1%).

Ciprofloxacin (n=49) and clindamycin (n=58) accounted for 3·5% and 1·5% respectively of antimicrobials prescribed for treatment of infection. A total of 30 cephalosporins were prescribed; one first-generation, one second-generation and 28 third-generation, representing 2·1% of all antimicrobials for treatment of infection. A detailed breakdown of antimicrobial agents for treatment of infection is shown in Appendix B Table IV.

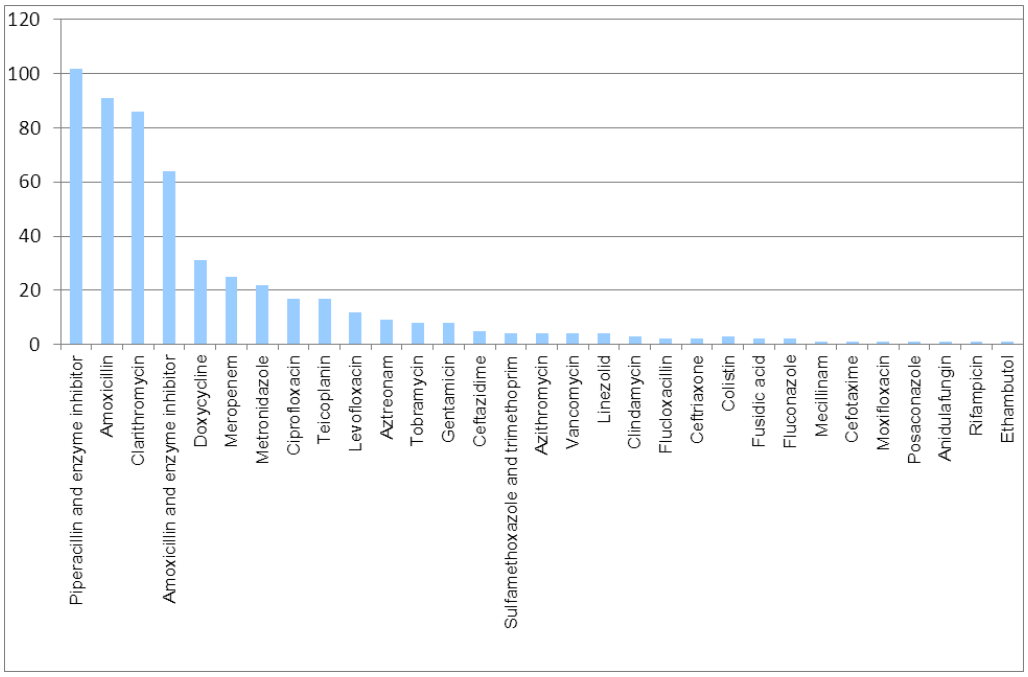
Table 26 Antimicrobials for treatment of infection

Antimicrobial	Total number of antimicrobial agents for treatment	Proportion %
Total	1,410	100·0
Piperacillin and enzyme inhibitor	287	20·4
Amoxicillin and enzyme inhibitor	152	10·8
Amoxicillin	114	8·1
Clarithromycin	96	6·8
Metronidazole	84	6.0
Flucloxacillin	78	5·5
Gentamicin	73	5·2
Meropenem	68	4·8
Teicoplanin	56	4·0
Ciprofloxacin	49	3·5
Doxycycline	39	2·8
Vancomycin	35	2·5
Trimethoprim	26	1·8
Benzylpenicillin	21	1·5
Clindamycin	21	1·5
Fluconazole	21	1·5
Aztreonam	16	1·1
Fusidic acid	16	1·1
Levofloxacin	16	1·1
Others	142	10·1

5.4.2 Treatment of respiratory infection – Antimicrobial agents

Figure 6 shows the distribution of antimicrobials prescribed for treatment of respiratory infections, i.e. pneumonia or acute bronchitis or exacerbations of chronic bronchitis (agents=32; prescriptions=534). Ten antimicrobials accounted for 87.5% of all antimicrobials prescribed for respiratory infections (prescriptions=467). The most commonly prescribed antimicrobial in this diagnostic category was piperacillin and enzyme inhibitor (tazobactam) (prescriptions=102).

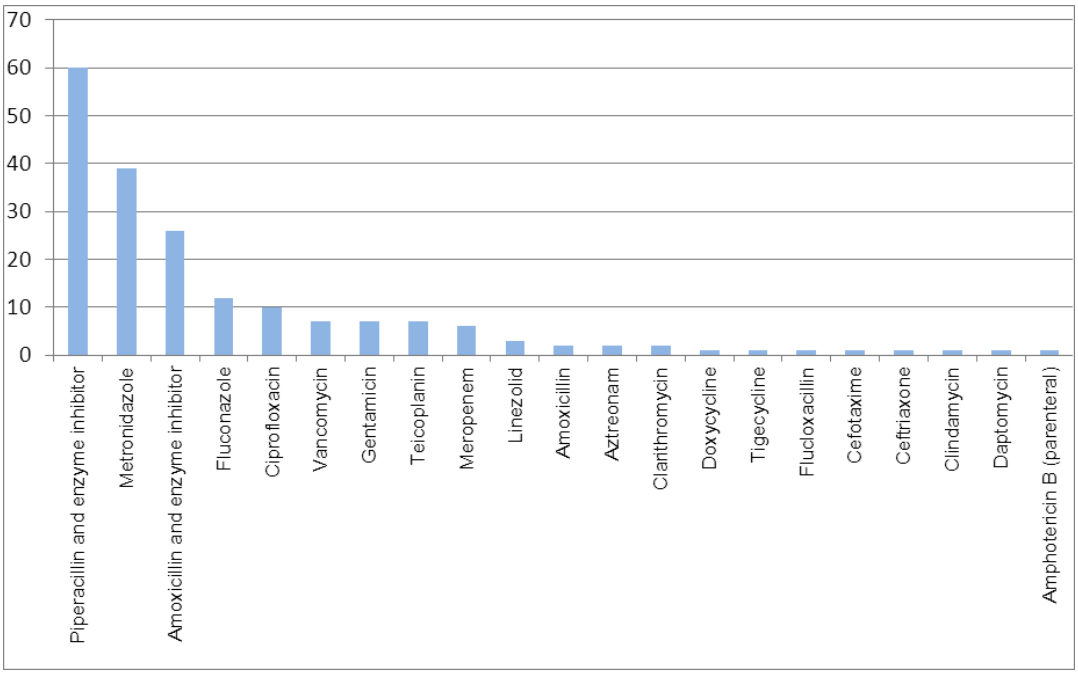
Figure 6 Antimicrobials prescribed for treatment of respiratory infections



5.4.3 Treatment of gastrointestinal infections – Antimicrobial agents

Figure 7 illustrates the distribution of antimicrobials prescribed for treatment of gastrointestinal infections (agents=21; prescriptions=191); 142 for treatment of intra-abdominal sepsis and 49 for treatment of gastroenteritis inclusive of *Clostridium difficile* infection. Three antimicrobials accounted for 65·4% of all antimicrobials prescribed in this category. The most commonly prescribed antimicrobial (prescriptions=60) was piperacillin and enzyme inhibitor (tazobactam).

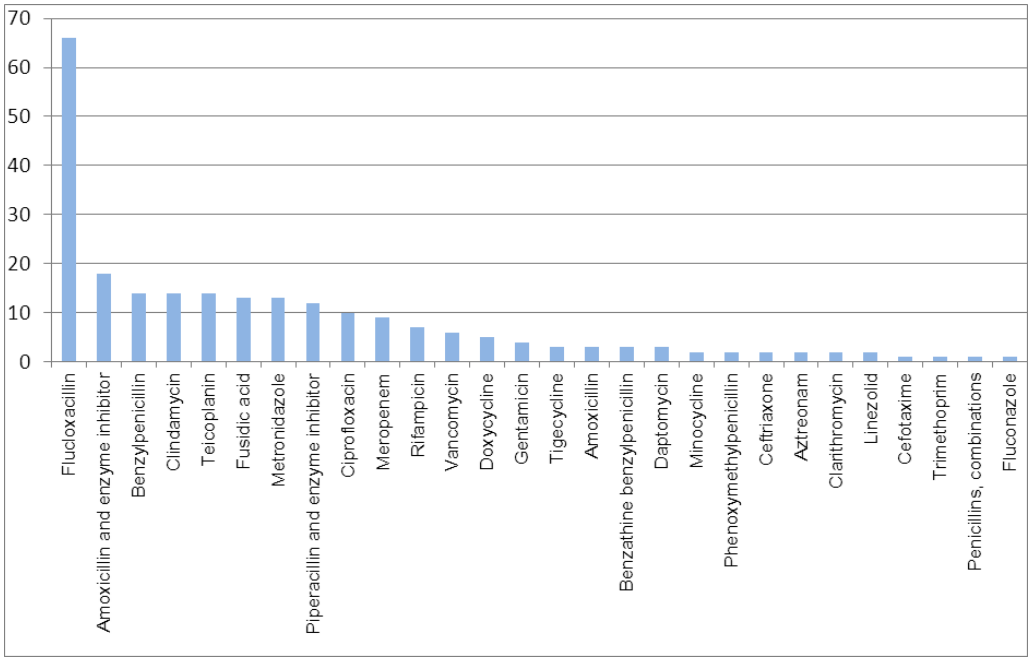
Figure 7 Antimicrobials prescribed for treatment of gastrointestinal infections



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

Figure 8 shows the distribution of antimicrobials prescribed for treatment of skin & soft tissue/bone & joint infections (agents=28; prescriptions=233). Ten antimicrobials accounted for 78·5% of all antimicrobials prescribed in this category (prescriptions=183). The most commonly prescribed antimicrobial (prescriptions=66) was flucloxacillin.

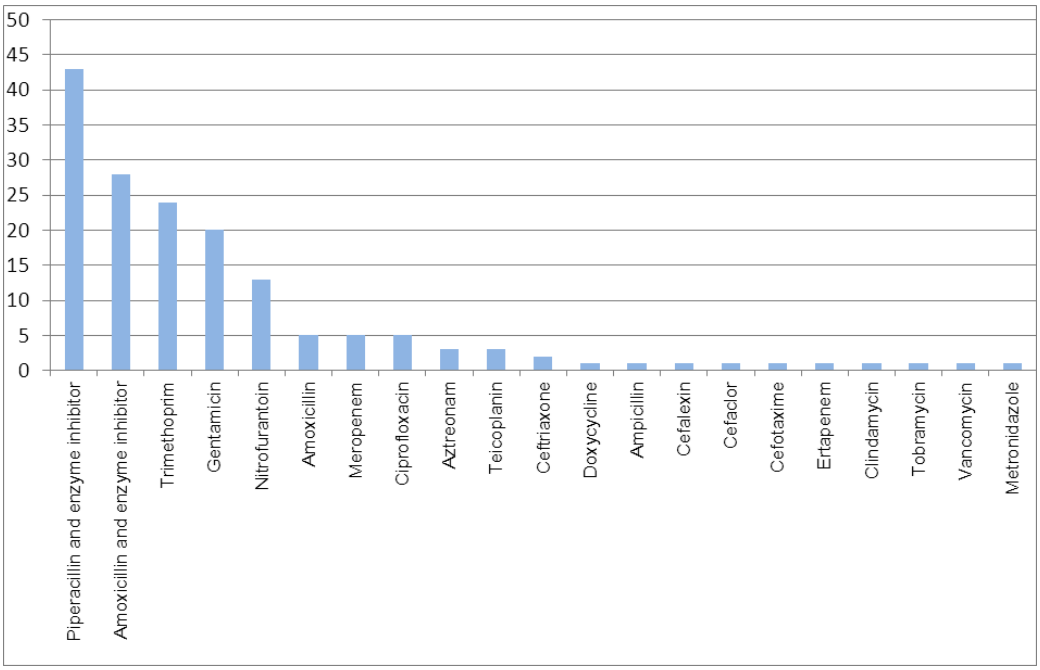
Figure 8 Antimicrobials prescribed for treatment of skin&soft tissue/bone&joint infections



5.4.5 Treatment of urinary tract infection (UTI) – Antimicrobial agents

Figure 9 displays the distribution of antimicrobials prescribed for treatment of urinary tract infections (agents=21; prescriptions=161). Five antimicrobials accounted for 79.5% of all antimicrobials prescribed for UTI. The most commonly prescribed antimicrobial (prescriptions=43) for UTI was piperacillin and enzyme inhibitor (tazobactam).

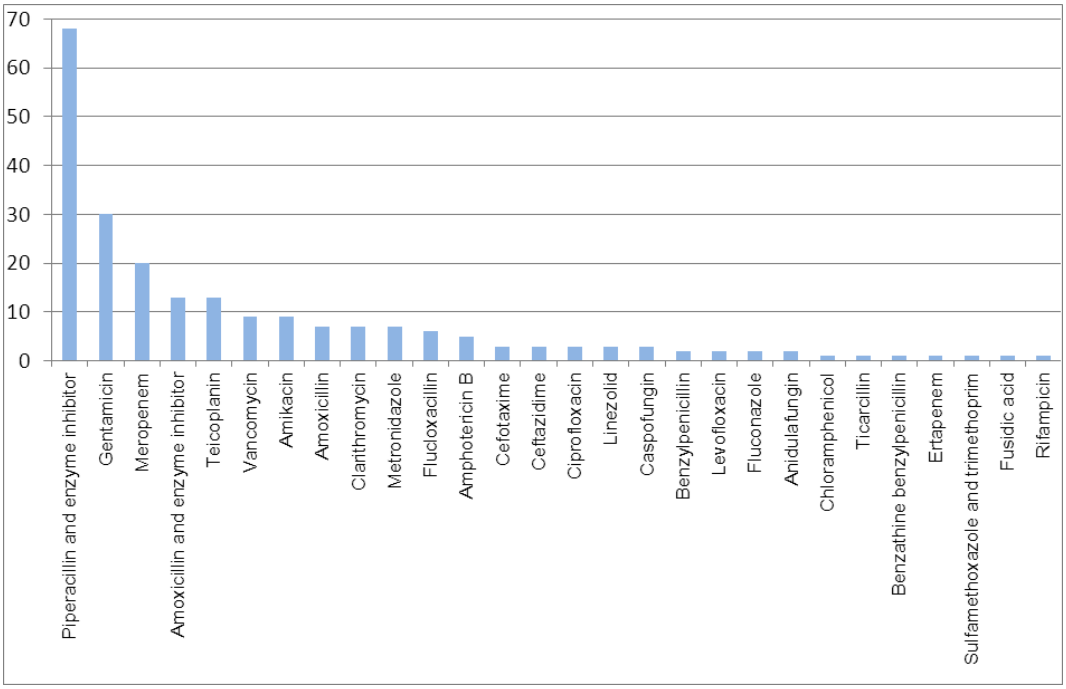
Figure 9 Antimicrobials prescribed for treatment of UTI



5.4.6 Treatment of systemic infection – Antimicrobial agents

Figure 10 shows the distribution of antimicrobials prescribed for treatment of systemic infections (agents=28; prescriptions=224). 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 68·3% of antimicrobials prescribed in this diagnostic category (prescriptions=153). The most commonly prescribed antimicrobial for systemic infections (prescriptions=68) was piperacillin and enzyme inhibitor (tazobactam).

Figure 10 Antimicrobials prescribed for treatment of systemic infections



5.5 Antimicrobial use – Surgical prophylaxis

A total of 15 different antimicrobial agents were used for surgical prophylaxis; representing 122 prescriptions, i.e. 7% of all antimicrobials recorded. The five most commonly used antimicrobials accounted for 80·3% of the total surgical prophylaxis. Amoxicillin and enzyme inhibitor was the most commonly prescribed agent in this category (37·7% of total), see Table 27. A detailed breakdown of antimicrobial agents for surgical prophylaxis is shown in Appendix B Table IV. Ten point seven per cent of surgical prophylaxis was given for greater than one-day. These comprised: eight prescriptions of amoxicillin and enzyme inhibitor and one prescription for each of: flucloxacillin, clindamycin, metronidazole, teicoplanin and piperacillin and enzyme inhibitor (tazobactam).

Table 27 Surgical prophylaxis – Distribution of antimicrobials

Antimicrobial name	Number of prescriptions	Proportion %
Total	122	100
Amoxicillin and enzyme inhibitor	46	37·7
Gentamicin	21	17·2
Flucloxacillin	14	11·5
Metronidazole (parenteral)	10	8·2
Cefuroxime	7	5·7
Benzylpenicillin	6	4·9
Piperacillin and enzyme inhibitor	5	4·1
Teicoplanin	4	3·3
Clindamycin	2	1·6
Sulfamethoxazole and trimethoprim	2	1·6
Amoxicillin	1	0·8
Ciprofloxacin	1	0·8
Ertapenem	1	0·8
Levofloxacin	1	0·8
Erythromycin	1	0·8

5.6 Antimicrobial use – Medical prophylaxis

A total of 28 different antimicrobial agents were used for medical prophylaxis representing 116 prescriptions, i.e. 6·6% of all antimicrobials reported. The most prescribed antimicrobial for medical prophylaxis (19% of total) was sulfamethoxazole & trimethoprim (co-trimoxazole) Antifungal agents accounted for 22.5% of all medical prophylaxis, see Table 28. A detailed breakdown of antimicrobial agents for medical prophylaxis is shown in Appendix B Table IV.

Table 28 Medical prophylaxis – Distribution of antimicrobials

Antimicrobial name	Number	Proportion %
Total	116	100
Sulfamethoxazole and trimethoprim	22	19·0
Posaconazole [#]	9	7·8
Azithromycin	7	6·0
Fluconazole [#]	7	6·0
Piperacillin and enzyme inhibitor	7	6·0
Amoxicillin and enzyme inhibitor	6	5·2
Nitrofurantoin	6	5·2

Trimethoprim	6	5·2
Amphotericin B (parenteral) #	5	4·3
Cefalexin	5	4·3
Gentamicin	5	4·3
Benzylpenicillin	4	3·4
Erythromycin	4	3·4
Metronidazole (oral- rectal)	3	2·6
Nystatin #	3	2·6
Ceftriaxone	2	1·7
Colistin (injection- infusion)	2	1·7
Flucloxacillin	2	1·7
Phenoxymethylpenicillin	2	1·7
Amoxicillin	1	0·9
Aztreonam	1	0·9
Caspofungin #	1	0·9
Cefotaxime	1	0·9
Combinations of long-acting sulfonamides	1	0·9
Doxycycline	1	0·9
Itraconazole #	1	0·9
Teicoplanin	1	0·9
Tetracycline	1	0·9

Antifungal agent

5.7 Antimicrobial use by hospital type

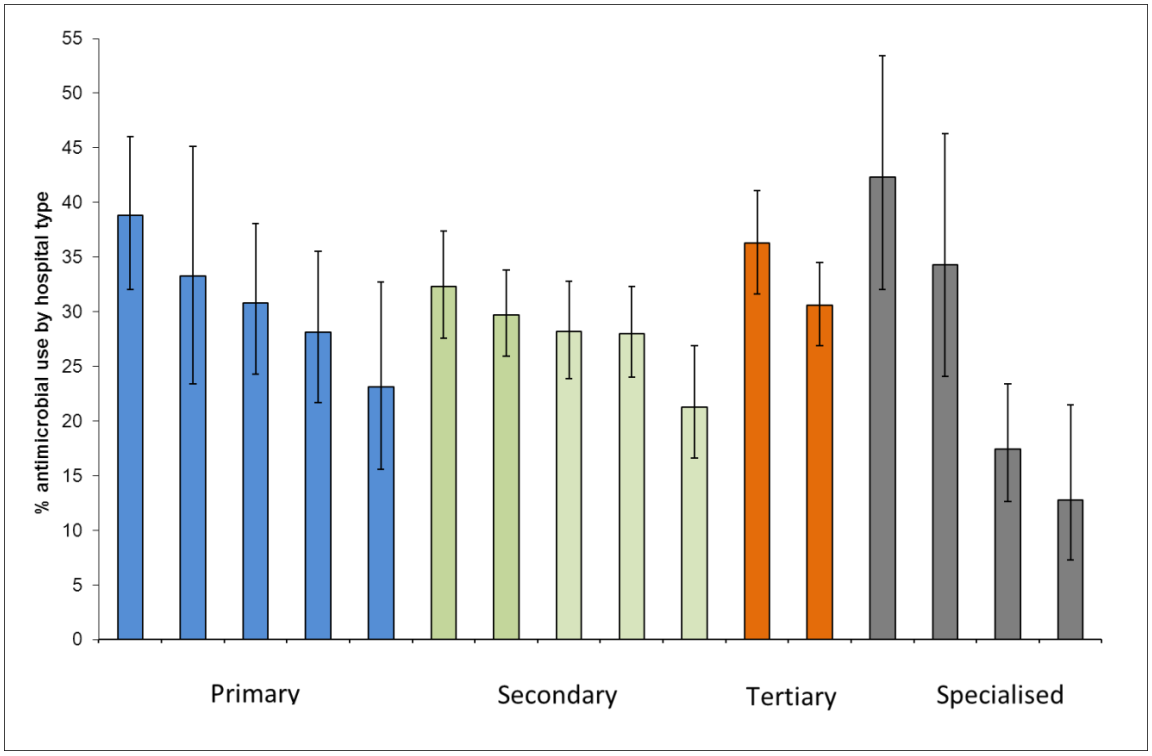
The highest prevalence of antimicrobial prescribing was in Tertiary hospitals, with 32·9% of patients receiving antimicrobials, followed by Primary level hospitals with 31·5% of patients receiving antimicrobials, Table 29.

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 see Figure 11.

Table 29 Prevalence of antimicrobial use by hospital type

Hospital type	Number of patients	Number receiving antimicrobials	Antimicrobial use % (95%CI)
Total	3,992	1,178	29·5 (28·1 – 31·0)
Primary	672	212	31·5 (28·1 – 35·2)
Secondary	1,947	553	28·4 (26·4 – 30·5)
Tertiary	952	313	32·9 (31·3 – 32·5)
Specialised	421	100	23·8 (22·4 – 25·2)

Figure 11 Antimicrobial use prevalence for individual hospitals by hospital type



5.9 *Antimicrobial use by ward specialty*

The highest prevalence of antimicrobial prescribing was in adult ICU, where 55·6% of patients received antimicrobials, Table 30. This was followed by medical and paediatric wards, where 34·4% and 29·2% of patients received antimicrobials, respectively. The lowest prevalence of antimicrobial use was in 'other' specialties (13·4%).

Table 30 Prevalence of antimicrobial use by ward specialty

Ward specialty	Number of patients	Number receiving antimicrobials	Antimicrobial use prevalence % (95%CI)
All specialties	3,992	1,178	29·5 (28·1 – 30·1)
Care of the elderly	282	76	27·0 (22·1 – 32·4)
Adult ICU	99	55	55·6 (45·7 – 65·0)
Medical	1,687	580	34·4 (32·2 – 36·7)
Obstetrics/Gynae	385	59	15·3 (12·1 – 19·3)
Paediatrics	178	52	29·2 (23·0 – 36·3)
Surgical	1,041	313	30·1 (27·4 – 32·9)
Other*	320	43	13·4 (10·1 – 17·6)

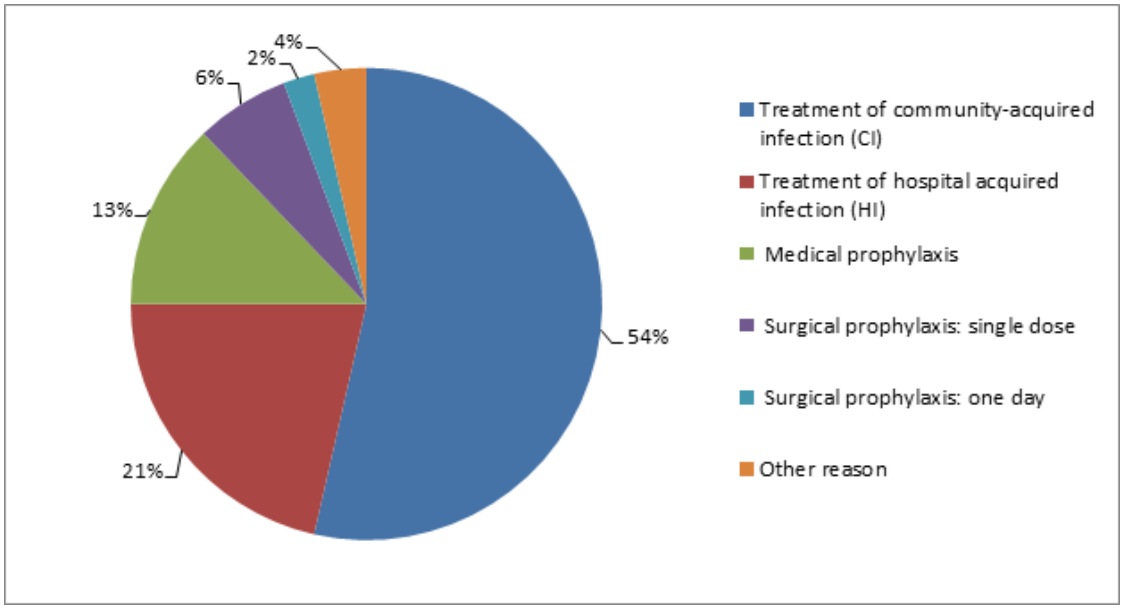
* Other = psychiatry; rehabilitation; combination of specialties (mixed ward)

5.10 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 383 paediatric patients and 22·7% (95%CI 18·8 – 27·2) were receiving antimicrobials. Neonates, on postnatal wards (n=128) 'well babies', had a low AMU prevalence (4·7%). The AMU prevalence in paediatric patients, excluding 'well babies', was 31·8% (95%CI 26·4 – 37·7).

Three-quarters of antimicrobials administered to patients under 16-year old was for treatment of infection, Figure 12. The most common reason for antimicrobial prescribing in paediatrics was for infections reported as community acquired, with 12·3% of patients receiving 54% of all antimicrobials given to paediatric patients. Surgical prophylaxis and medical prophylaxis accounted for 8% and 13% of all antimicrobials respectively.

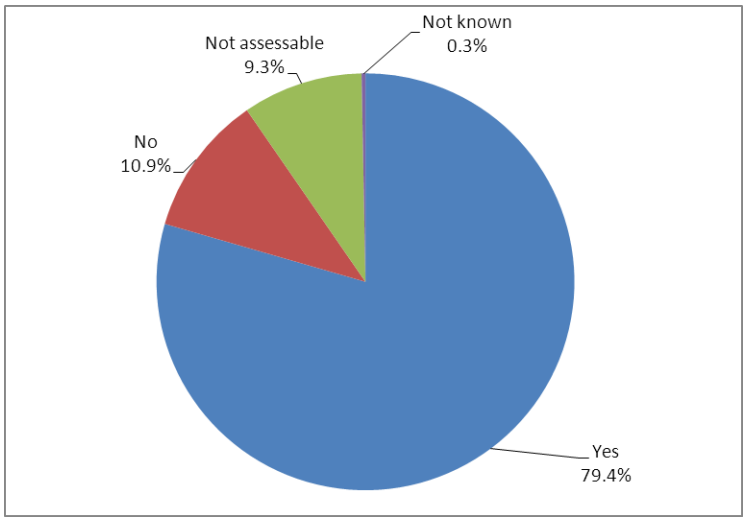
Figure 12 Antimicrobial indication for paediatric patients



5.11 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, 10·9% of all antimicrobials were noted as non-compliant with local guidelines and 9·3% were recorded as 'not assessable', i.e. antimicrobial administered for medical prophylaxis, or administered for treatment of infection in absence of local prescribing policy, or antimicrobials administered for surgical prophylaxis in absence of local prescribing policy, see Figure 13.

Figure 13 Antimicrobials - Compliant with local policy



There were 66 antimicrobial agents recorded of which 30 were considered to be non-compliant with local prescribing policies. Almost one-quarter of amoxicillin and enzyme inhibitor prescriptions did not meet local prescribing guidelines, Table 31.

Table 31 Antimicrobials – Non-compliant antimicrobials

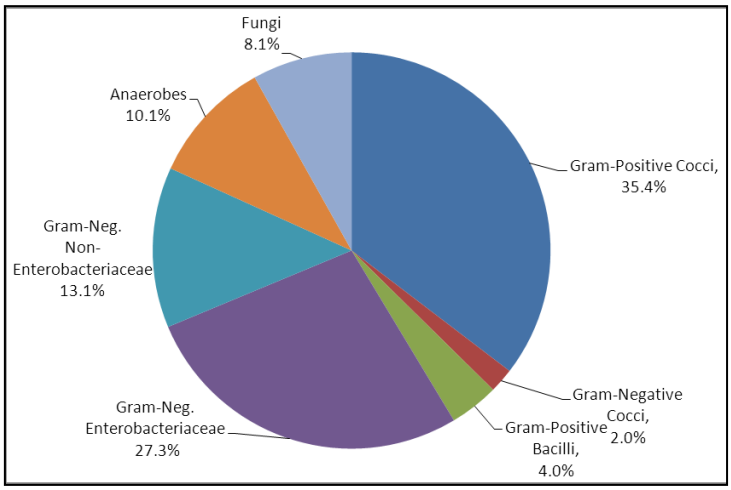
Antimicrobial	Total antimicrobials	Number non-compliant	% non-compliant
Total	**1,730**	**189**	**10·9**
Amoxicillin and enzyme inhibitor	216	52	24•1
Amoxicillin	125	8	6•4
Ciprofloxacin	52	10	19•2
Clarithromycin	102	19	18•6
Metronidazole	107	15	14•0
Trimethoprim	34	5	14•7
Piperacillin and enzyme inhibitor	286	33	11•5
Doxycycline	41	5	12•2
Teicoplanin	63	7	11•1
Meropenem	70	7	10•0
Gentamicin	103	6	5•8
Flucloxacillin	95	4	4•2
Other antimicrobial agents (n=16)	189	18	9•5
***Compliant antimicrobials* (agents=36)**	**247**	**0**	**0•0**

6 Microbiology results

6.1 Microbiology – Microorganisms

A total of 78 microbiology results with 99 microorganisms were reported (46·2% of HAI) for 169 infections. Positive microbiology results were not available for 53·2% of HAI, either because result was not available (33·7%), examination not done (9%), microorganism not identified (8·4%) or sterile specimen was received (3%). The most frequently recorded group of microorganisms was Gram negative organisms accounting for 38·4% of all microorganisms (Enterobacteriaceae 27·3% of total and gram negative non-Enterobacteriaceae 13·3% of total), followed by gram-positive cocci (35·4%), anaerobes (10.1%) and fungi 8.1%, see Figure 14.

Figure 14 Classification of microorganisms



The most frequently recorded microorganisms were *Staphylococcus aureus,* 14% followed by Enterococcus spp. 12%; Proteus spp. 10%; *Escherichia coli* 8% and *Clostridium difficile* 8%, see Table 32. 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 32 Microorganisms in Northern Ireland PPS 2012

Microorganisms	Number	% of total
Total	**99**	**100**
Gram-positive cocci	**35**	**35·4**
Staphylococcus aureus	14	14·1
Coag. negative staphylococci	7	7·1
Streptococcus spp.	2	2·0
Enterococcus spp.	12	12·1
Gram-negative cocci	**2**	**2·0**
Gram-positive bacilli	**4**	**4·0**
Gram-negative·Enterobacteriaceae	**27**	**27·3**
Citrobacter spp.	2	2·0
Enterobacter spp.	2	2·0
Escherichia coli	8	8·1
Klebsiella spp.	3	3·0
Proteus spp.	10	10·1
Serratia spp.	1	1·0
Other Enterobacteriaceae	1	1·0

Gram-neg. non-enterobacteriaceae	**13**	**13·1**
Pseudomonas aeruginosa	4	4·0
Stenotrophomonas maltophilia	1	1·0
Pseudomonadaceae family, other	4	4·0
Haemophilus spp.	1	1·0
Other Non-enterobacteriaceae	3	3·0
Anaerobic Bacilli	**10**	**10·1**
Clostridium difficile	8	8·1
Other Anaerobes	2	2·0
Fungi	**8**	**8·1**
Candida spp.	7	7·1
Other Parasites	1	1·0

6.2 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 33. Sensitivity data were reported for 14 *Staphylococcus aureus* isolates (nine meticillin sensitive (MSSA) and five meticillin resistant (MRSA)). In total 23 Enterobacteriaceae isolates had sensitivity data reported. Nineteen were sensitive to both third generation cephalosporins and carbapenems; four were resistant to third generation cephalosporins but sensitive to carbapenems; none were identified as resistant to both third generation cephalosporins and carbapenems. One *Pseudomonas* isolate was identified as carbapenem resistant. There were zero *Acinetobacter baumannii* recorded.

Table 33 ECDC-defined antimicrobial resistance

Microorganism	Antimicrobial	Number	%
Staphylococcus aureus	Oxacillin or cefoxitin sensitive (MSSA)	9	64·3
	Oxacillin or cefoxitin resistant (MRSA)	5	35·7
	Total	***14***	***100%***
Enterococcus spp.	Glycopeptide sensitive	8	66·7
	Glycopeptide resistant	3	25·0
	Not recorded	1	8·3
	Total	***12***	***100%***
Enterobacteriaceae*	3rd. generation cephalosporin sensitive + carbapenem sensitive	19	76·0
	3rd generation cephalosporin resistant + carbapenem sensitive	4	16·0
	3rd. generation cephalosporin resistant + carbapenem resistant	0	0·0
	Not recorded	2	8·0
	Total	***25***	***100%***
Pseudomonas aeruginosa	Carbapenem sensitive	2	50·0
	Carbapenem resistant	1	25·0
	Not recorded	1	25·0
	Total	***4***	***100%***

7 Comparison of 2012 and 2006 prevalence surveys

Note:
The patient populations and HAI definitions were not the same in 2012 and 2006. To make results comparable the populations were modified**.**
Therefore the results for 2012 shown for comparison with 2006 may not correspond with the overall 2012 results quoted elsewhere in this section.
Where comparisons are made with PPS conducted in England, Scotland and Wales in 2011, the Northern Ireland comparators are based on the total population surveyed (including paediatric and psychiatric patients).

7.1 Adjustments required to compare 2006 and 2012 HAI results

Direct comparison of the prevalence estimates from the 2006 survey with the 2012 survey are not possible due to differences in the patient population and the HAI definitions used. In 2006 the survey protocol was developed by the Hospital Infection Society [29] and used definitions of infections developed by Centers for Disease Control and Prevention (CDC). [23]

The following adjustments were required to facilitate comparison between the 2006 PPS and 2012 PPS in Northern Ireland:

- 2006 survey did not include paediatric patients and patients aged less than 16 years.

  These patients were excluded from the 2012 dataset for comparison with 2006.

- 2006 survey did not include psychiatric patients.

  These patients were excluded from the 2012 dataset for comparison with 2006.

- Asymptomatic bacteriurias were captured in the 2006 survey but not included in 2012.

  Asymptomatic bacteriurias reported in 2006 were excluded for comparison with 2012.

- 2012 an additional definition of clinical sepsis was added to systemic infections.

  Clinical sepsis infections reported in 2012 were excluded for comparison with 2006.

- 2012 an additional definition of catheter-related infections (not BSI) was included.

  Catheter-related infections (not BSI) reported in 2012 were excluded for comparison with 2006.

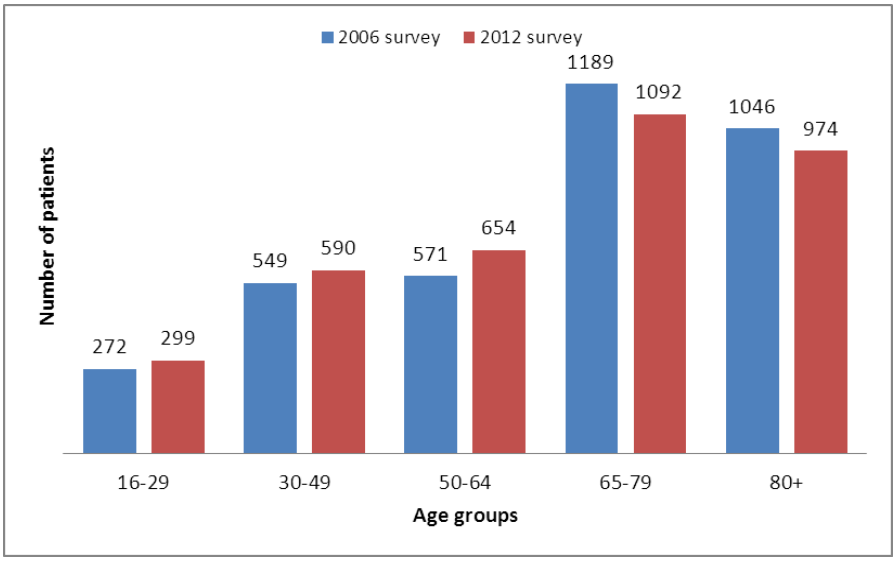
7.2 Comparison of survey populations

Table 34 and Figure 15 show the age distribution of comparable patients surveyed in the two point prevalence surveys (2006 and 2012).

Table 34 Number of patients by age group - 2006 and 2012

Age group (16+)	2006 survey (n=3,627)		2012 (n=3,409)	
	Number	% of patients	Number	% of patients
16-29 years	272	7·5	266	7·8
30-49 years	549	15·1	512	15·0
50-64 years	571	15·7	608	17·8
65-79 years	1,189	32·8	1,063	31·2
80+ years	1,046	28·8	960	28·2

Figure 15 Number of patients by age group – Northern Ireland 2006 and 2012



7.3 Comparison of ward specialties

Table 35 describes the distribution of specialties reported in 2006 and 2012. Paediatric patients and psychiatric patients were only reported in the 2012 survey and are excluded from comparisons. A decrease of almost one-third is seen in the proportion of patients in Care of the Elderly between both surveys - from 11·7% in 2006 to 8·3% in 2012.

Table 35 Number of patients by ward specialty – 2006 and 2012

Ward specialty	2006 survey (n=3,627)		2012 (n=3,409)	
	Number	% of patients	Number	% of patients
Medicine	1,617	44·6	1,655	48·5
Surgery	1,126	31·0	1,013	29·7
Care of the Elderly	426	11·7	282	8·3
Obstetrics and Gynae	321	8·9	257	7·5
Intensive care	66	1·8	98	2·9
Other	71	2·0	104	3·1

7.4 Comparison of device use

Only mechanically ventilated patients were recorded in the 2006 survey, therefore no direct comparison of intubation rates can be made.

The definitions relating to CVC, PVC and urinary catheter *in situ* were the same in the 2006 and 2012 surveys. However, to facilitate valid comparison between both surveys some adjustment was required, i.e. patients less than 16 years and psychiatric patients captured in 2012 were excluded from analysis (as neither were captured in 2006).

In 2012, PVC use was significantly higher than in 2006 (p<0·01). PVC use in 2012 was 47·9% (95%CI 46·2-49·6) compared to 38·7% in 2006 (95%CI 37·0 – 40·1), see Table 36.

CVC use was not significantly different between the two surveys; 5·0% (95%CI 4·3 – 5·7) in 2012 compared to 4·8% (95%CI 4·2 – 5·6) in 2006.

In 2012, urinary catheter use was not significantly different compared to 2006. In 2012, urinary catheter use was 19·6% (95%CI 18·3 – 20·9) compared to 20·4% in 2006 (95%CI 19·1-21·8).

Table 36 Device use by ward specialty comparison of 2006 and 2012 surveys

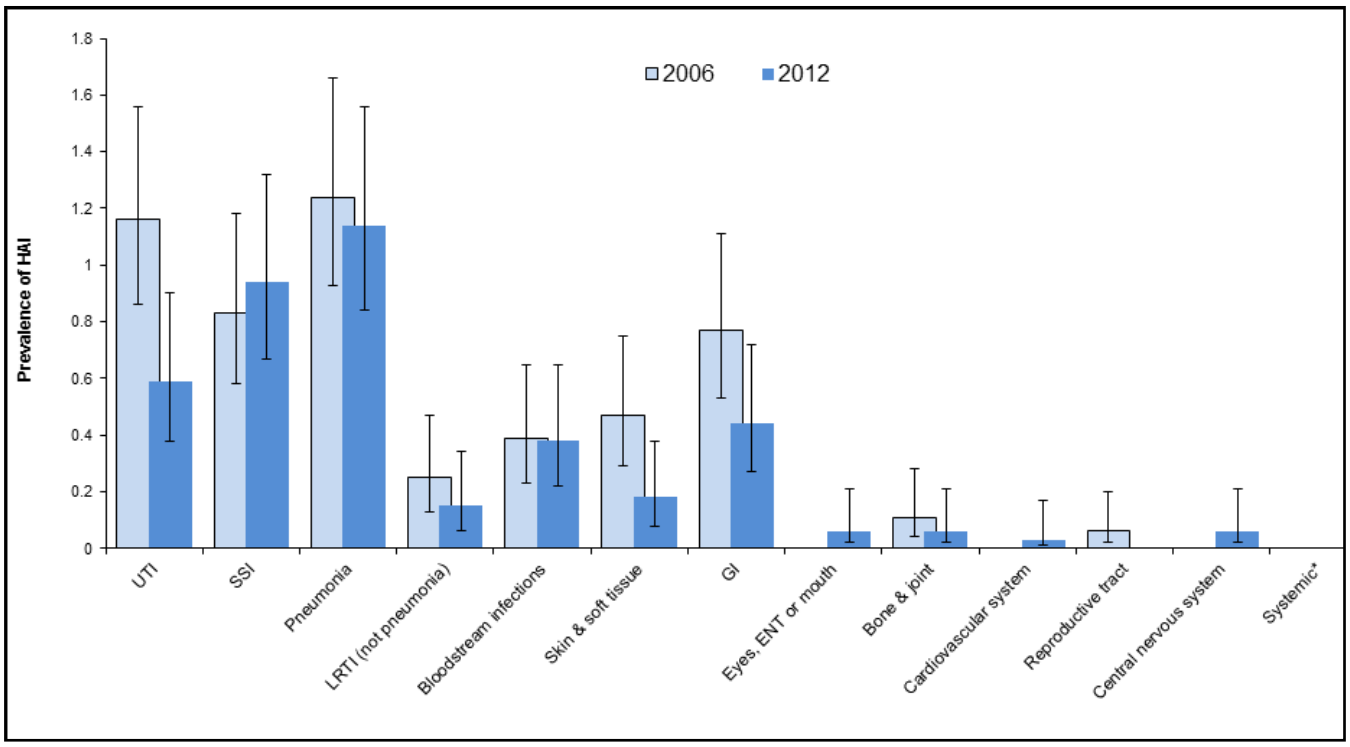
Ward specialty	Central vascular catheter *in situ*		Peripheral vascular catheter *in situ*		Urinary catheter *in situ*	
	% of patients within specialty					
	2006	2012	2006	2012	2006	2012
All specialties	4·8	4·9	38·7	47·9	20·4	19·6
Care of the Elderly	0·9	1·1	14·1	26·2	17·4	16·7
Adult intensive care	65·2	41·8	89·4	68·4	97·0	71·4
Medical	4·6	4·4	43·2	49·5	18·5	16·9
Obstetrics/Gynae	0·0	0·4	21·6	31·9	7·2	10·5
Surgical	4·7	4·9	44·2	53·2	23·8	22·3
Other	1·4	0·0	24·3	48·1	16·9	16·3

7.5 Comparison of HAI prevalence

Following adjustments to the patient population and HAI definitions (see 6.2), the HAI prevalence was calculated as: 4·7% in 2006 (95%CI 4·1 to 5·5) and 3·8% in 2012 (95%CI 3·3 to 4·5). There appears to be an 18·5% reduction in HAI prevalence between 2006 and 2012 (after adjustments are taken into account). This reduction was not reflected across all infection categories.

The prevalence of UTIs, pneumonias, lower respiratory tract infections (not pneumonia), skin & soft tissue and gastrointestinal infections were lower in 2012 than in 2006. The prevalence of gastrointestinal infection in 2006 was 0·8% (95%CI 0·5 – 1·1) and in 2012 0·4% (95CI 0·3 – 0·7). An increase in SSI prevalence was noted from 2006 to 2012. Figure 16 shows HAI prevalence and 95% confidence intervals by infection category in 2006 and 2012.

Figure 16 HAI prevalence by infection category – 2006 and 2012



*Systemic infections included a new clinical sepsis definition in 2012. Therefore to allow comparison across the two surveys clinical sepsis infections were removed.

7.6 Comparison of antimicrobial use

When similar survey populations were compared, overall use of antimicrobials was essentially unchanged between the two surveys. In 2006, 29·6% of patients were receiving at least one antimicrobial, while in 2012 this proportion was reported at 31·8% of patients surveyed. The proportion of patients receiving IV antimicrobials in 2006 was 15·2% (95%CI 14·0 – 16·3), but in 2012, for the comparable survey population, use of IV antimicrobials significantly increased to 21% (95%CI 19·7 – 22·4) (p<0·01).

7.7 Comparison of microbiology

The only microorganism data collected in 2006 related to meticillin resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile*.

There was a significant reduction (p<0·01) in MRSA prevalence, for a comparable population, from 0.9% (95%CI 0·6 – 1·2) in 2006 to 0·1% (95%CI <0·1 – 0·3) in 2012. MRSA was the causative organism in 15·7% of all HAI in 2006 compared to 2·6% in 2012. In 2006, seven of 16 bloodstream infections had MRSA as the causative organism (44%) but in 2012, for the comparable population, one of seven bloodstream infections were MRSA related.

In 2006, 24 patients were recorded with *Clostridium difficile* related hospital-acquired gastrointestinal infections. This equated to 0·8% of the surveyed population. In 2012, there were 8 patients with *Clostridium difficile* gastrointestinal infections or 0·2% of the population.

8 Discussion

This report presents the results of the 2012 point prevalence survey (PPS) of hospital – acquired infection (HAI) and antimicrobial use (AMU) in Northern Ireland acute hospitals. The majority of fieldwork was completed during May/June 2012 with one hospital undertaking the survey in September 2012[1]. The survey included 3,992 eligible patients in sixteen hospitals, occupying 88·5% of available acute beds. The remaining 11·5% of beds were not included either because the beds were not occupied or the patients were ineligible for inclusion in the survey, e.g. admitted after 8 am or transferred to another ward after 8 am 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.

Acute hospitals in Northern Ireland contributed to earlier UK point prevalence surveys of HAI, the most recent of which was completed in 2006. In addition, a limited PPS of antimicrobial use was conducted in five hospitals in Northern Ireland during 2009. These earlier prevalence surveys included only adult patients; however, PPS 2012 also included paediatric and psychiatric patients.

PPS 2012 is the first occasion that a prevalence survey in Northern Ireland, using a standardised European protocol, combined both HAI and AMU. Involvement in this PPS was on a voluntary basis, however, all acute Health and Social Care Trusts participated.

Planning and completion of, PPS 2012 was significantly enhanced by inter-disciplinary collaboration between PHA and HSC Trust Teams.

The collaboration between PHA and staff from the Health Protection Surveillance Centre, Health Service Executive, Dublin, helped in the successful delivery of PPS 2012.

Identification of future national policy priorities should be based on the ability to prevent specific HAI and improve antimicrobial prescribing. The evidence from this PPS points to a number of key areas that require consideration. Following on from the discussions on HAI prevalence, device use, microbiology and AMU prevalence a number of priorities that should be considered at both hospital and national level are outlined.

[1] South West Acute Hospital opened in June 2012 and fieldwork was deferred until September 2012.

8.1 HAI prevalence

The dynamic natures of healthcare delivery, the changing nature of the acute care population, the evolution of microorganisms, as well as the changing nature of targeted interventions are important factors influencing findings from successive point prevalence surveys.

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

The overall prevalence of HAI in acute care in Northern Ireland hospitals surveyed was 4·2% (95%CI 3·6 – 4·8). This rate is broadly similar to that reported for acute hospitals in Wales (4·3%; 95%CI 3·6 – 5·0) and in Scotland (4·9%; 95%CI 4·4– 5·4) and is lower than that reported for acute hospitals in England 6·5% (95%CI 4·8– 8·9). [(3) (4) (5)] Preliminary results for the Europe-wide PPS 2011/12 (approximately 250,000 patients) reported by ECDC indicate a HAI prevalence of 6·2% (95% CI 6·1 – 6·3).

HAI prevalence in PPS 2012 was lower than that reported in PPS 2006. Following appropriate adjustments, HAI prevalence in PPS 2012 was approximately 18% lower than in PPS 2006. This finding is reflective of trends reported by PHA for HAI incidence surveillance programmes. [(9) (30)]

8.1.1 HAI prevalence – Population profile

In PPS 2006, a linear relationship between age and HAI prevalence was reported. [(10)] This relationship was not observed in PPS 2012. In the adult population, the highest HAI prevalence occurred in 50-64 year old age group (5·8%), whereas in PPS 2006, the highest HAI prevalence occurred in those 75 years and over (7·6%).

A number of demographic changes were seen between comparable survey populations in PPS 2012 and PPS 2006. In particular, after adjustments, the proportion of adult patients aged over 65 years was lower in 2012 compared to 2006 (56% compared to 62%). The proportion of patients recorded in Care of the Elderly was lower in 2012 (7·4%) than in 2006 (11·7%). This suggests that older patients are less represented in this survey compared to the previous PPS.

In PPS 2012 the proportion of patients aged 65 or over was 51·8% of the total survey population. This was lower than the corresponding proportion reported by England 57%, Scotland 59·5% and Wales 62·7%.

After adjustments, HAI prevalence in Care of the Elderly was lower in PPS 2012 (8·3%) compared to PPS 2006 (11·7%). This may represent a service area where Trusts have particularly focussed infection prevention and control practices over recent years. It may also represent a higher turnover of older patients receiving acute services, including earlier discharge of patients back to community care settings, availability of home antibiotic teams, and an increasing trend towards care delivered outside the acute setting (e.g. admission avoidance schemes).

The prevalence of HAI in the paediatric population in PPS 2012 was 3·4% (95%CI 2·0 – 5·7). Overall HAI prevalence in the paediatric population was reduced by the 'well baby' cohort – well babies nursed on postnatal wards who had short lengths of stay and had a low HAI prevalence (0·8%). HAI prevalence for paediatric patients, excluding 'well babies', was 4·7% (95%CI 2·7 – 8·0), which was similar to that reported for the total population. The HAI prevalence for patients aged 1-23 months was 8.3% (95%CI 4·7% - 16·9%); this was similar to that observed in England (8·2%) and moderately higher than that in Scotland (5·5%) and Wales (5·6%); differences were not statistically significant.

8.1.2 HAI prevalence – Hospital type and ward specialty

HAI prevalence was significantly higher in Tertiary hospitals compared to Secondary hospitals; twice as many HAI were identified in Tertiary hospitals (6·8% 95%CI 5·8 – 9·2) than in Secondary hospitals (3·2% 95%CI 2·6 – 4.2). HAI prevalence was also significantly higher when Tertiary hospitals were compared to Primary hospitals (2·2% 95%CI 1·4 -3·7). This may represent the greater complexity of both patient need and services delivered in hospitals with greater specialisation of services.

HAI prevalence varied significantly according to ward specialism. While ICU patients had the highest HAI prevalence 9·1% (95%CI 4·7 – 16·4), they accounted for only 2·5% of all patients surveyed. The lowest HAI prevalence was recorded for patients in obstetrics/gynaecology wards at 0·8% (95%CI 0·3 – 2·3). This finding is likely to reflect the cohort of adult females presenting to acute obstetric services that are expected to be otherwise healthy.

8.1.3 HAI prevalence – Number and classification of infections

Overall, 166 patients were identified as having an active HAI in PPS 2012, only three patients were identified with two HAIs. The six most common types of HAI accounted for more than four fifths (84·6%) of all infections: pneumonia (24·3%), followed by SSI (18·9%), UTI (11·8%), systemic infection - specifically clinical sepsis (11·8%), gastrointestinal infections (8·9%), and BSI (8·9%).

While pneumonia, SSI and UTI featured in the top three HAI categories across all four UK administrations, pneumonia was the most common infection in Northern Ireland and England, UTI was the most common in Scotland and SSI was the most frequently reported in Wales. Preliminary results for Europe-wide PPS 2011/12, reported by ECDC, indicate that the top three infections were also pneumonia, SSI and UTI.

Almost one fifth (19·5% - 33 of 169) of HAI were present on admission to hospital. The majority of HAI (81·5%) identified during PPS 2012 developed during a patient's stay in the admitting hospital and 70% of these were related to a previous admission to the same hospital, the remaining 30% were related to a stay in another hospital.

Approximately one in five HAI (22%) were identified within the first two days of admission to hospital. The majority of HAI (54%) were identified more than one week following admission to hospital, with 21% of all HAIs reported more than three weeks after admission.

8.1.4 HAI Prevalence – Devices *in situ*

Half (50·8%) of all patients (95%CI 49·4 – 52·5) had an invasive device *in situ* at the time of survey completion. Peripheral vascular catheter (PVC), either arterial or venous, was the most common device present in 47.9% of patients. Urinary catheters were present in 17.1% of patients (95% CI 15·9 – 18·3). Invasive devices were most prevalent in adult ICU.

8.1.5 HAI prevalence – Comparison with PPS 2006

Following adjustments to the survey population to enable HAI comparisons between 2006 and 2012, the overall HAI prevalence in Northern Ireland reduced from 4·7% in 2006 to 3·8% in 2012. This represents a decline in HAI prevalence but remains within the margin of error calculated for each estimate.

Despite methodological differences between the 2006 and 2012 surveys, the top three infections remain consistent in both surveys. When combined, the two diagnostic categories of pneumonia and lower respiratory tract infection (not pneumonia) comprised the largest burden of infection in 2012 (accounting for 27·9% of all HAI recorded); unchanged since 2006 (when they accounted for 28·3% of all HAI recorded).

Pneumonia and lower respiratory tract infection

After differences in patient population and HAI definitions are taken into consideration, a reduction in the prevalence of hospital-acquired pneumonia was seen between 2006 and 2012, although this was not statistically significant. Prevalence of pneumonia in 2006 was 1·3 (95%CI 1·0 – 1·7) and in 2012 the comparable prevalence of pneumonia was 1·1 (95%CI 0·8 – 1·5).

The vast majority of pneumonias were clinically defined in both 2006 and 2012 (96% and 97% respectively). Microbiological confirmation of pneumonia was recorded for a small proportion of pneumonias in both surveys. The proportion of ventilator-associated pneumonias almost halved from 14·9% in 2006 (7 out of 47 in 2006) to 7·9% in 2012 (3 out of 38).

Surgical Site Infection (SSI)

A small but increasing burden of SSI was noted from 0·8% in 2006 (95%CI 0·6 – 1·2) to 0·9% in 2012 (95%CI 0·7 – 1·3). The increasing proportion of deep and organ space SSI observed between the two surveys (50% in 2006 to 69% in 2012) indicates that SSI in the acute setting is becoming more complex. 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 patient quality of life and future cost of healthcare delivery.

It is important to note that PPS 2012 included hospital in-patients only. A number of factors are likely to impact on the proportion of SSI identified in the acute care setting, including higher 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 incidence surveillance must include post-discharge follow-up.

Almost half of SSIs (46.9%) reported in PPS 2012 were identified following general surgical procedures. General surgical procedures are currently not included in SSI incidence surveillance in Northern Ireland.

The incidence of SSI following orthopaedic surgery has significantly reduced since the introduction of mandatory orthopaedic SSI incidence surveillance in Northern Ireland. [30] This reduction was reflected in PPS 2012 with orthopaedic SSI rates reduced by one third, from 0·3% in 2006 to 0·2% in 2012. A move towards ECDC-defined 'light surveillance' of SSI may in the future facilitate a different approach to incidence surveillance following orthopaedic surgery (given than SSI rates in this operative category continue to be maintained at a low level). [31]

No SSI following caesarean section delivery was reported in PPS 2012 (survey included hospital in-patients only). Currently mandatory incidence surveillance indicates that 90% of post-caesarean section SSI occurs following discharge from acute hospital care. It was therefore not unexpected that given the short length of stay for obstetric patients zero SSI were recorded following caesarean section in PPS 2012.

Urinary tracts infection (UTI)

The prevalence of symptomatic UTI halved from 1·2% in 2006 to 0·6% in 2012. Although there were reductions in urinary catheter use (20·4% in 2006; 19·6% in 2012) and in the percentage of UTIs deemed catheter-related (40·5% in 2006; 36·8% in 2012). These factors alone are unlikely to account for the reduction in the symptomatic UTI prevalence in PPS 2012.

A similar reduction in prevalence of symptomatic UTI was not reported in other UK administrations. In England and Wales the prevalence remained essentially unchanged - England 1·2% in 2006 and 2012, Wales 0·8% in 2006 and 2012. Further investigation of possible factors influencing the reduction of symptomatic UTI rates in Northern Ireland is warranted.

Systemic infection

A new definition of clinical sepsis in adults and children was added to the systemic infection HAI group in 2012. This definition was not available in 2006 PPS. This definition allowed data to be gathered, from both paediatric and adult populations, where there was clinical evidence of infection without positive microbiology confirmation.

All systemic infections (n=20) identified in 2012 were recorded as clinical sepsis. The proportion of systemic infections (in effect clinical sepsis) was 11·8% of all HAI and the comparable proportion of systemic infections in England was 10·5% of all HAI. All systemic infections recorded in England were also clinical sepsis.

Direct comparisons with Scotland and Wales cannot be made regarding clinical sepsis as they did not differentiate within the systemic infections group; nevertheless the proportion of systemic infections in Scotland and Wales was 3·3% and 2·7%, respectively.

Bloodstream infection (BSI)

There was no observed difference in BSI prevalence between the two surveys; in both 2006 and 2012, BSI was 0·4% (95%CI 0·2 – 0·7).

In 2006, seven of 16 bloodstream infections had MRSA as the causative organism (44%) and for the comparable population, one out of seven bloodstream infections had MRSA as the causative organism. Although these numbers are small they reflect a general decline in the incidence of MRSA bacteraemia. [9]

Gastrointestinal infection

Prevalence of gastrointestinal infections halved from 0·8% (95%CI 0·5 – 1·1) in 2006 to 0·4% (95%CI 0·3 – 0·7) in 2012. This reduction is likely to have been influenced by the considerable attention and focus given to prevention and control of *Clostridium difficile* infection in recent years. [9]

Skin and soft tissue

Prevalence of skin & soft tissue infection fell from 0·5% in 2006 to 0·2% in 2012. This reduction is likely to reflect a reduction in these infections caused by MRSA; in 2006, 58·8% were reported to be caused by MRSA compared with zero in PPS 2012. This finding indicates that efforts to reduce MRSA bacteraemia have also reduced clinical infections caused by MRSA.

8.1.6 HAI Priority areas

Until relatively recently the proportion of HAI considered preventable was estimated to be 25 – 40%. [32] More recent research suggests that up to 70% of all healthcare-associated infections are preventable using current evidence-based strategies. [7]

It is not possible to maintain incidence surveillance across all specialist areas. Hence 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. [33]

HAI was most frequently observed in the adult ICU setting. Approximately 10% of all HAI identified in this survey was in adult ICU. This finding is in keeping with PPS findings reported in other UK administrations. [3] [4] [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 (possibly 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. During 2011 this surveillance programme was moved from paper-based to electronic-based data capture and reporting systems. The impact of this surveillance programme has yet to be fully evaluated.

Respiratory tract infections (pneumonia and LRTI) were the most frequent HAI detected in PPS 2012. The majority of patients with infection were being cared for in ICU. It is recognised that surveillance of pneumonia is challenging, with validation of definitions used in pneumonia surveillance proving particularly complex. [34] [35] [36] [37] Centers for Disease Control and Prevention (CDC) recently proposed new definitions relating to ventilator-associated pneumonia. It is envisaged these definitions will prove less subjective and more 'user friendly'. [38]

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. PPS 2012 highlights the importance of SSI following General Surgery. This is an area that may benefit from targeted incidence surveillance.

Deep incisional and organ/space SSI cause the greatest morbidity and mortality and accounted for two-thirds of all SSIs. Superficial site infections are less likely to result in death or injury and their identification may prove challenging to standardise across hospitals.

PPS 2012 indicates that the prevalence of symptomatic UTI has halved between 2006 and 2012 in NI. As similar reductions have not been reported in UTI prevalence in other UK administrations, it is important to ensure that this finding relating to UTI prevalence in Northern Ireland is validated. Seven out of twenty patients (35%) with UTI had a urinary catheter in situ in the preceding seven days, suggesting that targeted programmes aimed at reducing overall use of urinary catheters and/or ensuring best practice for management of urinary catheters *in situ* is a key component of achieving further improvement in UTI rates.

SUMMARY OF HAI PRIORITIES

1. Continued focus on HAI prevention and control in ICU settings - with particular emphasis on maintaining the current ICU incidence surveillance programme, validating data reported on VAP, CLABSI and CAUTI, and using outputs from this programme to inform and assist with continued HAI improvement in the ICU setting.
2. Consideration should be given to reviewing HAI incidence surveillance programmes as currently established - in the context of findings arising from this survey and HAI improvements successfully achieved over recent years.
3. Realignment of surgical site infection surveillance to include surgical specialties, for which a high prevalence was reported, combined with assessment of potential for reduced data collection for current SSI programmes in which significant reductions have been demonstrated.
4. Development of methodologies to support standardised incidence surveillance of HAI most commonly reported in the hospital context, i.e. respiratory tract infections including pneumonia and LRTI.
5. Validation of PPS findings relating to reduced prevalence of symptomatic urinary tract infections in the hospital setting, combined with increased emphasis on targeted programmes to reduce overall use of urinary catheters and ensure best practice for management of catheters *in situ*.
6. Sustained 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.

8.2 Device use

Half of all patients surveyed (50·8%) had an invasive device in situ at the time of survey. While reported use of devices was highest in the ICU setting, a reduction was observed between 2006 and 2012. This finding may be due to the concerted focus on HAI improvement and implementation of high impact interventions and care bundles in ICU settings in recent years.

Conversely use of devices, particularly peripheral vascular catheters (PVCs), increased in a number of other settings, including Medical and Surgical wards. Half of all patients in each setting had a PVC in situ - PVC use in surgical wards increased by 10% from 2006; PVC use in Medical wards increased by 6% from 2006. [(10)]

The prevalence of central vascular catheter CVC use was 5·1%, which was similar to that recorded in 2006. However, use of CVC in the adult ICU setting dropped by one third from 65·2% in 2006 to 41·8% in 2012. CVC use recorded for other UK administrations was similar to that reported in Northern Ireland. As devices remain a significant risk factor for acquisition of HAI, learning arising from successful strategies in ICU should be implemented more widely across acute services.

The prevalence of urinary catheters was 18·8% which was similar to that observed in 2006 and was in line with other UK administrations. In common with the observations relating to PVC and CVC use, the use of urinary catheters in adult ICUs fell by one quarter from 97% in 2006 to 71·4% in 2012.

The prevalence of patients intubated (either with a tracheostomy or endotracheal tube) on the day of survey was 1·7%, similar rates of intubation were recorded for England (1·7%), Scotland (1·3%) and Wales (2·5%). Intubation rates for 2006 and 2012 cannot be compared as the 2006 survey collected data on mechanically ventilated patients only.

SUMMARY OF DEVICE USE PRIORITIES

1. Continued focus on presence of invasive devices as a significant risk factor for development of HAI in the hospital setting - emphasising the on-going requirement for implementation of high impact interventions (care bundles) relating to device insertion, duration of use and management.

2. Sustained emphasis on education and training of clinical staff responsible for insertion and maintenance of invasive devices, including regular assessment of competency in relevant clinical staff.

3. Consideration of reporting device prevalence across services and organisations, with a view to assisting with reduction of device use and shortening duration of use.

8.3 Antimicrobial use

The overall prevalence of AMU in acute care hospitals in Northern Ireland was 29·5%. This rate was lower than the corresponding rate reported for acute hospitals in England (34·3%), Scotland (32·3%) and Wales (32·7%). [3] [4] [5] Preliminary results reported by ECDC for Europe-wide PPS 2011/12 (covering approximately 250,000 patients) indicate an overall AMU prevalence of 36·3%.

In total, 1,751 antimicrobials were being given to 1,178 patients in this survey which equates to 1·5 antimicrobials per patient. Tertiary hospitals reported the highest prevalence of antimicrobial prescribing, with 32·9% of patients receiving antimicrobials. Just over three in ten patients in Primary hospitals (31·5%) were receiving antimicrobials, which was a higher prevalence than that reported for patients in Secondary level hospitals (28·4%).

Almost two thirds of antimicrobials were administered parenterally 65·2% and 34.6% were given orally. The proportion given parenterally was greater than the corresponding proportion reported in England (56%), Scotland (48%) and Wales (48%). This finding suggests that the proportion of antimicrobials administered parenterally can be reduced by switching from parenteral to oral antimicrobials, where appropriate.

The proportion of paediatric patients, particularly children aged between 2-15 years, in receipt of antimicrobials was (36·6%) which was a higher proportion than for other age groups. Antimicrobial use in patients over 65 years was essentially unchanged from the previous PPS, 31·8% in 2012 compared to 33·1% in 2006. Although recent years have seen considerable focus on HAI improvement programmes to combat *Clostridium difficile* infection in elderly patients. The findings from this PPS indicate that further improvement is required in this area.

AMU was greatest in adult ICU at 55·6%, significantly higher than that reported for other specialties. This finding is likely to reflect the complex patient group managed in this specialty. The most frequent indication for antimicrobial use (60%) was for treatment of infection considered to be community acquired. Surgical prophylaxis accounted for 7% of all AMU, while medical prophylaxis accounted for 6·6%.

The majority of antimicrobials used for treatment of infection were prescribed for respiratory tract infections (39%). Almost three quarters of the antimicrobials given for treatment of respiratory tract infections were prescribed for infections considered to be community acquired (74%). The second most common reason for prescribing antimicrobials was for treatment of skin & soft tissue infection (15%). Eighty per cent of paediatric patients were receiving parenteral antimicrobials at the time of survey completion. The prevalence of parenteral antimicrobials could be reduced by switching to oral antimicrobials where appropriate.

8.3.1 Antimicrobial use – Prescribed antimicrobials

A total of 66 different antimicrobial agents were recorded in this survey. Ten antimicrobials comprised two-thirds of all antimicrobial use (AMU) and the top 20 most commonly prescribed antimicrobials accounted for 84% of all AMU. This finding shows that clinicians use a relatively narrow range of antimicrobials, similar to other UK administrations. Meropenem, a broad spectrum beta-lactam and often regarded as the last resort beta-lactam agent, was the ninth most frequently prescribed antimicrobial overall (4·1% of all AMU).

8.3.2 Antimicrobial use – Compliance with local guidelines

PPS 2012 included an assessment of compliance with local prescribing guidelines that exists in in each Trust. The majority of prescriptions (79·4%) were reported as compliant with local policy and just over one in ten antimicrobials prescribed (11%) were not compliant with local guidelines.

The proportion of surgical prophylaxis given for longer than 24 hours was 11%. While this proportion was lower than the corresponding proportion reported in England (30%), Scotland (23·7%) and Wales (51·4%), it should be noted that there are only three conditions requiring antimicrobial prophylaxis for longer than 24 hours. Further work is required to validate this PPS finding and to effect timely improvement in antimicrobial stewardship in this area.

Rationale for treatment was recorded for nine out on ten antimicrobials prescribed in this survey. Documentation of rationale for treatment varied from 79% to 100% across acute hospitals. This finding is encouraging and is in keeping with that reported by other UK administrations.

Currently there are no regionally agreed performance targets or objectives associated with antimicrobial prescribing in the hospital setting in Northern Ireland. Following the introduction of *Clostridium difficile* Infection reduction targets in Scotland, the Scottish Government and Scottish Antimicrobial Prescribing Group (SAPG) agreed antimicrobial prescribing indicators relating to hospital-based empirical prescribing (rationale recorded and prescription compliant) and surgical prophylaxis. Evidence of beneficial impact of this approach is available through successive PPS surveys completed in Scotland. [(39)]

8.3.3 Antimicrobial use – 2006 PPS and 2009 ESAC

PPS 2006 focused predominantly on HAI prevalence; however some data relating to antimicrobial use was also captured. In 2006, one third of patients were on at least one antimicrobial agent. PPS 2012 reports a small increase in AMU prevalence, with 34·7% of patients receiving an antimicrobial.

AMU prevalence in 2012 is higher than that reported in the 2009 European Surveillance of AM Consumption (ESAC) survey in Northern Ireland, in which the overall prevalence of AMU was 29%. [(16)] Best practice guidance recommends a shift away from fluoroquinolone and cephalosporin use to minimise the risk of *Clostridium difficile* infection. Low levels of each of these antimicrobials were reported in this survey - 50 patients received cephalosporins (2·9%); 73 patients received fluoroquinolones (4·2%). The most commonly prescribed high risk antimicrobial in PPS 2012 was meropenem (4.1%).

8.3.4 AMU priority areas

While PPS 2012 indicates that the overall antimicrobial use in Northern Ireland is lower than that reported for other UK administrations, a higher proportion of patients were receiving parenteral antibiotics in Northern Ireland than other UK administrations. The proportion of AMU in older patients (aged 65 years and over) remained unchanged. Effective improvement and antimicrobial stewardship strategies should particularly address AMU in older patients (e.g. Care of the Elderly and medical services). Stewardship strategies should continue to ensure early switch from parenteral to oral agents where appropriate, conferring potential benefits of reducing the need for IV access and facilitating earlier hospital discharge.

A significant proportion of AMU reported in 2012 was for treatment of infection considered to be community acquired. This finding highlights the importance of ensuring effective antimicrobial stewardship across Northern Ireland. Guidelines for antimicrobial use in primary care in Northern Ireland [(40)] [(41)] 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. Best practice in antimicrobial prescribing should be assured across acute and primary/community care settings.

The majority of antimicrobials prescribed for treatment were for respiratory infections. Three quarters of respiratory infections identified in this survey were considered to have their origin in the community setting. Pneumonia was the most commonly identified infection accounting for 24·3% of all HAI reported. These findings indicate that local and regional interventions for HAI prevention and control and antimicrobial stewardship could usefully target infections of the respiratory system. This is likely to include respiratory infections presenting in complex acute services (e.g. ventilator-associated pneumonia in critical care) and also those presenting in primary/community care settings (e.g. lower respiratory tract infection following influenza).

More than one in ten antimicrobials prescribed in PPS 2012 were administered for prophylaxis, 7% for surgical prophylaxis and medical prophylaxis 6·6%. Surgical prophylaxis should be usually given within one hour prior to surgical incision (vancomycin within 2 hours). Further work should assess the nature and timing of prophylactic antimicrobials.

While the use of antimicrobial agents associated with *Clostridium difficile* infection was relatively low in this survey (cephalosporins 2·9%; fluoroquinolones 4·2%), the prevalence of meropenem use is of concern (4·1%). Meropenem was the third most commonly used antimicrobial for treatment of infections in the 'systemic infections' diagnostic category and the sixth most commonly used agent for treatment of respiratory infections.

Inappropriate use of antimicrobials is regarded as a major driver for the development of resistance in micro-organisms. [(42)] While no carbapenem resistant Enterobacteriaceae (CRE) was identified in this survey, carbapenem resistance was identified for one *Pseudomonas* infection surveyed. Regional and local Trust guidelines on 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).

All HSC Trusts in Northern Ireland have agreed local guidelines addressing best practice in antimicrobial prescribing. Trusts should continue to monitor these local guidelines. No antimicrobial consumption data for acute Trusts is currently available for benchmarking across Northern Ireland, unlike in Scotland and Wales. [43] [44] Further developments are required in this area to facilitate assessment and monitoring of antimicrobial consumption data over time. This would highlight departures from regional and/or local guidelines and would potentially allow for greater consistency in antimicrobial use between hospitals and services.

Through regular point prevalence surveys it is possible to monitor a set of quality indicators relating to antimicrobial prescribing – including compliance with local policy, recording of indication for treatment, use of parenteral versus oral agents, early switch to oral agents when appropriate and overall proportion of antimicrobial prescribed. These quality indicators may then be used to facilitate comparison between services and hospitals.

SUMMARY OF ANTIMICROBIAL PRIORITIES

1. Continued focus on the critical importance of effective antimicrobial stewardship in the hospital context and across the whole health economy, including primary and community care settings.
2. Development, and robust implementation across all Trusts of, local guidelines addressing appropriate use of important broad spectrum antimicrobials e.g. meropenem.
3. Development of regionally agreed quality indicators for AMU to assist with benchmarking across organisations and with peer organisations in other UK administrations.
4. Regular reporting and assessment of antimicrobial consumption data for each hospital, with case-mix stratification.
5. Sustained emphasis on ensuring appropriate antimicrobial use, particularly in those aged 65 years and over, and on promoting early switch from parenteral to oral agents as clinically appropriate.
6. Consideration of targeted programme aimed at reducing antimicrobial requirements and ensuring appropriate antimicrobial use for infections of the respiratory system, particularly pneumonia.
7. Validation of survey findings relating to antimicrobials used for prophylaxis, and in particular surgical prophylaxis lasting longer than 24 hours.
8. Development of antimicrobial stewardship and prescribing competencies, with particular emphasis on leadership provided through multi-disciplinary team working.

8.4 Microbiology

Gram-negative organisms accounted for the largest proportion of microorganism identified in PPS 2012, included Enterobacteriaceae (27·3%), non-Enterobacteriaceae Gram-negative organisms (13·1%) and Gram-negative Cocci (2·0%). Gram-positive Cocci accounted for 35·4% while anaerobic organisms accounted for 10·1% of microorganism identified. There were similar proportions of Enterobacteriaceae reported in England (32·4%) and Scotland 30%. [3] [4]

Sixteen per cent of Enterobacteriaceae isolates were reported as third generation cephalosporin resistant, indicating the likely presence of an extended spectrum beta lactamase (ESBL) producing organism. Similar levels of third generation cephalosporin resistant Enterobacteriaceae were reported in England (12·4% of all Enterobacteriaceae) and in Scotland one-fifth were third generation cephalosporin resistant. [3] [4] The emergence of Enterobacteriaceae as one of the most frequent microorganisms detected in relation to HAI requires further investigation, with a view to informing appropriate prevention and control strategies.

The prevalence of MRSA-related HAI and *Clostridium difficile* infection has reduced dramatically since the previous PPS. In PPS 2012, approximately 0·1% of the total survey population had an infection caused by MRSA compared to 0·9% in 2006. *Clostridium difficile* infection was detected in 0·2% of the hospital population in 2012 compared to 1·1% in 2006. These findings are in keeping with data reported through incidence surveillance of both MRSA and *Clostridium difficile* Infection in Northern Ireland over recent years. [9]

Clostridium difficile infection was detected in 0.4% of the total survey population in England and in Scotland the prevalence was 0·2%. MRSA prevalence was <0·1% in the English survey population and <0·1% in the Scottish survey population. [3] [4]

Comparable microbiologically data was not available for Wales.

SUMMARY OF MICROBIOLOGY PRIORITIES

1. Continued focus on the importance of developing appropriate regional and local capacity to monitor ‘drug-bug’ combinations across the health economy.
2. Development of guidance on the prevention and control of Enterobacteriaceae in hospital and healthcare settings.

9 Conclusions

Point prevalence surveys are an effective mechanism to gather high quality, representative data from a range of health care providers within a region to a common standard. In Northern Ireland, the use of web entry has further improved the quality of data at source, with data being checked at hospital level before onward transmission.

Prevalence surveys allow for data collection from hospitals over a shorter timeframe than incidence surveillance and can provide estimates on the overall burden of HAI and AMU at a particular point in time. This is the first occasion that data on both HAI and AMU were collected simultaneously, increasing the efficiency of the survey.

Repeated prevalence surveys in the hospital setting are useful to determine changes in the overall epidemiology of HAI and AMU. They are useful for monitoring the effectiveness of infection prevention and control programmes and for determining the priority areas for HAI and AMU within hospitals.

In Northern Ireland we have 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 that need careful consideration by individual Trusts, PHA and DHSSPS. Further prevalence surveys of both HAI and AMU will remain important to measure the impact from new policies, guidance and interventions in future years.

The data from this survey should be used to support HAI improvement across all 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.

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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

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A.4 Ward census

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A.8 Underlying disease prognosis

A.9 Algorithm for the definition of hospital acquired infection

Appendix B – Additional 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 A.1 Regional PPS Delivery Group members

Name	Organisation
Dr. Lourda Geoghegan	Consultant in Health Protection Public Health Agency
Dr. Brian Smyth	Consultant in Health Protection Public Health Agency
Gerard McIlvenny	Surveillance Manager Public Health Agency
Mark McConaghy	Regional Surveillance Officer Public Health Agency
Caroline McGeary	Senior Infection Control Nurse Public Health Agency
Rachel Spiers	Intern Public Health Agency
Dr. Nizam Damani	Consultant Microbiologist Southern Health and Social Care Trust
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
Irene Thompson	Senior Nurse, Infection Prevention and Control Belfast Health and Social Care Trust
Colin Lavelle	Senior Data Analyst Belfast Health and Social Care Trust
Sinead McElroy	Antimicrobial Pharmacist Western Health and Social Care Trust
Shireen McGlone	Infection Prevention & Control Nurse Western Health and Social Care Trust

Appendix A.2 Patient Information Leaflet (page 1)

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

Patient information

Public Health Agency

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.

Appendix A.2 Patient Information Leaflet (page 2)

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 first survey to be carried out across all European countries. The survey will take place in hospitals in Northern Ireland in June 2012.

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.

Appendix A.3 Hospital Staff Information Leaflet (page 1)

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

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

Healthcare staff information leaflet

HSC Public Health Agency

Appendix A.3 Hospital Staff Information Leaflet (page 2)

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 first 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 June 2012. The PPS in NI is coordinated by the Public Health Agency (PHA), the agency responsible for the monitoring of infectious diseases and antimicrobial use here.

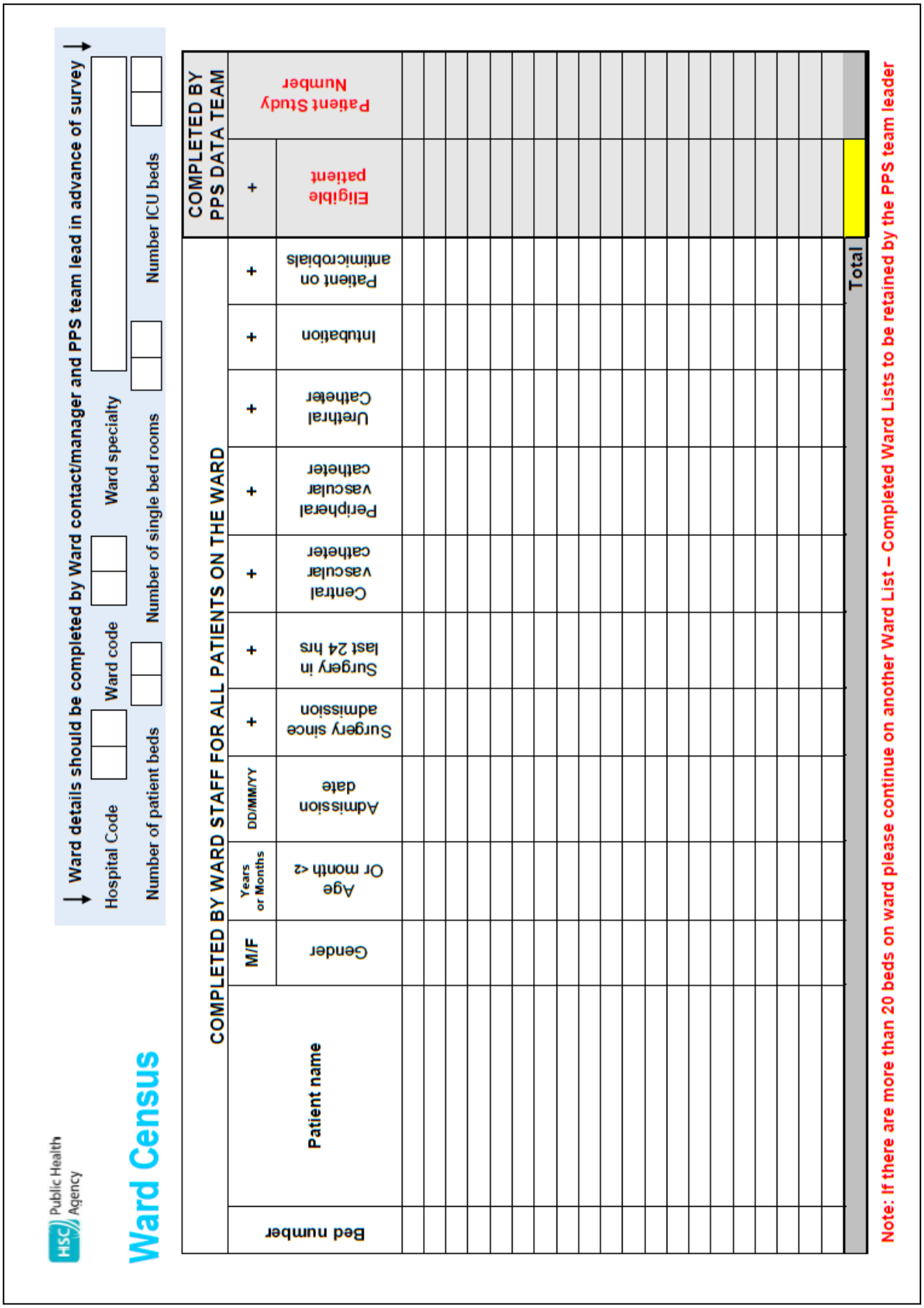
What data will be collected?

- 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 2012 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 June 2012.
- 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 admitted to 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



Appendix A.5 Patient Form (page 1)

Public Health Agency

PATIENT FORM
SURVEY OF HOSPITAL-ACQUIRED INFECTIONS & ANTIMICROBIAL USE

Survey date D D / M M / Y Y

1. Patient details

Hospital code | Ward code | Patient ID

Unique identifier

Ward specialty

Consultant specialty

Age in years

If < 2 years old, age in months

Admission date D D / M M / Y Y

Gender ☐ Male ☐ Female

2. Risk factors

Surgery since admission ☐ No ☐ Yes → *Surgical procedure*

Central vascular catheter ☐ No ☐ Yes

Peripheral vascular catheter ☐ No ☐ Yes

Urethral catheter ☐ No ☐ Yes

Intubation ☐ No ☐ Yes

Underlying disease prognosis
☐ None/non-fatal disease ☐ End of life prognosis
☐ Life limiting prognosis ☐ Not known

3. Condition of interest

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

4. Antimicrobial use (if more than 2 antimicrobials, use extension sheet)

First Antimicrobial

Route ☐ Parenteral ☐ Oral ☐ Rectal ☐ Inhalation

Reason recorded in notes ☐ No ☐ Yes ☐ Unknown

Indication

Diagnosis site code

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

Second Antimicrobial

Route ☐ Parenteral ☐ Oral ☐ Rectal ☐ Inhalation

Reason recorded in notes ☐ No ☐ Yes ☐ Unknown

Indication

Diagnosis site code

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

Appendix A.5 Patient Form (page 2)

5. Hospital-acquired infection data (HAI)

HAI 1

Infection

If SSI, record the site

Source of BSI

Relevant device in situ before onset ☐ Yes ☐ No

Present at admission ☐ Yes ☐ No

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

Date of onset D D / M M / Y Y

Microorganism 1 Resistance 1

Microorganism 2 Resistance 2

Microorganism 3 Resistance 3

HAI 2

Infection

If SSI, record the site

Source of BSI

Relevant device in situ before onset ☐ Yes ☐ No

Present at admission ☐ Yes ☐ No

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

Date of onset D D / M M / Y Y

Microorganism 1 Resistance 1

Microorganism 2 Resistance 2

Microorganism 3 Resistance 3

HAI 3

Infection

If SSI, record the site

Source of BSI

Relevant device in situ before onset ☐ Yes ☐ No

Present at admission ☐ Yes ☐ No

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

Date of onset D D / M M / Y Y

Microorganism 1 Resistance 1

Microorganism 2 Resistance 2

Microorganism 3 Resistance 3

Appendix A.6 Hospital Form

HSC Public Health Agency

Hospital Form

SURVEY OF HOSPITAL-ACQUIRED INFECTIONS AND ANTIMICROBIAL USE

Hospital

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

The information below can be taken from official hospital data returns
e.g http://www.dhsspsni.gov.uk/index/stats_research/hospital-stats/inpatients.htm

Hospital size (total number of beds)

Number of acute care beds

Number of admissions **Year** e.g. '11' for 2011/12

Number of patient days **Year**

Alcohol hand rub consumption (litres) **Year**

WTE infection control nurses (e.g. 5.25) **Year**

WTE infection control doctors

Any exclusion of wards for PPS? ☐ No ☐ Yes

If Yes, list wards that have been excluded (type ward name)

The information below is taken from aggregating each of the Ward Census forms

Number of ICU beds

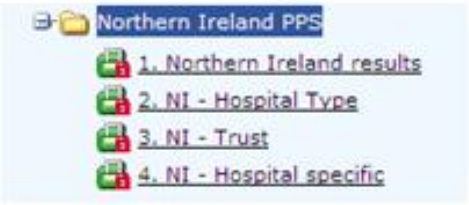
Total number of beds in included wards

Total number of patients included in PPS

Number of single patient rooms in PPS

Appendix A.7 Suite of reports available to participating hospitals

Series of reports:



Suite of reports within each series:

No.	Description
1	Prevalence of Hospital-acquired Infections and Antimicrobial Use
2	Hospital-acquired Infections and Antimicrobial Use - Numbers per patient
3	Ward specialty groups
4	Gender and Age groups
5	Gender and Ward Specialty
6	Patient risk factors and Ward Specialty
7	Hospital-acquired infection - Patient characteristics
8	Hospital-acquired infection - Distribution of HAI groups
9	Hospital-acquired infection - SSI and Device-Associated Infections
10	Hospital-acquired infection - Onset and Origin
11	Hospital-acquired infection - Prevalence by Ward specialty and Gender
12	Antimicrobial use - Patient characteristics
13	Antimicrobial use - Agents ATC 4th level and Route
14	Antimicrobial use - Agents ATC 5th level
15	Antimicrobial use - Indication for use and quality indicators
16	Antimicrobial use - Surgical prophylaxis
17	Antimicrobial use - Age groups
18	Antimicrobial use - Ward Specialty
19	Micro-organisms isolated
20	Microbiology and antimicrobial resistance

Report example:

Prevalence survey of hospital acquired infection and antimicrobial prescribi

Northern Ireland Results

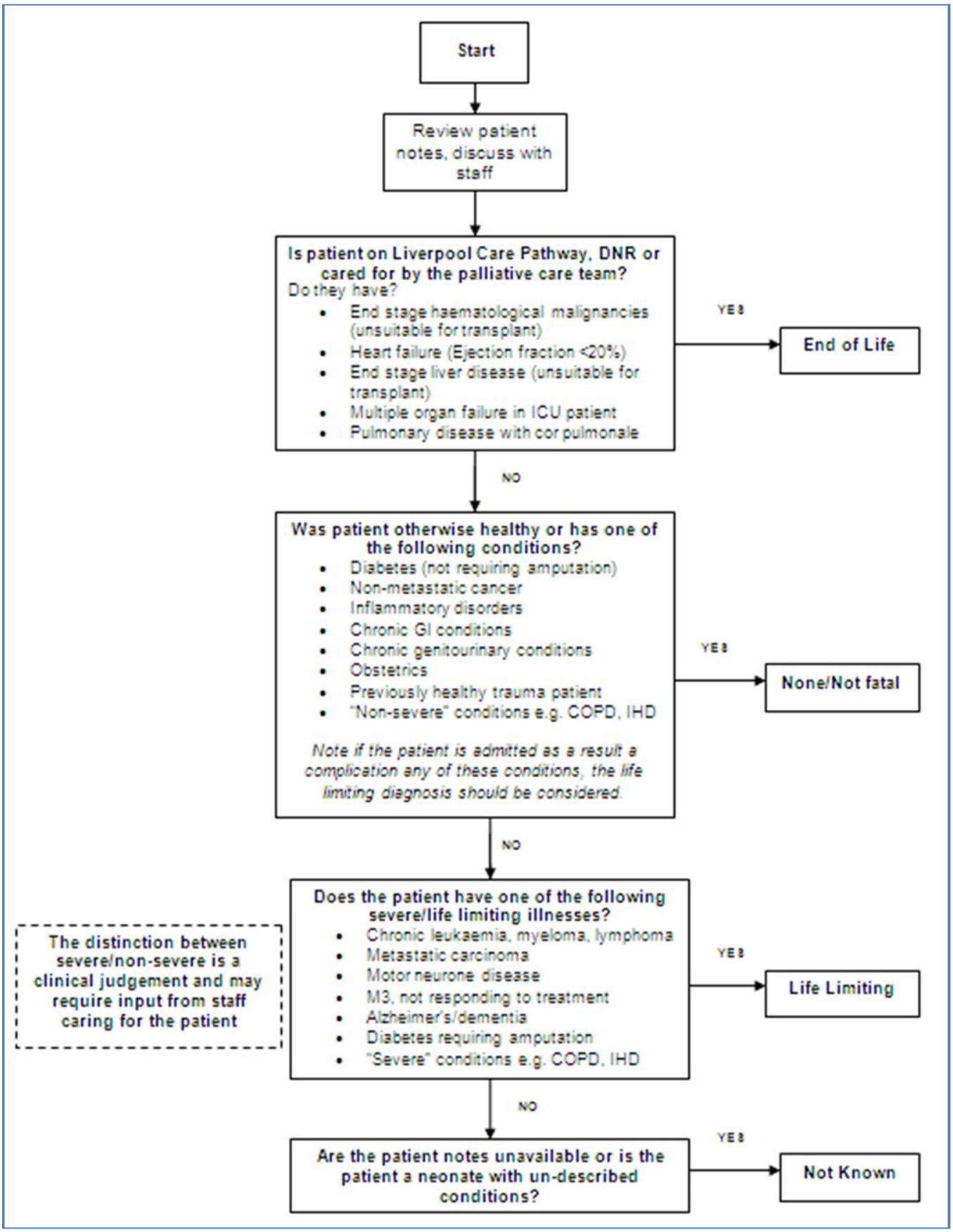
Table: Prevalence of Hospital-acquired Infections and Antimicrobial Use

Last populated: 11:18 - 21/09/2012
Produced by Health Protection Team, Public Health Agency, Belfast.

Hospital-acquired Infection	
Total patients surveyed	3992 100.00%
Number of patients with Hospital-acquired Infections (HAI) / Prevalence	166 4.16%
Antimicrobial use	
Patients receiving antimicrobials / Prevalence	1178 29.51%

Cell Contents:
- Count
- Column Percentage

Appendix A.8 Underlying disease prognosis



Appendix A.9 Algorithm for the definition of Hospital-Acquired Infection

Onset of HAI		Case Definition
All HAI types *Day 3 onwards*		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 one year after surgery is also considered and the patient either has symptoms that meet the case definition and/or is on antimicrobial treatment for infection.*	AND	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 *Active neonate infection whilst in hospital*		
OR		
Breast abscess *Occurring within seven days of childbirth*		

Appendix B Table I

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	**166**	**4.2% (3.6-4.8)**	**169**	**100%**
Pneumonia	41	1.0% (0.7-1.4)	41	24.3%
PN1 (Pneumonia, clinical + positive quantitative culture from minir	1	0.0% (0.0-0.1)	1	0.6%
PN4 (Pneumonia, clinical + positive sputum culture or non-quantit	12	0.3% (0.2-0.5)	12	7.1%
PN5 (Pneumonia - Clinical signs of pneumonia without positive mi	28	0.7% (0.5-1.0)	28	16.6%
Other lower respiratory tract inf.	6	0.2% (0.1-0.3)	6	3.6%
LRI-BRON (Bronchitis, tracheobronchitis, bronchiolitis, tracheitis, v	1	0.0% (0.0-0.1)	1	0.6%
LRI-LUNG (Other infections of the lower respiratory tract)	5	0.1% (0.0-0.3)	5	3.0%
Surgical site infections	32	0.8% (0.5-1.1)	32	18.9%
SSI-S (Surgical site infection, Superficial incisional)	10	0.3% (0.1-0.5)	10	5.9%
SSI-D (Surgical site infection, Deep incisional)	14	0.4% (0.2-0.6)	14	8.3%
SSI-O (Surgical site infection, Organ/Space)	8	0.2% (0.1-0.4)	8	4.7%
Urinary tract infections	20	0.5% (0.3-0.8)	20	11.8%
UTI-A (symptomatic urinary tract infection, microbiologically confi	11	0.3% (0.1-0.5)	11	6.5%
UTI-B (symptomatic urinary tract infection, not microbiologically c	9	0.2% (0.1-0.4)	9	5.3%
Bloodstream infections	15	0.4% (0.2-0.6)	15	8.9%
BSI (Bloodstream infection (laboratory-confirmed) , other than CR	13	0.3% (0.2-0.6)	13	7.7%
CRI3-CVC (Microbiologically confirmed CVC-related bloodstream i	2	0.1% (0.0-0.2)	2	1.2%
Catheter-related infections w/o BSI	2	0.1% (0.0-0.2)	2	1.2%
CRI2-CVC (General CVC-related infection (no positive blood cultur	2	0.1% (0.0-0.2)	2	1.2%
Cardiovascular system infections	1	0.0% (0.0-0.1)	1	0.6%
CVS-VASC (Arterial or venous infection)	1	0.0% (0.0-0.1)	1	0.6%
Gastro-intestinal system infections	15	0.4% (0.2-0.6)	15	8.9%
GI-CDI (Clostridium difficile infection)	8	0.2% (0.1-0.4)	8	4.7%
GI-GIT (Gastrointestinal tract (esophagus, stomach, small and lar	1	0.0% (0.0-0.1)	1	0.6%
GI-IAB (Intraabdominal infection, not specified elsewhere)	6	0.2% (0.1-0.3)	6	3.6%
Skin and soft tissue infections	10	0.3% (0.1-0.5)	10	5.9%
SST-SKIN (Skin infection)	6	0.2% (0.1-0.3)	6	3.6%
SST-ST (Soft tissue (necrotizing fascitis, infectious gangrene, nec	3	0.1% (0.0-0.2)	3	1.8%
SST-BRST (Breast abscess or mastitis)	1	0.0% (0.0-0.1)	1	0.6%
Bone and joint infections	2	0.1% (0.0-0.2)	2	1.2%
BJ-JNT (Joint or bursa)	1	0.0% (0.0-0.1)	1	0.6%
BJ-DISC (Disc space infection)	1	0.0% (0.0-0.1)	1	0.6%
Central nervous system infections	3	0.1% (0.0-0.2)	3	1.8%
CNS-IC (Intracranial infection)	2	0.1% (0.0-0.2)	2	1.2%
CNS-MEN (Meningitis or ventriculitis)	1	0.0% (0.0-0.1)	1	0.6%
Eye, Ear, Nose or Mouth infection	2	0.1% (0.0-0.2)	2	1.2%
EENT-ORAL (Oral cavity (mouth, tongue, or gums))	2	0.1% (0.0-0.2)	2	1.2%
Systemic infections	20	0.5% (0.3-0.8)	20	11.8%
SYS-CSEP (Clinical sepsis in adults and children)	20	0.5% (0.3-0.8)	20	11.8%

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

Table II Acute Hospital SSI and related surgical procedure		
	Number	Percent
ENT/Neck Surgery	2	6.3
General-Abdominal Surgery	9	28.1
General-Bile duct- liver or pancreatic surgery	1	3.1
General-Colon surgery	3	9.4
General-Gallbladder Surgery	1	3.1
General-Herniorrhaphy	1	3.1
Ortho-Hip prosthesis	4	12.5
Ortho-Open reduction of fracture	1	3.1
Ortho-Spinal Fusion	2	6.3
Thoracic Surgery	2	6.3
Urology-Kidney Transplant	1	3.1
Vascular-Limb amputation	1	3.1
Vascular-Peripheral vascular bypass surgery	1	3.1
Unknown	3	9.4
Total	32	100

Appendix B Table III

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	3992	100.0%	166	4.2%	1178	29.5%
Age						
<1y	186	4.7%	3	1.6%	23	12.4%
1-4y	126	3.2%	9	7.1%	40	31.7%
5-14y	59	1.5%	1	1.7%	19	32.2%
15-24y	185	4.6%	5	2.7%	46	24.9%
25-34y	277	6.9%	7	2.5%	75	27.1%
35-44y	263	6.6%	7	2.7%	60	22.8%
45-54y	366	9.2%	14	3.8%	97	26.5%
55-64y	464	11.6%	29	6.3%	161	34.7%
65-74y	672	16.8%	33	4.9%	249	37.1%
75-84y	837	21.0%	35	4.2%	236	28.2%
>=85y	556	13.9%	23	4.1%	171	30.8%
Missing/Unk	1	0.0%	0	0.0%	1	100.0%
Gender						
F	2169	54.3%	81	3.7%	591	27.2%
M	1823	45.7%	85	4.7%	587	32.2%
Length of stay (7)						
1-3d	1338	33.5%	32	2.4%	362	27.1%
4-7d	981	24.6%	35	3.6%	386	39.3%
8-14d	714	17.9%	42	5.9%	218	30.5%
>=3w	949	23.8%	56	5.9%	210	22.1%
Missing/Unk	10	0.3%	1	10.0%	2	20.0%
Surgery since admission						
No surgey	3286	82.3%	111	3.4%	918	27.9%
NHSN surgery	533	13.4%	46	8.6%	184	34.5%
Non-NHSN/minimal surgery	131	3.3%	7	5.3%	58	44.3%
Missing/Unk	42	1.1%	2	4.8%	18	42.9%
McCabe score						
Non fatal disease	2792	69.9%	83	3.0%	720	25.8%
Ultimately fatal disease	844	21.1%	59	7.0%	340	40.3%
Rapidly fatal disease	109	2.7%	9	8.3%	42	38.5%
Missing/Unk	247	6.2%	15	6.1%	76	30.8%
Central vascular catheter						
No	3792	95.0%	125	3.3%	1047	27.6%
Yes	200	5.0%	41	20.5%	131	65.5%
Peripheral vascular catheter						
No	2259	56.6%	56	2.5%	376	16.6%
Yes	1733	43.4%	110	6.3%	802	46.3%
Urinary catheter						
No	3311	82.9%	102	3.1%	870	26.3%
Yes	681	17.1%	64	9.4%	308	45.2%
Intubation						
No	3895	97.6%	150	3.9%	1125	28.9%
Yes	97	2.4%	16	16.5%	53	54.6%

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 IV (part 1)

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	1751	100.0%	1410	100.0%	122	100.0%	116	100.0%
A07AA (Intestinal antiinfectives, antibi	**17**	**1.0%**	**13**	**0.9%**	**0**	**0.0%**	**3**	**2.6%**
A07AA02 (Nystatin)	5	0.3%	2	0.1%	0	0.0%	3	2.6%
A07AA09 (Vancomycin (oral))	11	0.6%	10	0.7%	0	0.0%	0	0.0%
A07AA10 (Colistin (oral))	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J01AA (Tetracyclines)	**50**	**2.9%**	**45**	**3.2%**	**0**	**0.0%**	**2**	**1.7%**
J01AA02 (Doxycycline)	41	2.3%	39	2.8%	0	0.0%	1	0.9%
J01AA04 (Lymecycline)	1	0.1%	0	0.0%	0	0.0%	0	0.0%
J01AA06 (Oxytetracycline)	1	0.1%	0	0.0%	0	0.0%	0	0.0%
J01AA07 (Tetracycline)	1	0.1%	0	0.0%	0	0.0%	1	0.9%
J01AA08 (Minocycline)	2	0.1%	2	0.1%	0	0.0%	0	0.0%
J01AA12 (Tigecycline)	4	0.2%	4	0.3%	0	0.0%	0	0.0%
J01BA (Amphenicols)	**1**	**0.1%**	**1**	**0.1%**	**0**	**0.0%**	**0**	**0.0%**
J01BA01 (Chloramphenicol)	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J01CA (Penicillins, extended spectrum w	131	7.6%	117	8.4%	1	0.8%	1	0.9%
J01CA01 (Ampicillin)	2	0.1%	1	0.1%	0	0.0%	0	0.0%
J01CA04 (Amoxicillin)	127	7.3%	114	8.1%	1	0.8%	1	0.9%
J01CA11 (Mecillinam)	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J01CA13 (Ticarcillin)	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J01CE (Beta-lactamase sensitive penicilli	**41**	**2.3%**	**28**	**2.0%**	**6**	**4.9%**	**6**	**5.2%**
J01CE01 (Benzylpenicillin)	32	1.8%	21	1.5%	6	4.9%	4	3.4%
J01CE02 (Phenoxymethylpenicillin)	5	0.3%	3	0.2%	0	0.0%	2	1.7%
J01CE08 (Benzathine benzylpenicillin)	4	0.2%	4	0.3%	0	0.0%	0	0.0%
J01CF (Beta-lactamase resistant penicilli	**96**	**5.5%**	**78**	**5.5%**	**14**	**11.5%**	**2**	**1.7%**
J01CF05 (Flucloxacillin)	96	5.5%	78	5.5%	14	11.5%	2	1.7%
J01CR (Combinations of penicillins, incl.	**529**	**30.2%**	**441**	**31.2%**	**51**	**41.8%**	**13**	**11.2%**
J01CR02 (Amoxicillin and enzyme inhibitor)	218	12.4%	152	10.9%	46	37.7%	6	5.2%
J01CR05 (Piperacillin and enzyme inhibitor)	311	17.8%	287	20.3%	5	4.1%	7	6.0%
J01DB (First-generation cephalosporins)	**7**	**0.4%**	**1**	**0.1%**	**0**	**0.0%**	**5**	**4.3%**
J01DB01 (Cefalexin)	7	0.4%	1	0.1%	0	0.0%	5	4.3%
J01DC (Second-generation cephalospor	**8**	**0.5%**	**1**	**0.1%**	**7**	**5.7%**	**0**	**0.0%**
J01DC02 (Cefuroxime)	7	0.4%	0	0.0%	7	5.7%	0	0.0%
J01DC04 (Cefaclor)	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J01DD (Third-generation cephalosporins	**35**	**2.0%**	**28**	**2.0%**	**0**	**0.0%**	**3**	**2.6%**
J01DD01 (Cefotaxime)	13	0.7%	10	0.7%	0	0.0%	1	0.9%
J01DD02 (Ceftazidime)	8	0.5%	8	0.6%	0	0.0%	0	0.0%
J01DD04 (Ceftriaxone)	14	0.8%	10	0.7%	0	0.0%	2	1.7%
J01DF (Monobactams)	**17**	**1.0%**	**16**	**1.1%**	**0**	**0.0%**	**1**	**0.9%**
J01DF01 (Aztreonam)	17	1.0%	16	1.1%	0	0.0%	1	0.9%
J01DH (Carbapenems)	**74**	**4.2%**	**70**	**5.0%**	**1**	**0.8%**	**0**	**0.0%**
J01DH02 (Meropenem)	71	4.1%	68	4.8%	0	0.0%	0	0.0%
J01DH03 (Ertapenem)	3	0.2%	2	0.1%	1	0.8%	0	0.0%
J01EA (Trimethoprim and derivatives)	**34**	**1.9%**	**26**	**1.8%**	**0**	**0.0%**	**6**	**5.2%**
J01EA01 (Trimethoprim)	34	1.9%	26	1.8%	0	0.0%	6	5.2%
J01ED (Long-acting sulfonamides)	**1**	**0.1%**	**0**	**0.0%**	**0**	**0.0%**	**1**	**0.9%**
J01ED20 (Combinations of long-acting sulfo	1	0.1%	0	0.0%	0	0.0%	1	0.9%

LEGEND:

Trt: treatment intention, SP: surgical prophylaxis, MP: medical prophylaxis

Appendix B Table IV (part 2)

Table IV Antimicrobial agents (ATC4 and ATC5) by indication Page 2 of 2	Total UK-NI (n=16)							
	Total	%	Trt	%	SP	%	MP	%
J01EE (Combinations of sulfonamides ar	**29**	**1.7%**	**5**	**0.4%**	**2**	**1.6%**	**22**	**19.0%**
J01EE01 (Sulfamethoxazole and trimethopr	29	1.6%	5	0.4%	2	1.6%	22	19.0%
J01FA (Macrolides)	**123**	**7.0%**	**100**	**7.1%**	**1**	**0.8%**	**11**	**9.5%**
J01FA01 (Erythromycin)	9	0.5%	0	0.0%	1	0.8%	4	3.4%
J01FA09 (Clarithromycin)	102	5.8%	96	6.8%	0	0.0%	0	0.0%
J01FA10 (Azithromycin)	12	0.7%	4	0.3%	0	0.0%	7	6.0%
J01FF (Lincosamides)	**23**	**1.3%**	**21**	**1.5%**	**2**	**1.6%**	**0**	**0.0%**
J01FF01 (Clindamycin)	23	1.3%	21	1.5%	2	1.6%	0	0.0%
J01GB (Aminoglycosides)	**121**	**6.9%**	**91**	**6.5%**	**21**	**17.2%**	**5**	**4.3%**
J01GB01 (Tobramycin)	9	0.5%	9	0.6%	0	0.0%	0	0.0%
J01GB03 (Gentamicin)	103	5.9%	73	5.2%	21	17.2%	5	4.3%
J01GB06 (Amikacin)	9	0.5%	9	0.6%	0	0.0%	0	0.0%
J01MA (Fluoroquinolones)	**73**	**4.2%**	**66**	**4.7%**	**2**	**1.6%**	**0**	**0.0%**
J01MA02 (Ciprofloxacin)	54	3.1%	49	3.5%	1	0.8%	0	0.0%
J01MA12 (Levofloxacin)	18	1.0%	16	1.1%	1	0.8%	0	0.0%
J01MA14 (Moxifloxacin)	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J01RA (Combinations of antibacterials)	**1**	**0.1%**	**1**	**0.1%**	**0**	**0.0%**	**0**	**0.0%**
J01RA01 (Penicillins, combinations with oth	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J01XA (Glycopeptide antibacterials)	**94**	**5.4%**	**81**	**5.7%**	**4**	**3.3%**	**1**	**0.9%**
J01XA01 (Vancomycin (parenteral))	28	1.6%	25	1.8%	0	0.0%	0	0.0%
J01XA02 (Teicoplanin)	66	3.8%	56	4.0%	4	3.3%	1	0.9%
J01XB (Polymyxins)	**4**	**0.2%**	**2**	**0.1%**	**0**	**0.0%**	**2**	**1.7%**
J01XB01 (Colistin (injection, infusion))	4	0.2%	2	0.1%	0	0.0%	2	1.7%
J01XC (Steroid antibacterials)	**19**	**1.1%**	**16**	**1.1%**	**0**	**0.0%**	**0**	**0.0%**
J01XC01 (Fusidic acid)	19	1.1%	16	1.1%	0	0.0%	0	0.0%
J01XD (Imidazole derivatives)	**75**	**4.3%**	**57**	**4.0%**	**9**	**7.4%**	**1**	**0.9%**
J01XD01 (Metronidazole (parenteral))	75	4.3%	57	4.0%	9	7.4%	1	0.9%
J01XE (Nitrofuran derivatives)	**19**	**1.1%**	**13**	**0.9%**	**0**	**0.0%**	**6**	**5.2%**
J01XE01 (Nitrofurantoin)	19	1.1%	13	0.9%	0	0.0%	6	5.2%
J01XX (Other antibacterials)	**16**	**0.9%**	**16**	**1.1%**	**0**	**0.0%**	**0**	**0.0%**
J01XX08 (Linezolid)	12	0.7%	12	0.9%	0	0.0%	0	0.0%
J01XX09 (Daptomycin)	4	0.2%	4	0.3%	0	0.0%	0	0.0%
J02AA (Antimycotics, antibiotics)	**12**	**0.7%**	**5**	**0.4%**	**0**	**0.0%**	**5**	**4.3%**
J02AA01 (Amphotericin B (parenteral))	12	0.7%	5	0.4%	0	0.0%	5	4.3%
J02AC (Triazole derivatives)	**41**	**2.3%**	**22**	**1.6%**	**0**	**0.0%**	**17**	**14.7%**
J02AC01 (Fluconazole)	29	1.7%	21	1.5%	0	0.0%	7	6.0%
J02AC02 (Itraconazole)	1	0.1%	0	0.0%	0	0.0%	1	0.9%
J02AC04 (Posaconazole)	11	0.6%	1	0.1%	0	0.0%	9	7.8%
J02AX (Other antimycotics for systemic	**9**	**0.5%**	**8**	**0.6%**	**0**	**0.0%**	**1**	**0.9%**
J02AX04 (Caspofungin)	5	0.3%	4	0.3%	0	0.0%	1	0.9%
J02AX05 (Micafungin)	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J02AX06 (Anidulafungin)	3	0.2%	3	0.2%	0	0.0%	0	0.0%
J04AB (Antimycobacterials, antibiotics)	**13**	**0.7%**	**12**	**0.9%**	**0**	**0.0%**	**0**	**0.0%**
J04AB02 (Rifampicin)	13	0.7%	12	0.9%	0	0.0%	0	0.0%
J04AC (Hydrazides)	**1**	**0.1%**	**1**	**0.1%**	**0**	**0.0%**	**0**	**0.0%**
J04AC01 (Isoniazid)	1	0.1%	1	0.1%	0	0.0%	0	0.0%
J04AK (Other drugs for treatment of tu	**1**	**0.1%**	**1**	**0.1%**	**0**	**0.0%**	**0**	**0.0%**
J04AK02 (Ethambutol)	1	0.1%	1	0.1%	0	0.0%	0	0.0%
P01AB (Nitroimidazole derivatives)	**36**	**2.1%**	**27**	**1.9%**	**1**	**0.8%**	**2**	**1.7%**
P01AB01 (Metronidazole (oral, rectal))	36	2.1%	27	1.9%	1	0.8%	2	1.7%

LEGEND:
Trt: treatment intention, SP: surgical prophylaxis, MP: medical prophylaxis

Appendix B Table V

Table V Antimicrobial treatment diagnosis site by indication						
	Total UK-NI (n=16)					
	Total	%	CI	%	HI	%
Total N of diagnoses (N of infections)	971	100.0%	731	100.0%	213	100.0%
Respiratory tract	375	38.6%	277	37.9%	84	39.4%
PNEU (Pneumonia)	298	30.7%	206	28.2%	81	38.0%
BRON (Acute bronchitis or exacerbations of chronic bronchitis)	77	7.9%	71	9.7%	3	1.4%
Urinary tract	140	14.4%	112	15.3%	23	10.8%
CYS (Symptomatic Lower UTI)	70	7.2%	53	7.3%	15	7.0%
PYE (Symptomatic Upper UTI)	69	7.1%	59	8.1%	7	3.3%
ASB (Asymptomatic bacteriuria)	1	0.1%	0	0.0%	1	0.5%
Systemic infections	140	14.4%	99	13.5%	36	16.9%
BAC (Lab-confirmed bacteraemia)	27	2.8%	15	2.1%	12	5.6%
CSEP (Clinical sepsis (suspected bloodstream infection without lab	44	4.5%	35	4.8%	7	3.3%
FN (Febrile Neutropaenia or other form of manifestation of infecti	32	3.3%	21	2.9%	11	5.2%
SIRS (Systemic inflammatory response with no clear anatomic site	26	2.7%	20	2.7%	5	2.3%
UND (Completely undefined, site with no systemic inflammation)	11	1.1%	8	1.1%	1	0.5%
Cardiovascular system	10	1.0%	8	1.1%	2	0.9%
Gastro-intestinal system	132	13.6%	105	14.4%	27	12.7%
GI (GI infections (salmonellosis, antibiotic associated diarrhoea))	35	3.6%	24	3.3%	11	5.2%
IA (Intraabdominal sepsis including hepatobiliary)	97	10.0%	81	11.1%	16	7.5%
Skin/soft tissue/bone/joint	143	14.7%	105	14.4%	35	16.4%
SST (Cellulitis, wound, deep soft tissue not involving bone)	101	10.4%	71	9.7%	27	12.7%
BJ (Septic arthritis (including prosthetic joint), osteomyelitis)	42	4.3%	34	4.7%	8	3.8%
Central nervous system	13	1.3%	11	1.5%	2	0.9%
Eye/ear/nose/throat	14	1.4%	11	1.5%	3	1.4%
Genito-urinary system/obs.	4	0.4%	3	0.4%	1	0.5%
Missing/Unknown	0	0.0%	0	0.0%	0	0.0%
LEGEND:						
CI: treatment intention for community infection						
HI: treatment intention for hospital infection						

Appendix B Table VI

Table VI Distribution of microorganisms isolated in HAI

	Total		PN/LRI(1)		SSI		UTI		BSI(2)		GI(3)	
N of HAI, all	169		47		32		20		15		15	
N of HAI with microorganisms, all	78	46.2%	12	25.5%	19	59.4%	9	45.0%	14	93.3%	11	73.3%
N of microorganisms	99	100.0%	12	100.0%	29	100.0%	10	100.0%	16	100.0%	14	100.0%
GRAM-POSITIVE COCCI	35	35.4%	3	25.0%	13	44.8%	1	10.0%	6	37.5%	2	14.3%
STAPHYLOCOCCUS AUREUS	14	14.1%	3	25.0%	4	13.8%	0	0.0%	3	18.8%	0	0.0%
COAG.-NEG. STAPHYLOCOCCI	7	7.1%	0	0.0%	2	6.9%	0	0.0%	3	18.8%	1	7.1%
STREPTOCOCCUS SPP.	2	2.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
ENTEROCOCCUS SPP.	12	12.1%	0	0.0%	7	24.1%	1	10.0%	0	0.0%	1	7.1%
GRAM-NEGATIVE COCCI	2	2.0%	1	8.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
GRAM-POSITIVE BACILLI	4	4.0%	0	0.0%	2	6.9%	0	0.0%	1	6.3%	0	0.0%
ENTEROBACTERIACEAE	27	27.3%	3	25.0%	7	24.1%	6	60.0%	6	37.5%	2	14.3%
CITROBACTER SPP.	2	2.0%	0	0.0%	0	0.0%	0	0.0%	2	12.5%	0	0.0%
ENTEROBACTER SPP.	2	2.0%	0	0.0%	2	6.9%	0	0.0%	0	0.0%	0	0.0%
ESCHERICHIA COLI	8	8.1%	1	8.3%	2	6.9%	0	0.0%	2	12.5%	1	7.1%
KLEBSIELLA SPP.	3	3.0%	1	8.3%	1	3.4%	0	0.0%	1	6.3%	0	0.0%
PROTEUS SPP.	10	10.1%	0	0.0%	2	6.9%	5	50.0%	1	6.3%	1	7.1%
SERRATIA SPP.	1	1.0%	1	8.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
OTHER ENTEROBACTERIACEAE	1	1.0%	0	0.0%	0	0.0%	1	10.0%	0	0.0%	0	0.0%
GRAM-NEG., NON-ENTEROBACTERIACEAE	13	13.1%	5	41.7%	2	6.9%	3	30.0%	1	6.3%	1	7.1%
PSEUDOMONAS AERUGINOSA	4	4.0%	2	16.7%	0	0.0%	1	10.0%	0	0.0%	1	7.1%
STENOTROPHOMONAS MALTOPHILIA	1	1.0%	0	0.0%	0	0.0%	0	0.0%	1	6.3%	0	0.0%
PSEUDOMONADACEAE FAMILY, OTHER	4	4.0%	2	16.7%	1	3.4%	0	0.0%	0	0.0%	0	0.0%
HAEMOPHILUS SPP.	1	1.0%	1	8.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
OTH. NON-ENTEROBACTERIACEAE	3	3.0%	0	0.0%	1	3.4%	2	20.0%	0	0.0%	0	0.0%
ANAEROBIC BACILLI	10	10.1%	0	0.0%	1	3.4%	0	0.0%	0	0.0%	8	57.1%
CLOSTRIDIUM DIFFICILE	8	8.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	8	57.1%
OTHER ANAEROBES	2	2.0%	0	0.0%	1	3.4%	0	0.0%	0	0.0%	0	0.0%
FUNGI	8	8.1%	0	0.0%	4	13.8%	0	0.0%	2	12.5%	1	7.1%
CANDIDA SPP.	7	7.1%	0	0.0%	3	10.3%	0	0.0%	2	12.5%	1	7.1%
OTHER PARASITES	1	1.0%	0	0.0%	1	3.4%	0	0.0%	0	0.0%	0	0.0%
NEGATIVE CODES(4)	91	53.8%	35	74.5%	13	40.6%	11	55.0%	1	6.7%	4	26.7%
MICRO-ORGANISM NOT IDENTIFIED	14	8.3%	6	12.8%	2	6.3%	3	15.0%	1	6.7%	0	0.0%
EXAMINATION NOT DONE	17	10.1%	9	19.1%	4	12.5%	1	5.0%	0	0.0%	0	0.0%
STERILE EXAMINATION	5	3.0%	0	0.0%	0	0.0%	1	5.0%	0	0.0%	2	13.3%
NOT (YET) AVAILABLE/MISSING	55	32.5%	20	42.6%	7	21.9%	6	30.0%	0	0.0%	2	13.3%

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

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