National Point Prevalence Survey of Healthcare Associated Infection, Device Usage and Antimicrobial Prescribing 2017

Wales

HCAI and AMR Programme

GIG CYMRU NHS WALES
Iechyd Cyhoeddus Cymru
Public Health Wales

The Healthcare Associated Infection and Antimicrobial Resistance Programme can be accessed via the Public Health Wales website: http://www.publichealthwales.wales.nhs.uk/

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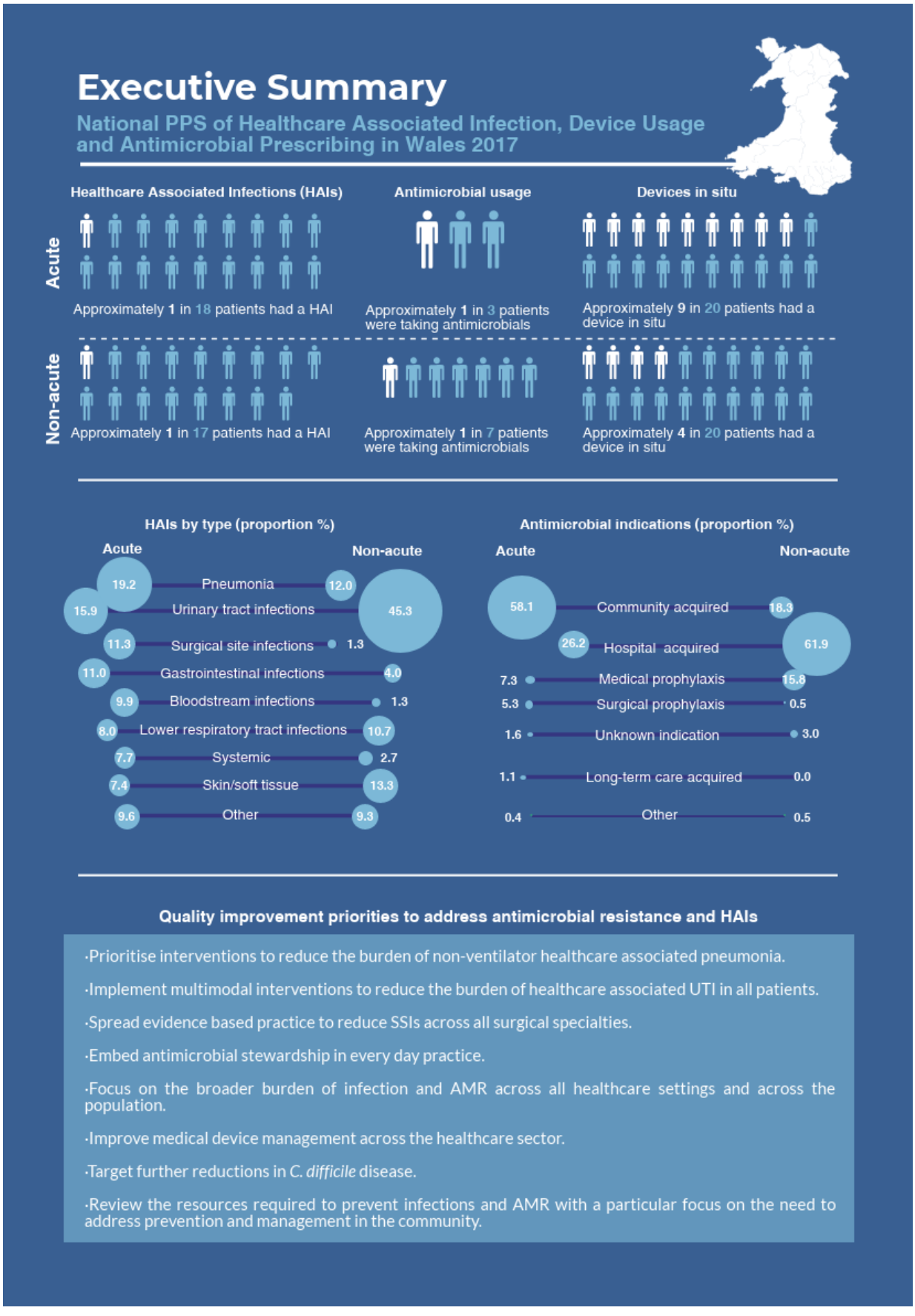
Glossary

ABMU	Abertawe Bro Morgannwg University Health Board
AM	Antimicrobial
AMR	Antimicrobial resistance
BSI	Bloodstream infection
CAUTI	Catheter associated urinary tract infection
COI	Community onset infections
CI	Confidence intervals
CNS	Central nervous system
CRI	Catheter related infection
CRI-CVC	Catheter related infection (central vascular catheter)
CRI-PVC	Catheter related infection (peripheral vascular catheter)
CVC	Central vascular catheter
CVS	Cardiovascular system
ECDC	European Centre for Disease Prevention and Control
ENT	Ear, nose, throat
EU	European Union
GI	Gastrointestinal infection
HAI	Healthcare associated infection
HALT	Healthcare associated infections in long-term care facilities
IP&C	Infection prevention and control
ICU	Intensive care unit
IQR	Inter-quartile range
LRT	Lower respiratory tract
MDRO	Multi-drug resistant organism
NHS	National Health Service
PPS	Point prevalence survey
PHW	Public Health Wales
PPS	Point prevalence survey
PVC	Peripheral vascular catheter
RTI	Respiratory tract infection
SSI	Surgical site infection
UTI	Urinary tract infection
VAP	Ventilator associated pneumonia
WHO	World Health Organisation
WTE	Whole time equivalent

Executive Summary



Survey characteristics and population

- A total of 7643 patients in 55 hospitals were included in the 2017 survey (21 acute and 34 non-acute hospitals). Patients aged 65 and over made up 67% and 88% of patients within acute and non-acute hospitals, respectively. This increase in the population age was more pronounced in the non-acute sector with a 13% increase in the 65 and over age group since 2011.

Characteristics of HAI in Welsh hospitals 2017

- A total of 364 HAIs were reported in the acute hospitals and 75 in non-acute hospitals (prevalence of 5.5% and 6.0%, respectively). The top three most common infections within the acute hospitals was pneumonia (19.2% of infections), UTIs (15.9%) and SSIs (11.3%). Compared to 2011, pneumonia has risen by approximately 7% (12.4% infections in 2011) and the proportion of SSI has more than halved (23.7% of infections in 2011) while UTI remain similar since 2011.
- In non-acute hospitals, UTIs made up the largest group of HAIs in 2017 and 2011 and has increased by approximately 9% since 2011 accounting for nearly half of all HAIs (45.3% 2017; 36.1% 2011). Pneumonia has more than doubled in prevalence (0.72% prevalence 2017; 0.2% 2011).

- ***Community onset infections being treated within acute and non-acute hospitals:*** During the 2017 survey, data were collected on the total burden of infection within acute hospitals for specific infection types: BSI, UTI, pneumonia and GI. Over two thirds of GIs, UTIs and pneumonia being treated in the acute hospitals were community onset. The total prevalence of pneumonia was 3.5% with HAI pneumonia having a prevalence of 1.1% (community onset 2.4%).

- ***Burden of key infection types and associated antimicrobial prescribing:*** A summary of 5 key infection types (UTI, pneumonia, BSI, SSI, GI) (link here)

- ***Microbiology:*** The most common organism reported in acute hospitals was *Eschericia coli*. (25.2% of isolates). *Staphylococcus aureus* was the second most common reported organism within acute hospitals (11% of isolates).

Device usage in Wales 2017

- Within acute hospitals more than a third of patients had a PVC in situ and approximately one in six had a urinary catheter at the time of the survey. Use of urinary catheter / intubation of patients were significantly ($p<0.05$) lower in the 2017 survey (16.2%/ 1.6%) compared with 2011 (19.2% / 2.5%). Within non-acute hospitals approximately one in six patients had a urinary catheter in situ (17.0%) and this was significantly ($p<0.05$) higher than in the 2011 survey (12.1%).

Antimicrobial usage in Wales 2017

- A total of 2186 patients were prescribed one or more antimicrobials at the time of the survey within the acute sector (prevalence of 34.2%). In the non-acute sector 1243 patients were prescribed antimicrobials (prevalence 14.6%). Over 80% of antimicrobials were prescribed for the treatment of infection. Patient specialties with the highest usage included ICU and paediatrics (acute hospitals) with prescribing rates of 51.1% and 40.5%. In non-acute hospitals medicine had the highest rate (18.7%). Prescribing rates of 36.7% and 9.4% were noted for surgical specialties in acute and non-acute hospitals.

- ***Antimicrobials for treatment of infection:*** The most common reason for treatment was for RTIs in acute hospitals. (76% prescribed for pneumonia). Treatment of skin / bone / soft tissue infections and UTIs were also common. The most commonly prescribed antimicrobials included: piperacillin / tazobactam (14.9%) and co-amoxiclav (11.9%).

- The prescribing pattern was similar within non-acute hospitals. The most commonly prescribed antimicrobials included: doxycycline (14.8%), co-amoxiclav (10.5%), nitrofurantoin (9.9%) and trimethoprim (9.3%).

- ***Antimicrobials for prevention of infection:*** Medical prophylaxis: Within acute hospitals azithromycin (13.3%) was the most commonly prescribed antimicrobial with trimethoprim and cefalexin (21.9%) in non-acute hospitals.

  Surgical prophylaxis: Co-amoxiclav and teicoplanin (16.0%) was the most commonly prescribed (acute hospitals).

- The reason for medical prophylaxis prescribing was documented for over 80% of prescriptions within acute hospitals and 37.5% in non acute hospitals.

1. Introduction

Healthcare-associated infections (HAIs) and antimicrobial resistance (AMR) are a serious public health risk. Estimating the burden of infection and antimicrobial usage is essential to reduce preventable infections and inappropriate antibiotic prescribing.

The scale of the threat of AMR and the need for action was set out in the Lord O'Neill review on AMR [1]. In response to this threat, Wales launched an antimicrobial AMR delivery plan in 2016 [2]. The delivery plan provides a framework for empowering and enabling NHS organisations across Wales to work with partner organisations, patients and the public in meeting Welsh Government expectations in tackling antimicrobial resistance (AMR) and its consequences.

HAI are associated with increased morbidity and mortality and excess costs. As a significant proportion of them are preventable, they are considered to be a marker of quality of patient care [1]. As a result, infection prevention and control is a key priority for the NHS [2]. HAIs can prolong hospital stay, increase resistance of microorganisms to antimicrobials and increase mortality. In Europe, HAIs cause 16 million extra days of hospital stay, 37, 000 attributable deaths and contribute to an additional 110, 000 every year [3].

In 2011 / 2012, the European Centre for Disease Prevention and Control (ECDC) coordinated the first EU-wide point prevalence survey (PPS) (ref). Data were collected on HAIs and antimicrobial use in European hospitals. A total 6% of patients had at least one HAI with pneumonia / lower respiratory tract infections most commonly identified. Over a third of all patients received at least one antimicrobial agent [4]. Wales participated in this European coordinated survey by undertaking a national survey in November 2011. The HAI prevalence within the acute sector was 4.3% with surgical site infections being the highest infection type [5]. Over a third of patients received at least one antimicrobial, in-line with the European prevalence [5].

During 2016 / 2017 the second EU-wide survey of the prevalence of HAI and antimicrobial prescribing was conducted by ECDC. The Welsh Government supported Public Health Wales (PHW) to co-ordinate the participation of all Health Boards in Wales. The survey was conducted during June 2017. The results from the Welsh 2017 survey provide an opportunity for PHW to review the current epidemiology of HAI and antimicrobial prescribing patterns and share findings with Health Boards in Wales. Additional data were collated during the survey on community onset infections. Although not all will be healthcare related they can contribute heavily to the total burden of infection, especially within acute hospitals. Results from this survey will also inform advice to Welsh Government on key priority areas of work around infection reduction, antimicrobial stewardship and quality improvement interventions required to reduce AMR and HAIs.

Aims and objectives

*To conduct a PPS within acute and non-acute hospitals in Wales and report findings at a Wales and Health Board level, s*pecifically to:

- Determine the HAI prevalence as well as the type of infections causing the greatest burden of disease within acute and non-acute hospitals
- To estimate the percentage of community onset infections (COI) contributing to the total burden of infection within acute hospitals
- Determine the prevalence of device usage and estimate device related infections
- Measure antimicrobial prescribing and report on types of antimicrobials prescribed
- Identify priority areas for infection reduction, antimicrobial stewardship and quality improvement interventions to reduce antimicrobial resistance and healthcare associated infections
- Contribute to ECDC EU-wide prevalence survey results for 2016 / 2017

2. Methods

Study design

The PPS was carried out in Welsh hospitals during June 2017. The Welsh Government supported the engagement of NHS Wales in the survey and all acute and non-acute hospitals participated. The study protocol in Wales was developed by PHW using the ECDC protocol for PPS [6].

Data were collected by Health Board staff. This included Infection Prevention and Control nurses, antimicrobial pharmacists and ward pharmacists. Each ward surveyed was completed within one day.

Data capture in Wales was via a PPS tool developed by Baxter, ICNet [7]. This allowed for data to be captured electronically via a web form. In addition any suspected infections could be confirmed as meeting ECDC definitions by using a built-in infection checker available as part of the tool. This allowed for greater consistency on infection data across Wales.

Data were extracted from a number of sources available on the ward at the time of the survey. These included nursing and medical notes, surgical notes, temperature charts, drug charts, laboratory reports (microbiology and haematology results) and care plans.

Further details on the study design can be found in the ECDC protocol [6]. In Wales data were also collected on Community onset Infections (COI) as well as HAIs in acute hospitals.

Training and support

A training package was developed by PHW HAI / AMR programme. Training on PPS data items to be collected and specifically around infection definitions was conducted across Health Boards in Wales. Training was provided on how to access and complete the PPS web form developed. Additional training was provided around using the infection checker. Training was provided to Infection Prevention and Control staff and pharmacists. A train the trainer approach was carried out in order to cascade the necessary information to all staff involved in the PPS.

During the PPS members of the HAI / AMR team were available to support local Health Board teams. In addition a helpline was provided for support with the web tool through ICNet (Baxter).

Inclusion and exclusion criteria

The survey included all NHS acute and non-acute hospitals in Wales, with the exception of mental health hospitals. The inclusion of non-acute hospitals was in addition to the requirements of the ECDC protocol. All wards were included apart from psychiatric, outpatient and A&E departments. As described in the ECDC protocol, patients were only included where they were on the ward at 8am and were still present at the time of survey. Patients who were temporarily off the ward for diagnostic procedures were also included where possible. Day cases and outpatients were excluded.

Data definitions

Full details of the dataset included in the Welsh survey can be found in the User Requirements document for Point Prevalence Survey data capture (using ICNet Enterprise Monitor) [8]. In summary all data items included in the ECDC protocol [6] were included apart from the McCabe score, whether an antimicrobial was changed with reasons (e.g. escalation / de-escalation, switch) and recording of pan-drug resistant microorganisms.

Infection data

HAI

The ECDC definitions for HAI were used to determine the presence of an infection and the infection type [6]. HAI were captured for patients with an active HAI at the time of survey (related to acute or non-acute care hospital stay) and/or receiving an antimicrobial drug at the time of the survey.

An **active HAI** present on the day of the survey is defined as follows:

- An infection is active when signs and symptoms of the infection are present on the survey date *or* signs and symptoms were present in the past and the patient is (still) receiving treatment for that infection on the survey date. The presence of symptoms and signs should be verified until the start of the treatment in order to determine whether the treated infection matches one of the case definitions of healthcare-associated infection.

AND

- The onset of symptoms was on Day 3 or later (day of admission = Day 1) of the current admission *or* the patient presents with an infection but has been readmitted less than 48 hours after a previous admission to an acute care hospital; *or*
- The patient has been admitted (or develops symptoms within two days) with an infection that meets the case definition of an active surgical site infection (SSI), i.e. the SSI occurred within 30 days of the operation (or in the case of surgery involving an implant, was a deep or organ/space SSI that developed within 90 days of the operation) and the patient either has symptoms that meet the case definition and/or is on antimicrobial treatment for that infection; *or*
- The patient has been admitted (or develops symptoms within two days) with *C. difficile* infection less than 28 days after a previous discharge from an acute care hospital; *or*
- An invasive device was placed on Day 1 or Day 2, resulting in an HAI before Day 3.

Only infections originating with the current acute or non-acute hospital were included or those from other acute / non-acute hospitals. Those from long term care facilities such as nursing homes were excluded as HAI.

Community onset infections (COI)

In addition to HAI an estimation of the number of COIs were determined in acute hospitals in Wales. These infections were defined as infections originating within the community, including both those that were and were not directly healthcare

related. This allowed for the total burden of infection within acute hospitals to be estimated. COIs were collected for urinary tract infections (UTIs), pneumonia, gastrointestinal infections (GIs) and bloodstream infections (BSIs). These infections were considered COIs if they met ECDC clinical criteria of an HAI but did not meet the ECDC timing criteria of an HAI as defined above.

Microbiology

Microbiology data were recorded for HAIs if laboratory results were available at the time of the survey. Laboratory data could be accessed electronically and / or by checking medical notes. Results that were not available at the time of the survey were not included. Additional resistance information was collected where required if available.

Antimicrobial data

Antimicrobial data were collected for all patients receiving at least one antimicrobial on the day of the survey. In addition, surgical prophylaxis (at least one dose) that was prescribed in the 24 hours prior to 8am of the survey or on the day of the survey was included. Topical antimicrobials and antivirals were excluded from the survey.

The indication for prescribing an antimicrobial was recorded as treatment of a hospital or community acquired infection; surgical prophylaxis or medical prophylaxis. The prescribing definitions of hospital / community infections and surgical prophylaxis are provided below:

Hospital acquired infection – symptoms started 48 hours or more after admission to hospital or where the clinician deemed the infection as hospital acquired.

Community acquired infection – Did not meet a hospital acquired infection, i.e. present on admission

Surgical prophylaxis – single dose given (includes up to 24hours prior to the survey), more than one dose given in a 24 hour period, more than one dose given over more than a 24 hour period.

Data collection and management

Patient Data

Data were collected using a PPS web tool specifically designed for the purpose of the PPS by Baxter (ICNet). Data were entered on to a web form where built-in validation and rules were applied to reduce data inaccuracies. Some fields were mandated to reduce blanks / gaps in the data. Data were held in a database by ICNet for further analysis.

Hospital structure and process indicator data

Hospital level structure and process indicator data was compiled from the StatsWales website [9], infection control teams, pharmacy departments and from Freedom of Information requests to health boards. Where StatsWales data differed from data provided by hospitals, the data from the hospital was used. Infection control staff often work between several hospitals within the health board that employs them. In these cases the whole time equivalent (WTE) spent at each hospital was estimated by the infection control team.

Hospital level data on alcohol hand rub purchases was obtained from health board procurement departments.

PHW extracted the numbers of laboratory *C. difficile* stool tests and blood culture sets from Datastore, the data warehouse for Welsh laboratory data. Permission to extract this data was obtained from the data owners where appropriate data sharing agreements were not already in place.

Data analysis

The survey included all 21 acute NHS hospitals and 34 non-acute NHS hospitals in Wales, with the exclusion of mental health hospitals. The results were reported separately for acute and non-acute hospital types. Paediatric patients were grouped with adult patients for analysis due to their low numbers.

In common with other countries' analyses of PPS data, patient specialty was used for the analysis because this was more relevant to patients' HAI and antimicrobial status than ward specialty [10;11]. However, in cases where the patient was on an ICU ward but the patient specialty was not ICU, the patient specialty was changed to ICU for the analysis.

Where infections were reported as CRI3 (microbiologically confirmed CVC/PVC-related BSIs), they were classified as BSIs.

Average length of stay was calculated from the total number of patient days per year divided by the annual number of discharges. Some indicators were reported as a proportion of the number of beds or patient days in the hospital. If a hospital was missing any data for such a calculation, both the numerator and denominator for that hospital were excluded from the overall Wales figure.

Data was managed and analysed using STATA 14.1 and Microsoft Excel 2007 was used to produce tables and charts.

Statistical analysis

The prevalence of HAIs, antimicrobials and devices was reported as the number of patients with one or more HAIs (or antimicrobials or devices) per 100 patients surveyed. Prevalence of individual HAI types, antimicrobial drugs or device types were also reported per 100 patients and 95% Wilson confidence intervals (CIs) were calculated.

Univariate logistic regression was used to identify risk factors for HAIs and antimicrobial prescribing in acute and non-acute hospitals. Risk factors with a p-value less than 0.10 were initially included in multivariable logistic models. This resulted in multivariable logistic regression models for HAIs and antimicrobial use in acute hospitals. In non-acute hospitals, the univariate analysis did not identify any significant risk factors for HAIs and only one risk factor (length of stay) was identified for antimicrobial use.

There were multiple significant risk factors for HAIs and antimicrobial use in acute hospitals, so the risk factors were then tested through a backward stepwise approach, eliminating factors to give the most parsimonious HAI and antimicrobial models. To compare the models between each step, a Wald test was used with statistical significance set at $P<0.05$.

The resulting HAI and antimicrobial multivariable models were used to adjust hospital HAI and antimicrobial rates according to their patients' risk factors. Applying the model to the patient level dataset provided estimated probability of each patient having an HAI or being on an antimicrobial based on their risk factors. These probabilities were then summed for each hospital and healthboard to give the expected number of patients with HAIs (or on antimicrobials) in each hospital and healthboard. The expected prevalence was then used with the observed prevalence and overall prevalence to calculate the adjusted prevalence:

$$\text{Adjusted prevalence} = P*(O/E)$$

Where: P=overall prevalence
O=observed prevalence
E=expected prevalence

Comparisons with previous point prevalence surveys

Data were compared in the latest survey (2017) with the 2011 PPS where applicable. To make a direct comparison of 2017 data with 2011, some adjustments to the 2017 data were required such as excluding certain specialties. Details on how data were compared are detailed in the results section. Where PPS data were compared with the 2006 PPS, paediatric data were excluded because paediatric patients were not included in the 2006 survey.

Validation of the 2017 PPS data

The validity of the 2017 PPS data was assessed using a validation team of experts in PPS data collection. The validation team consisted of 70% staff from PHW. Three members were hospital staffs that were based at different hospitals within Wales. The team was multi-disciplinary with experience of microbiology, epidemiology, infection control and AMR. Over 80% of the members had undergone two or more previous PPS.

Ten acute hospitals were validated at the same time as the primary PPS was conducted. This represented 50% of hospitals from the primary PPS. One hospital was excluded from the sample as it was a tertiary hospital (cancer hospital). The sample was representative of the total PPS as hospitals were recruited across Wales with small and large bedded hospitals included with similar patient mix. Hospitals were not randomly sampled due to geographical difficulties and limited availability of team members. Hospital members of the validation team did not validate data from their own hospital. There were three key individuals present at all validation days. One member had experience of antimicrobial prescribing and two within the team with healthcare infection experience, including ECDC definitions and working with patients' notes / laboratory reports.

Data variables collected for the validation was identical to the primary PPS. Results for the validation were not discussed with the primary data collectors. There was no opportunity for primary data to be changed as a result. Validation data was completed for all patients on a selected ward within the hospital and the wards were randomly selected on the day. A minimum of 750 patients were required to be validated with numbers per hospital dependant on size and number of wards surveyed during that particular day. In Wales validation data was collated for 969 patients. Validators had access to the same electronic systems as primary data collectors, e.g. laboratory results.

The first two cases validated by the validators for an infection were carried out independently by the two members of the team and then cross checked by each other to ensure consistency / accuracy. Antibiotics prescribed on the drug chart were cross checked with the patient's notes by the pharmacist within the team.

Validation data was captured using the same web tool utilised for collection of primary PPS data (including the infection checker). Data collection was not blinded. If the validator agreed with all variables captured, including the infection recorded during the primary PPS for a patient they were able to mark the record as validated and save with no changes required to the data. If the validator disagreed with variables or the infection / antibiotics then they altered the validation record and saved the updated data.

Results from the validation exercise allowed for sensitivity and specificity of the data to be determined. From this an adjusted prevalence of HAI and antimicrobial usage could be determined for Wales based on over / under reporting and incorrect reporting (e.g. false negatives). The definitions of sensitivity and specificity are given below:

Sensitivity (also called the **true positive rate**) measures the proportion of positives that are correctly identified (e.g. the proportion of patients with a HAI who are correctly identified as having a HAI)

Specificity (also called the **true negative rate**) measures the proportion of negatives that are correctly identified (e.g. the proportion of patients without a HAI that are correctly identified as not having a HAI)

3. Results

Survey Characteristics

A total of 7643 patients in 55 hospitals were included in the survey. All 21 NHS acute hospitals and a total of 34 non-acute NHS hospitals were surveyed. Independent hospitals were not included in the survey. The total number of hospitals, wards, beds and patients included in the national 2017 PPS are described in Table 3.1.

Table 3.1 *Number of hospitals, wards and patients surveyed 2017*

Hospital type	Hospitals	Wards	Beds	Patients
Acute	21	368	7848	6400
Non-acute	34	61	1464	1243
Total	55	429	9312	7643

The number of patients surveyed by NHS Health Board across Wales is described in Figure 3.1. The figure includes the proportion of acute and non-acute patients captured as a proportion by Health Board and NHS Trust in Wales.

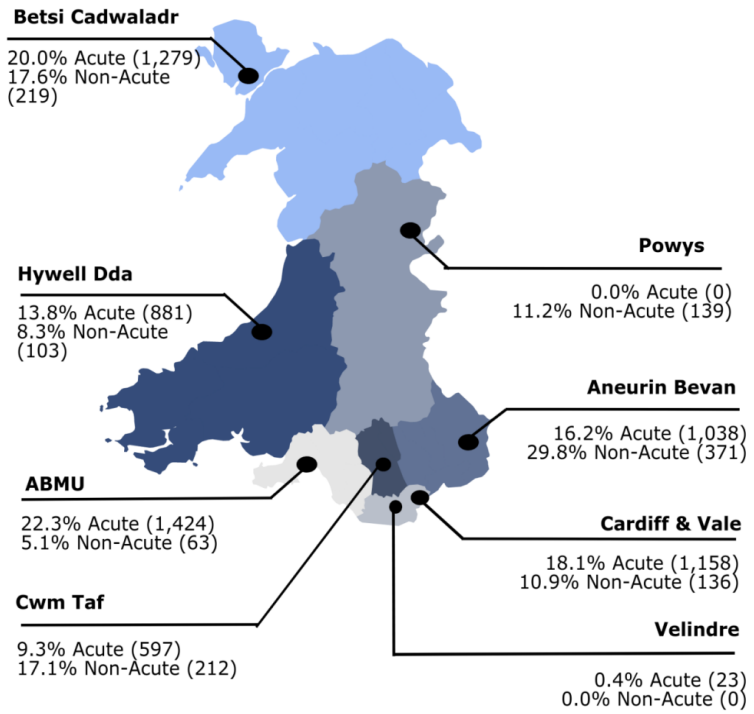


Figure 3.1 *Total number of acute and non-acute patients surveyed, by NHS Health Board*

Survey population

The age and sex distribution of acute and non-acute hospital patient population is shown in Figures 3.2 and 3.3, respectively. Acute hospital patients had a median age of 74, ranging from 0 to 113 years (inter-quartile range (IQR): 57-83 years) and 47% of patients were male (n=3001). In 2011 the median age of hospital patients was 72. Patients aged 65 years and over made up 67% of patients, compared to 63% in 2011

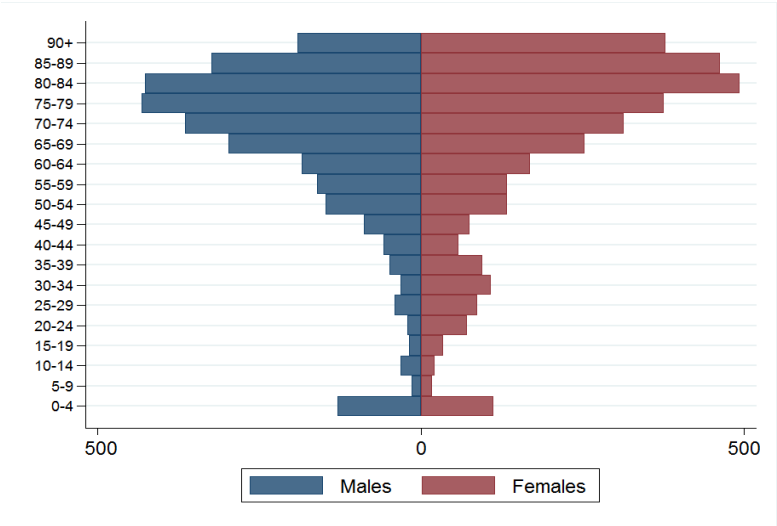


Figure 3.2 *Number of patients surveyed in acute hospitals by age and sex (2017)*

Non-acute hospital patients had a median age of 83, ranging from 0-105 years (IQR: 74-89) and 42% of patients were male (n=525). Patients age 65 years and over made up 88% of patients compared with 75% in 2011.

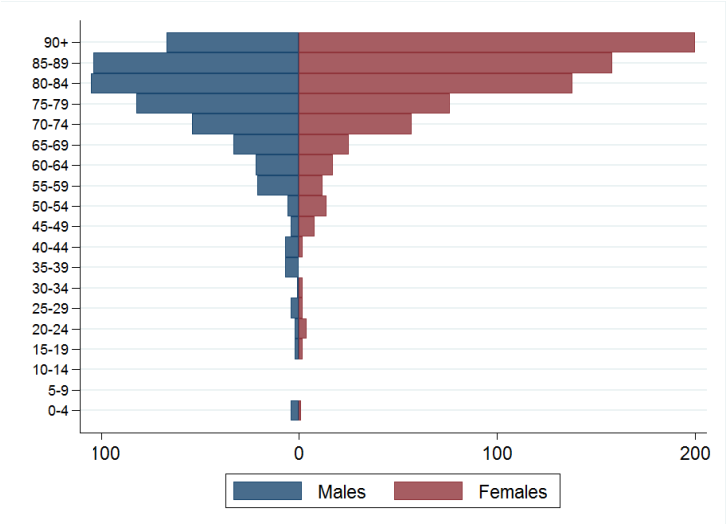


Figure 3.3 *Number of patients surveyed in non-acute hospitals by age and sex (2017)*

Table 3.2 provides the distribution of patients by patient specialty within the acute and non-acute sector. The majority of patients were captured under medicine and surgical specialty within the acute sector and rehabilitation and geriatric medicine within the non-acute sector.

Table 3.2 *Distribution of patients by patient specialty in acute and non-acute hospitals 2017*

	Acute		Non-acute	
Patient specialty	Number	% of patients	Number	% of patients
Medicine	3,212	50.2	193	15.5
Surgery	1,837	28.7	32	2.6
Geriatric medicine	452	7.1	382	30.7
Obstetrics	239	3.7	0	0.0
ICU	237	3.7	0	0.0
Rehabilitation	174	2.7	621	50.0
Paediatrics*	163	2.5	0	0.0
Gynaecology	81	1.3	0	0.0
Psychology	1	0.0	0	0.0
Long term care	0	0.0	15	1.2
Other	3	0.0	0	0.0
Unknown	1	0.0	0	0.0
Total	6,400	100.0	1,243	100.0

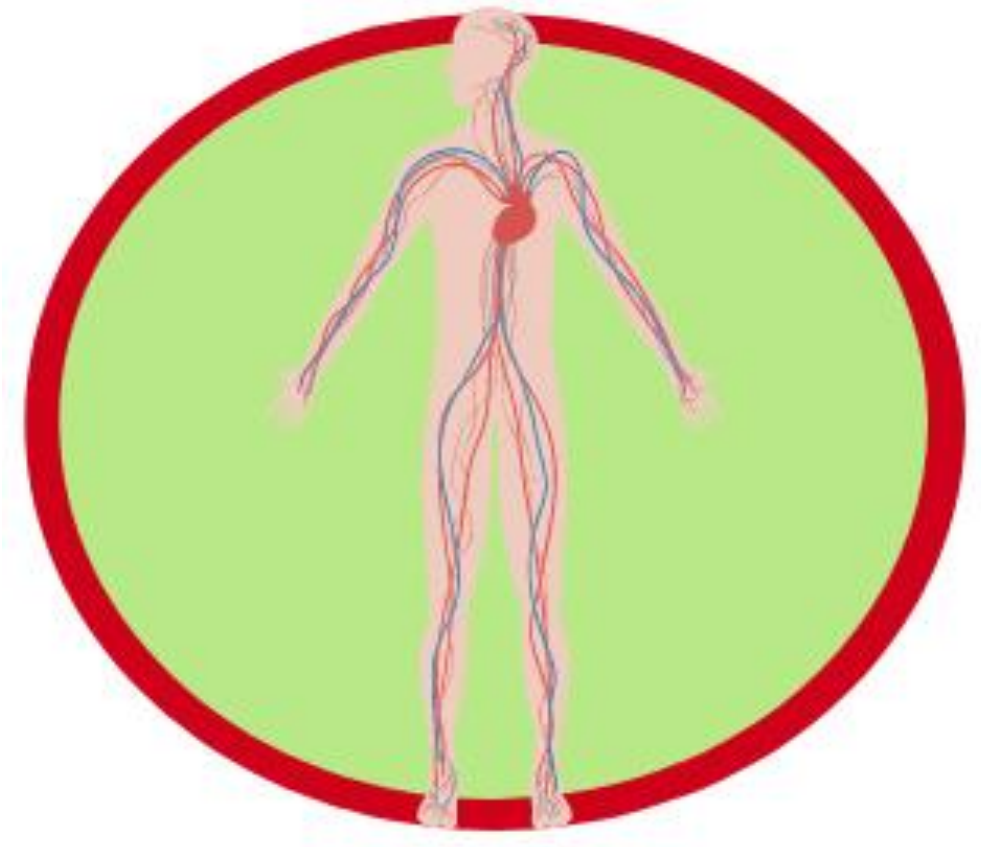
* Includes general neonatal patients

The proportion of patients aged 65 and over within the acute and non-acute sector has increased since 2011. An increase of 4% and 13% were noted, respectively. Table 3.3 provides a summary of the survey population in the acute and non-acute hospitals in 2017.

Table 3.3 Detail on the survey population within acute and non-acute hospitals in Wales 2017

Population summary	Acute hospital	Non-acute hospital
Median age	74	83
Age range	0-113	0-105
% 65 and over	67%	88%
Comparison with 2011 (65 and over)	4% increase	13% increase
Sex	53% female	58% female
Greatest patient specialty surveyed	Medicine, surgery	Rehabilitation, geriatric medicine, medicine

Healthcare associated infections within hospitals in Wales

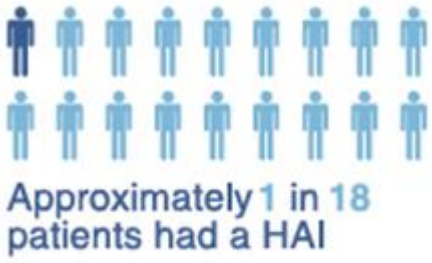


Healthcare associated infections within hospitals in Wales

Prevalence of HAI

Prevalence of HAI in acute hospitals 2017

Acute hospitals



A total of 352 patients in acute hospitals had at least one HAI at the time of the survey. The overall prevalence was 5.5% (95% CI: 5.0- 6.1). The acute HAI prevalence in 2017 was significantly higher ($p<0.05$) than in 2011 (4.3%) (Table 3.4)

Table 3.4 *Prevalence of HAI in 2017 (Wales) in the acute sector*

Hospital type	No. patients	No. patients with HAI*	HAI prevalence (%)	95% CI	2011: HAI prevalence (%)
Acute	6400	352	5.5	(5.0-6.1)	4.3 (3.8-4.8)

*Infections originating from or in an acute hospital

Comparison with previous surveys (2006 and 2011) with 2017

Previous surveys were conducted in Wales in 2006 and 2011. It must be noted that a direct comparison cannot be made with 2017 for various reasons. These include exclusion of paediatric patients during the 2006 survey; the 2017 survey was conducted in June compared to November for 2006 / 2011. In addition, in 2017 staff entering data had access to electronic data for determining infections, such as microbiology results, chest x-rays and for some clinical signs / symptoms. Table 3.5 provides a comparison of the HAI prevalence within the acute sector for 2017 with 2006 and 2011. For comparison the paediatric group has been excluded from the 2011 and 2017 surveys. Between 2006 and 2011 there was a significant ($p<0.05$) reduction in the HAI rate and then there was a marginally significant increase between 2011 and 2017. The 2017 rate is still lower than the 2006 rate, although not significantly.

Table 3.5 *Comparison of HAI prevalence in acute hospitals by PPS year (excluding peadiatric wards)*

PPS year	No. patients	No. HAIs	Prevalence (%)	95% CI
2006	5734	364	6.4	(5.7-7.0)
2011	6217	271	4.4	(3.9-4.9)
2017	6230	347	5.6	(5.0-6.2)

The HAI prevalence by patient specialty is shown in Figure 3.4. In acute hospitals, the specialty with the highest HAI prevalence was ICU where approximately one in nine ICU patients had a HAI at the time of the survey (17.7%). The HAI prevalence in ICU was significantly higher ($p<0.05$) than any other specialty. The lowest HAI rates were in gynaecology / obstetrics (1.3%) and paediatrics (1.8%). These rates were significantly lower ($p<0.05$) than in surgery and ICU. Further detail on HAI prevalence in acute hospitals by patient specialty is detailed in the Appendix, Table A1.

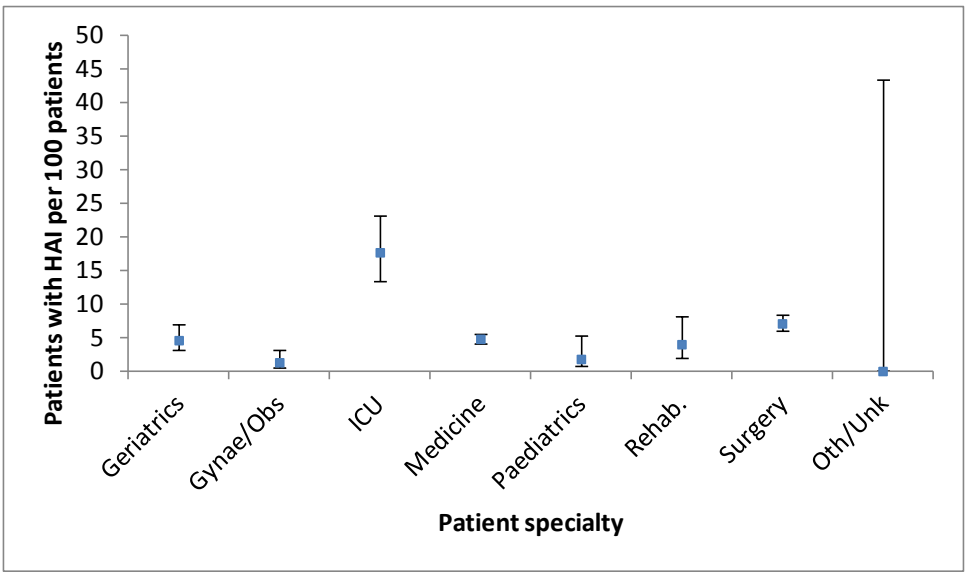
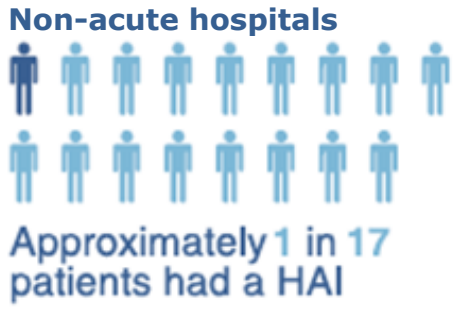


Figure 3.4 *HAI prevalence by patient specialty in acute hospitals 2017*

Prevalence of HAI in non-acute hospitals 2017



A total of 74 patients in non-acute hospitals had at least one HAI at the time of the survey. The overall prevalence was 6.0% (95% CI: 4.8–7.4). The non-acute HAI prevalence in 2017 was significantly higher ($p<0.05$) than in 2011 with approximate doubling of the prevalence (3.2%) (Table 3.6)

Table 3.6 *Prevalence of HAI in 2017 (Wales) in the non-acute sector*

Hospital type	No. patients	No. patients with HAI*	HAI prevalence (%)	95% CI	2011: HAI prevalence (%)
Non-acute	1243	74	6.0	(4.8-7.4)	3.2 (2.6-4.0)

*Infections originating from or in a non-acute hospital

The HAI prevalence by patient specialty in non-acute hospitals is shown in Figure 3.5. In non-acute hospitals, the specialties with the highest HAI prevalence were medicine (8.8%) and rehabilitation (8.2%). No HAIs were captured within the specialty of surgery. The prevalence of HAI did not significantly differ between specialty ($p<0.05$).

Further detail of HAI prevalence in non-acute hospitals by patient specialty can be found in the Appendix, Table A2.

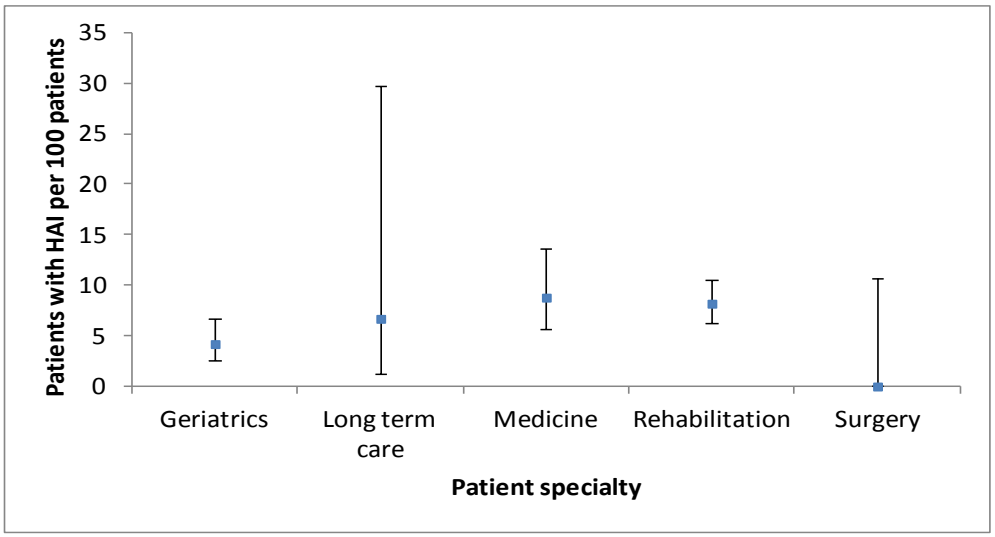


Figure 3.5 *HAI prevalence by patient specialty in non-acute hospitals 2017*

Characteristics of HAI occurring in Welsh hospitals 2017

Acute Hospitals

A total of 364 HAIs occurring in 352 patients were reported during the 2017 survey. Table 3.7 details the number, percentage and prevalence of HAI by infection type for 2017. The most common HAIs reported were pneumonia (n=70, 19.2%), UTI (n=58, 15.9%) and SSI (n=41, 11.3%). Gastrointestinal infections accounted for 11% of infections and BSI 9.9%.

Table 3.7 *Number and prevalence of HAIs by infection site in acute hospitals (Wales 2017)*

Infection site	No. infections	% of HAIs	Prevalence (%)
Pneumonia	70	19.2	1.09
UTI	58	15.9	0.91
SSI	41	11.3	0.64
GI	40	11.0	0.63
BSI**	36	9.9	0.56
LRT	29	8.0	0.45
Systemic	28	7.7	0.44
Skin/soft tissue	27	7.4	0.42
Bone/joint	12	3.3	0.19
Eye/ENT	10	2.8	0.16
CRI-PVC*	5	1.4	0.08
Neonatal	3	0.8	0.05
CVS	2	0.6	0.03
Reproductive tract	1	0.3	0.02
CRI-CVC*	1	0.3	0.02
CNS	1	0.3	0.02
Total	364	100.0	

*Excluding CRI3 BSIs
**Includes BSIs originating from CVCs or PVCs

Figure 3.6 provides the distribution of HAI types in acute hospitals for 2017 and the previous survey in 2011. In 2011 the highest reported HAI type was SSI (n=71, 23.7%). UTIs accounted for 16.7% of HAIs and pneumonia 12.4%. Although pneumonia, UTIs and SSIs remain the three most common HAIs in acute hospitals, in 2017 pneumonia is of greatest concern. Compared to 2011 the proportion of cases that are pneumonia has risen by approximately 7% and the proportion of SSI cases has more than halved. UTIs remain similar in 2017 to 2011.

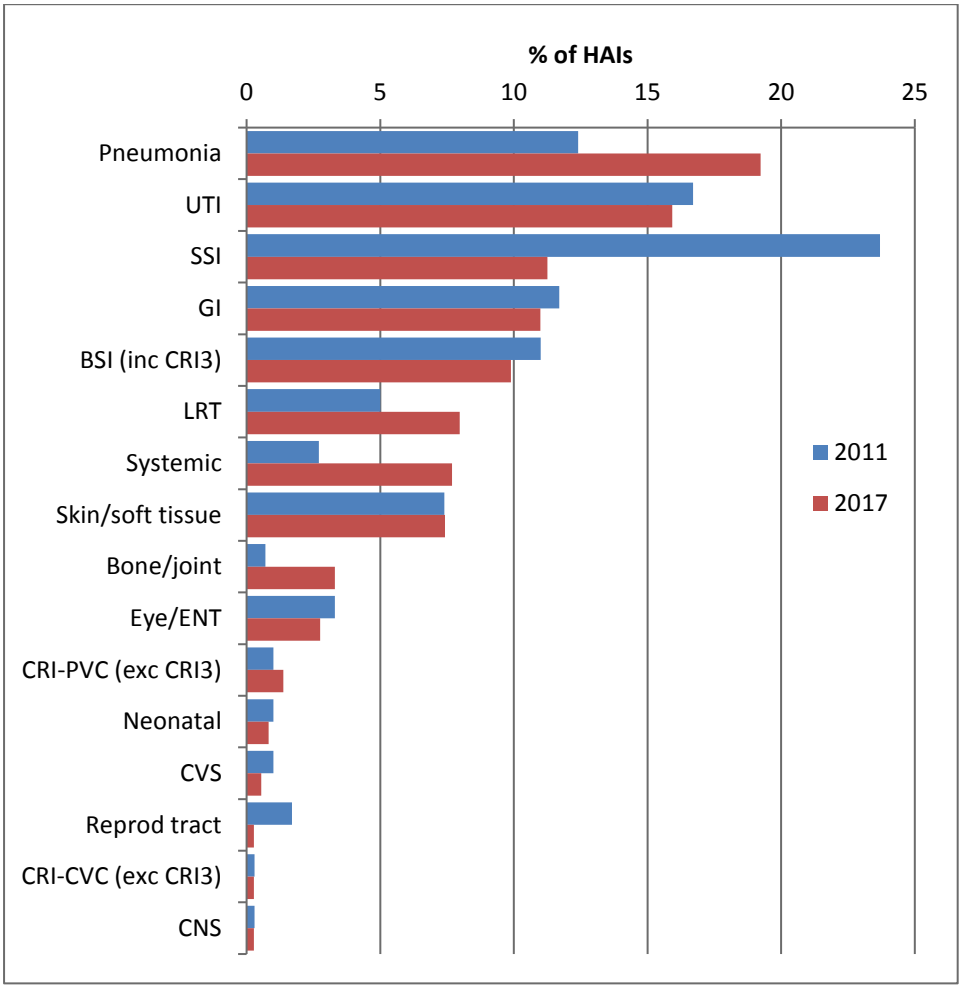


Figure 3.6 *Distribution of HAI types in non-acute hospitals for 2017 compared with 2011*

Non-acute Hospitals

A total of 75 HAIs occurring in 74 patients were reported during the 2017 survey. Table 3.8 details the number, percentage and prevalence of HAI by infection type for 2017. The most common HAIs reported were UTI (n=34, 45.3%), skin / soft tissue (n=10, 13.3%) and pneumonia (n=9, 12.0%). Lower respiratory tract infections (LRT) accounted for 10.7% of infections and eye / ENT 5.3%.

Table 3.8 *Number and prevalence of HAIs by infection site in non-acute hospitals (Wales 2017)*

Infection site	No. infections	% of HAIs	Prevalence (%)
UTI	34	45.3	2.74
Skin/soft tissue	10	13.3	0.80
Pneumonia	9	12.0	0.72
LRT	8	10.7	0.64
Eye/ENT	4	5.3	0.32
GI	3	4.0	0.24
Bone/joint	3	4.0	0.24
Systemic	2	2.7	0.16
SSI	1	1.3	0.08
BSI	1	1.3	0.08
Reproductive	0	0.0	0.00
CNS	0	0.0	0.00
Total	75	100.0	

Figure 3.7 provides the distribution of HAI types in non-acute hospitals for 2017 and the previous survey in 2011. In 2011 the highest reported HAI type was UTI (n=30, 36.1%). Eyes / ENT infections accounted for 14.5% of HAIs and skin / soft tissue and LRT 12.1%. In non-acute hospitals, UTIs made up the largest group of HAIs in 2011 and in 2017 this has increased by approximately 9% in 2017 to make up nearly half of all HAIs. Pneumonia has more than doubled in prevalence since 2011, while SSI prevalence has reduced by 80% and GIs by 63% since 2011.

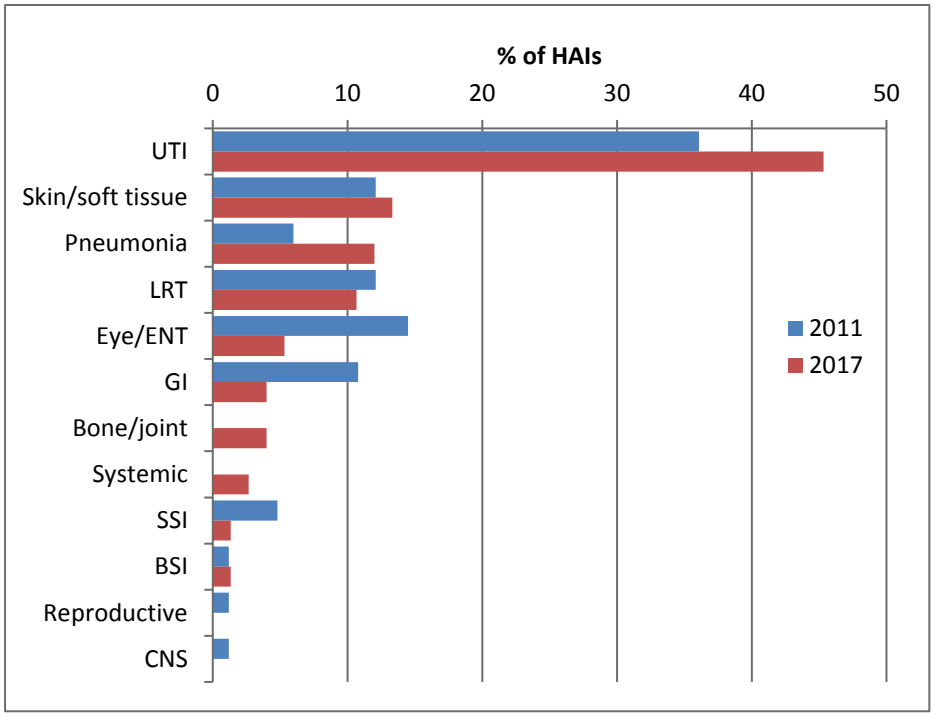


Figure 3.7 *Distribution of HAI types in acute hospitals for 2017 compared with 2011*

Community onset infections being treated within acute and non-acute hospitals in Wales 2017

During the 2017 survey data were collected on the total burden of infection within acute hospitals in Wales for specific infection types. The infection types included BSI, UTI, pneumonia and GI. This additional data allowed for the proportion of acute HAI to be compared with community onset infections. The acute HAI were determined using the ECDC definitions of infection whilst the community onset infections did not meet the timing of an ECDC hospital acquired infection. It is important to note that it was not possible to determine if all community onset infections were healthcare related, however they still pose a burden within acute hospitals. Details on the proportion of community onset versus acute HAI are shown in Table 3.9.

Table 3.9 *The proportion of community onset infections versus HAIs in acute hospitals for four types of infections identified during the 2017 PPS*

Infection	COI (%)	HAI (%)	Total Burden (%)
BSI	49.3	50.7	100
GI	68.3	31.7	100
Pneumonia	68.5	31.5	100
UTI	66.5	33.5	100

There was a 50% split between BSIs that were community onset versus acute HAI. For GI, pneumonia and UTI over two thirds of infections being treated in the acute hospitals were community onset.

In acute hospitals 26% of HAIs were present at admission. HAIs present on admission included patients admitted with an infection from another acute hospital or patients readmitted to the same hospital. A total of 85% of HAIs were associated with the current hospital and 72% were associated with the current ward.

In non-acute hospitals 13% of HAIs were present at admission. A total of 80% of HAIs were associated with the current hospital and 77% were associated with the current ward.

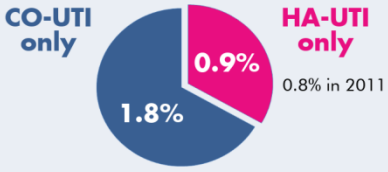
Detail on the top five infections within acute hospitals in Wales 2017

The burden of UTI, pneumonia, BSI, SSI and GI in Welsh acute care hospitals are detailed in the following Infographic pages. Specifically Infographic 1 – UTI, Infographic 2 – pneumonia, Infographic 3 – BSI, Infographic 4 – SSI and Infographic 5 – GI.

Burden of UTI in Welsh acute care hospitals

Data is shown for all urinary tract infections (UTI) identified in acute hospitals. Includes healthcare associated infections (HAI) using ECDC definitions and community onset infections (COI).

Prevalence of UTI

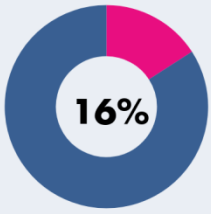


Total Prevalence **2.7%**

1/3 of all UTIs were hospital acquired

2/3 of all UTIs had their onset in the community and may not all be healthcare related

HA-UTI accounted for

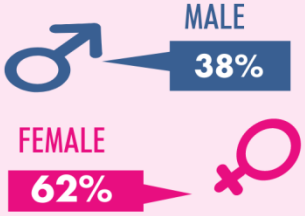


of all HAI

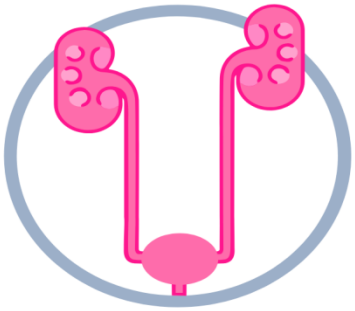
Causative Microorganisms

Top 3	%
1.*E. coli*	61
2. *Enterococcus faecalis*	5
3. *Staphylococcus aureus*	5

Demographics



Median Age **80**



Urinary Catheterisation

All UTI

35%

of patients with a UTI had a catheter in situ within 7 days prior to onset of infection

HAI

1/2 of all patients with a HA-UTI had a catheter in situ within 7 days prior to onset of infection

60% in 2011

Antimicrobial Prescribing

1/10 of all antimicrobials prescribed were for the treatment of UTI

Most commonly prescribed antimicrobials for treatment of

Lower UTI	Upper UTI
1. Trimethoprim (37%)	1.Co-amoxiclav (29%)
2. Co-amoxiclav (16%)	2. Piperacillin/Tazobactam (20%)
3. Nitrofurantoin (13%)	3. Ciprofloxacin(16%)

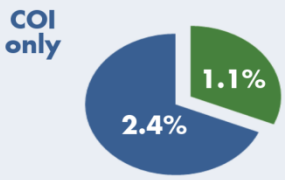
3/4 of antimicrobials given for UTIs were for lower UTIs

Infographic 1

Burden of pneumonia in Welsh acute care hospitals

Data is shown for all pneumonia infections identified in acute hospitals. Includes healthcare associated infections (HAI) using ECDC definitions and community onset infections (COI).

Prevalence of pneumonia

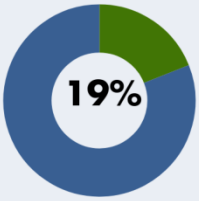


Total Prevalence **3.5%**

3/10 of all pneumonia infections were hospital acquired

7/10 of all pneumonia infections had their onset in the community and may not all be healthcare related

HA-Pneumonia accounted for



of all HAI

Causative Microorganisms

Microorganism	%
Pseudomonas aeruginosa	21
Haemophilus influenza	13
Staphylococcus aureus	8
Klebsiella pneumonia	8
Other	50

Demographics

MALE **60%**

FEMALE **40%**

Median Age **73**

Intubation

All pneumonia Infections

31%

of patients with pneumonia were intubated within 48 hours prior to infection

HAI

4/10 of patients with HA pneumonia were intubated within 48 hours prior to infection

24% in 2011

Antimicrobial Prescribing

1/5 of all antimicrobials prescribed were for the treatment of pneumonia

Most commonly prescribed antimicrobials for treatment of pneumonia

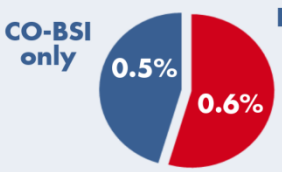
1. Piperacillin/Tazobactam (22%)
2. Clarithromycin (16%)
3. Co-amoxiclav (16%)

Infographic 2

Burden of BSI in Welsh acute care hospitals

Data is shown for all bloodstream infections (BSI) identified in acute hospitals. Includes healthcare associated infections (HAI) using ECDC definitions and community onset infections (COI).

Prevalence of BSI



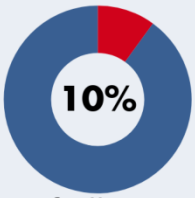
Total Prevalence **1.1%**

1/2

of all BSIs were hospital acquired

1/2 of all BSIs had their onset in the community and may not all be healthcare related

HA-BSIs accounted for

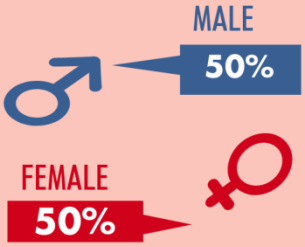


of all HAI

Causative Microorganisms

Microorganism	%
E.coli	21
Staphylococcus aureus	15
Streptococcus spp.	11
Enterococcus spp.	9
Other	43

Demographics



Median Age **72**

Vascular Catheterisation

All BSI

55%

of patients with a BSI had a vascular catheter in-situ within 48 hours prior to infection

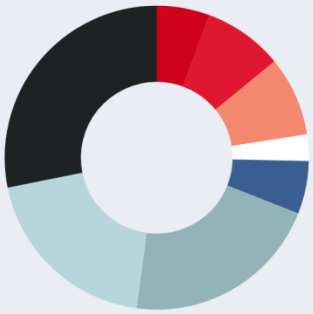
HAI

3/4

of patients with a HA-BSI had a vascular catheter in-situ within 48 hours prior to infection

15% in 2011

BSI Origin



Catheter (5.63%) Digestive (8.45%)
Pulmonary (8.45%) SSI (2.82%)
SST (5.63%) UTI (21.13%)
Unknown (19.72%) Other (28.17%)

Antimicrobial Prescribing

9%

of all antimicrobials prescribed were for the treatment of a BSI

Most commonly prescribed antimicrobials for treatment of a BSI

1. Piperacillin/Tazobactam (31%)
2. Meropenem (12%)
3. Co-amoxiclav (11%)

Infographic 3

Burden of SSI in Welsh acute care hospitals

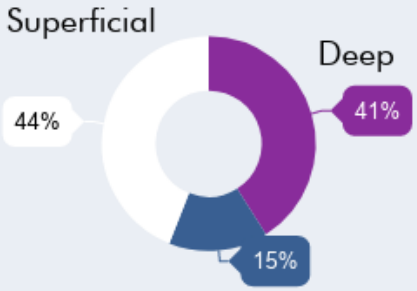
Data is shown for all hospital acquired surgical site infections (SSI) identified in acute hospitals using ECDC definitions.

Prevalence of SSI

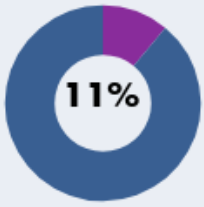
0.6%

1.1% in 2011

SSI Type



HA-SSI accounted for



of all HAI

Causative Microorganisms

Top 5	%
Staphylococcus aureus	27
E.coli	14
Coagulase-negative staphylococci	9
Enterococcus faecalis	9
Enterococcus faecium	9

Demographics

MALE 59%

FEMALE 41%

Median Age 64

Surgery since admission

27%

of SSIs were attributable to surgery during previous admissions

Surgical Specialty

Specialty	%
General	24
Orthopaedic/ traumatology	24
Cardiac	12
Paediatric general	7
Other	32

Antimicrobial Prescribing

4% of all antimicrobials prescribed were prescribed for the treatment of an SSI

Most commonly prescribed antimicrobials for treatment of

Skin soft tissue infections

1. Flucloxacillin (21%)
2. Vancomycin (parenteral) (10%)
3. Co-amoxiclav (7%)
4. Piperacillin/Tazobactam (7%)

Bone and joint infections

1. Rifampicin (18%)
2. Flucloxacillin (13%)
3. Teicoplanin (11%)
4. Fusidic Acid (11%)

Infographic 4

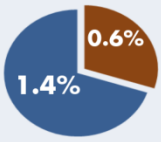
Burden of GI in Welsh acute care hospitals

Data is shown for gastrointestinal infections (GI) identified in acute hospitals. Includes healthcare associated infections (HAI) using ECDC definitions and community onset infections (COI).

Prevalence of GI

CO-GI only

HA-GI only



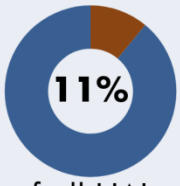
0.5% in 2011

Total Prevalence **2.0%**

3/10
of all GIs were hospital acquired

7/10 of all GIs had their onset in the community and may not all be healthcare related

HA-GI accounted for



of all HAI

Causative Microorganisms

Microorganism	%
C. difficile	35
E.coli	9
Enterococcus faecalis	7
Klebsiella pneumonia	7
Other	25

Demographics

MALE **50%**

FEMALE **50%**

Median Age **69**

C.difficile

All GI

1/4

patients with a GI had *C.difficile*

HAI

68%

of patients with a HA-GI had *C.difficile*

Antimicrobial Prescribing

14% of all antimicrobials prescribed were for the treatment of a GI

Most commonly prescribed antimicrobials for treatment of

Intra-abdominal sepsis

1. Piperacillin/Tazobactam (21%)
2. Metronidazole (p) (21%)
3. Co-amoxiclav (14%)

Gastro-intestinal infections

1. Vancomycin (o) (27%)
2. Metronidazole (o/r) (20%)
3. Metronidazole (p) (10%)

Infographic 5

Microbiology

Acute hospitals

In acute hospitals positive microbiology results were available at the time of survey for 34% of recorded infections (124/364). In total 246 isolates were recorded with some patients having one or more isolates recorded. The distribution of microorganisms is shown in Table 3.10. The most common organisms were *E. coli* (25% of isolates, n=62), *S. aureus* (11% of isolates, n=27), and *C. difficile* (8% of isolates, n=19). The most common isolate groups were *Enterobacteriaceae sp.* (39% of isolates, n=96), Gram positive cocci (31% of isolates, n=77) and Gram negative bacilli (13% of isolates, n=32) (Figure 3.8).

Table 3.10 *Distribution of the top 5 microorganisms reported in acute hospitals in 2017*

Microrganism	No. of microorganisms	% microorganisms
Escherichia coli	62	25.2
Staphylococcus aureus	27	10.98
Clostridium difficile	19	7.72
Pseudomonas aeruginosa	12	4.88
Enterococcus faecalis	11	4.47

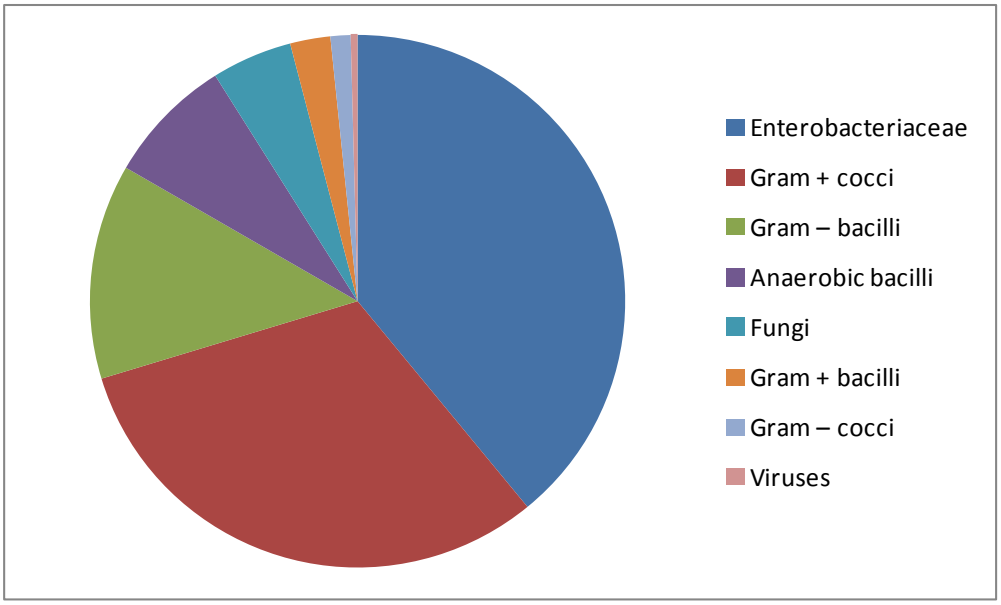


Figure 3.8 *Distribution of microorganism isolates by group reported in acute hospitals in 2017*

Non-acute hospitals

In non-acute hospitals positive microbiology results were available at the time of survey for 23% of recorded infections (17/75). The most common organisms were *E. coli* (35% of isolates, n=8), *Proteus* species (9% of isolates, n=2) and *Pseudomonas aeruginosa* (9% of isolates, n=2). *Enterobacteriaceae sp.* made up 57% of isolates (n=13), Gram positive cocci made up 13% (n=3) and Gram negative bacilli made up 13% (n=3).

Table 3.11 *Distribution of the top 3 microorganisms reported in non-acute hospitals in 2017*

Microrganism	No. of microorganisms	% microorganisms
Escherichia coli	8	34.78
Proteus spp., not specified	2	8.7
Pseudomonas aeruginosa	2	8.7

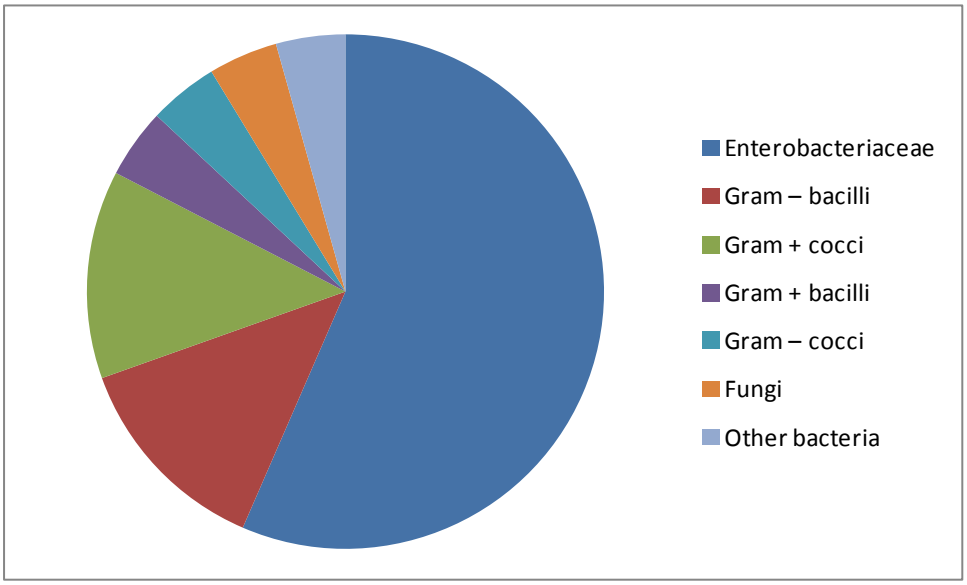


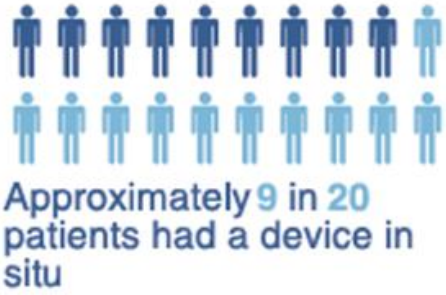
Figure 3.9 *Distribution of microorganism isolates by group reported in non-acute hospitals in 2017*

Prevalence of device usage within hospitals in Wales 2017

Prevalence of device usage within hospitals in Wales 2017

Prevalence of device usage in acute hospitals 2017

Acute hospitals



A total of 2864 patients in acute hospitals had one or more devices in situ at the time of the survey. The overall prevalence was 44.8% (95% CI: 43.5- 46.0). There was a significant decrease ($p<0.05$) in the use of urinary catheters and intubation compared to 2011 (Table 3.12)

The prevalence of urinary catheters, peripheral vascular catheters (PVCs), central vascular catheters (CVCs) and the use of intubation is shown in Table 3.12. Approximately 45% of patients had one or more devices in situ during the survey in 2017. More than a third of patients had a PVC in situ (35.8%) and approximately one in six had a urinary catheter in situ at the time of the survey (16.2%). The prevalence of CVC use was 4.2% and 1.6% for intubated patients. The prevalence of device usage in 2017 was compared with 2011. The use of urinary catheter and intubation of patients was significantly ($p<0.05$) lower in the 2017 survey compared with 2011.

Table 3.12 *Prevalence of device usage within acute hospitals in Wales 2017*

	2017 (patients=6400)			2011 (patients=6588)	
Device type	No. patients with device	Prevalence (%)	95% CI	Prevalence (%)	95% CI
Urinary catheter	1037	16.2	15.3-17.1	19.2	18.3-20.2
PVC	2288	35.8	34.6-36.9	34.9	33.8-36.1
CVC	271	4.2	3.8-4.8	5.1	4.6-5.6
Intubation	103	1.6	1.3-1.9	2.5	2.2-2.9
Patients with 1 or more device(s)	2864	44.8	43.5-46.0	45.9	44.7-47.1

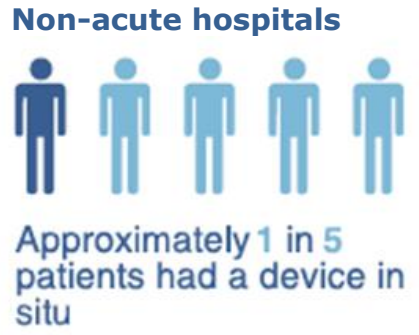
Details of device usage and prevalence by patient specialty are described in Table 3.13. The highest prevalence of all devices was reported in intensive care patients in acute hospitals (urinary catheter 60.3%; PVC 61.6%; CVC 41.8%; intubation 27.0%). Approximately 2 in 10 patients in gynaecology (22.2%) and surgical specialties (20.0%) had a catheter in situ. Over half of patients in gynaecology (53.1%) and 42.0% of patients in surgical specialties had a PVC in situ at the time of the survey. Approximately 1 in 10 paediatric patients had a CVC in situ.

Table 3.13 *Number and prevalence of device usage by patient specialty within acute hospitals in Wales 2017*

Device type	Patient specialty*	No. patients	No. devices	Prevalence (%)	95% CI
Urinary catheter	Geriatric medicine	452	62	13.7	10.8-17.2
	Gynaecology	81	18	22.2	14.5-32.4
	Obstetrics	239	9	3.8	2.0-7.0
	ICU	237	143	60.3	54-66.4
	Medicine	3212	422	13.1	12.0-14.4
	Other	3	0	0.0	0.0-56.1
	Paediatrics	163	1	0.6	0.1-3.4
	Psychology	1	0	0.0	0.0-79.3
	Rehabilitation	174	14	8.0	4.9-13.1
	Surgery	1837	368	20.0	18.3-21.9
	Unknown	1	0	0.0	0.0-79.3
PVC	Geriatric medicine	452	98	21.7	18.1-25.7
	Gynaecology	81	43	53.1	42.3-63.6
	Obstetrics	239	37	15.5	11.4-20.6
	ICU	237	146	61.6	55.3-67.6
	Medicine	3212	1137	35.4	33.8-37.1
	Other	3	0	0.0	0.0-56.1
	Paediatrics	163	48	29.4	23.0-36.9
	Psychology	1	0	0.0	0.0-79.3
	Rehabilitation	174	7	4.0	2.0-8.1
	Surgery	1837	772	42.0	39.8-44.3
	Unknown	1	0	0.0	0.0-79.3
CVC	Geriatric medicine	452	5	1.1	0.5-2.6
	Gynaecology	81	4	4.9	1.9-12
	Obstetrics	239	0	0.0	0.0-1.6
	ICU	237	99	41.8	35.7-48.1
	Medicine	3212	81	2.5	2.0-3.1
	Other	3	0	0.0	0.0-56.1
	Paediatrics	163	17	10.4	6.6-16.1
	Psychology	1	0	0.0	0.0-79.3
	Rehabilitation	174	0	0.0	0.0-2.2
	Surgery	1837	65	3.5	2.8-4.5
	Unknown	0	0	0.0	-
Intubation	Geriatric medicine	452	0	0.0	0.0-0.8
	Gynaecology	81	2	2.5	0.7-8.6
	Obstetrics	239	0	0.0	0.0-1.6
	ICU	237	64	27.0	21.8-33
	Medicine	3212	10	0.3	0.2-0.6
	Other	3	0	0.0	0.0-56.1
	Paediatrics	163	3	1.8	0.6-5.3
	Psychology	1	0	0.0	0.0-79.3
	Rehabilitation	174	1	0.6	0.1-3.2
	Surgery	1837	23	1.3	0.8-1.9
	Unknown	1	0	0.0	0.0-79.3

*Patients in ICU wards when surveyed, are classified with the patient specialty ICU

Prevalence of device usage in non-acute hospitals 2017



A total of 248 patients in non-acute hospitals had one or more devices in situ at the time of the survey. This was a significant ($p<0.05$) proportion increase since 2011. The overall prevalence was 20.0% (95% CI: 17.8- 22.3). There was a significant decrease ($p<0.05$) in the use of CVCs and intubation compared to 2011 but a significant increase ($p<0.05$) in the use of urinary catheters (Table 3.14)

The prevalence of urinary catheter, PVC, CVC and the use of intubation is shown in Table 3.14. A total of 20% of patients had one or more devices in situ during the survey in 2017. Approximately one in six had a urinary catheter in situ at the time of the survey (17%). The prevalence of PVC use was 3.5% and 0.2% for CVC and for intubated patients. The use of urinary catheters was significantly ($p<0.05$) higher in the 2017 survey whilst CVC usage and intubation of patients was significantly ($p<0.05$) lower in 2017 compared with the 2011 survey.

Table 3.14 *Prevalence of device usage within non-acute hospitals in Wales 2017*

	2017 (patients=1243)			2011 (patients=2506)	
Device type	No. patients with device	Prevalence (%)	95% CI	Prevalence (%)	95% CI
Urinary catheter	211	17.0	15.0-19.2	12.1	10.9-13.4
PVC	43	3.5	2.6-4.6	2.6	2.1-3.3
CVC	3	0.2	0.1-0.7	1.6	1.2-2.2
Intubation	2	0.2	0.0-0.6	1.8	1.3-2.3
Patients with 1 or more device(s)	248	20.0	17.8-22.3	13.7	12.4-15.1

Details of device usage and prevalence by patient specialty are described in Table 3.15. Approximately 3 in 14 patients in geriatric medicine (20.9%) had a urinary catheter in situ. Approximately 2 in 13 (15.6%) surgical patients had a PVC in situ and 1.0% medical patients a CVC in situ at the time of the survey.

Table 3.15 *Number and prevalence of device usage by patient specialty within non-acute hospitals in Wales 2017*

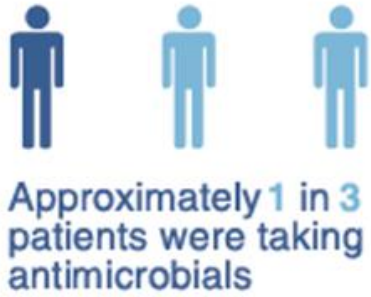
Device type	Patient specialty	No. patients	No. devices	Rate (%)	95% CI
Urinary catheter	Geriatric medicine	382	80	20.9	17.2-25.3
	Long term care	15	2	13.3	3.7-37.9
	Medicine	193	27	14.0	9.8-19.6
	Rehabilitation	621	99	15.9	13.3-19.0
	Surgery	32	3	9.4	3.2-24.2
PVC	Geriatric medicine	382	14	3.7	2.2-6.1
	Long term care	15	1	6.7	1.2-29.8
	Medicine	193	11	5.7	3.2-9.9
	Rehabilitation	621	12	1.9	1.1-3.3
	Surgery	32	5	15.6	6.9-31.8
CVC	Geriatric medicine	382	1	0.3	0.0-1.5
	Long term care	15	0	0.0	0.0-20.4
	Medicine	193	2	1.0	0.3-3.7
	Rehabilitation	621	0	0.0	0.0-0.6
	Surgery	32	0	0.0	0.0-10.7
Intubation	Geriatric medicine	382	0	0.0	0.0-1.0
	Long term care	15	0	0.0	0.0-20.4
	Medicine	193	0	0.0	0.0-2.0
	Rehabilitation	621	2	0.3	0.1-1.2
	Surgery	32	0	0.0	0.0-10.7

Antimicrobial usage in Wales 2017

Antimicrobial usage in Wales 2017

Prevalence of antimicrobial prescribing in acute hospitals 2017

Acute hospitals



A total of 2186 patients in acute hospitals were prescribed one or more antimicrobials at the time of the survey. The overall prevalence was 34.2% (95% CI: 33.0-35.3). There was no significant change ($p<0.05$) in the prescribing rate compared to 2011 (Table 3.16)

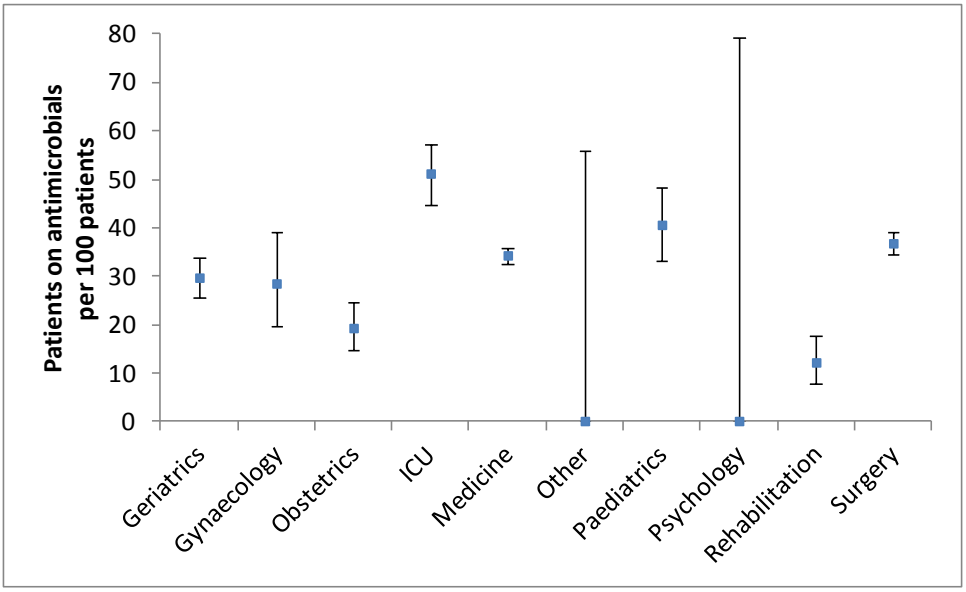
The prevalence of antimicrobial prescribing in the acute hospitals is shown in Table 3.16. More than a third of patients in acute hospitals were receiving at least one antimicrobial at the time of the survey.

Table 3.16 *Prevalence of antimicrobial usage in Wales 2017 in the acute sector*

Hospital type	No. patients	No. patients on AMs	AMR prevalence (%)	95% CI	2011: AMR prevalence (%)
Acute	6400	2186	34.2	(33.0-35.3)	32.7 (31.6-33.9)

Figure 3.10 shows the prescribing rates of patients on one or more antimicrobials by specialty in acute hospitals. ICU was the specialty with the highest antimicrobial usage rate (51.1%), which was significantly higher ($p<0.05$) than the majority of other specialties. The second highest usage rate was in paediatrics, with 40.5% of patients on antimicrobials. Besides the specialties 'other' and 'psychology', which had four patients in total, the lowest antimicrobial usage rates were in rehabilitation (12.1%), which had a significantly lower rate ($p<0.05$) than the majority of other specialties. This was followed by obstetrics with a usage rate of 19.2%.

Details on antimicrobial prescribing rates in acute hospitals by patient specialty can be found in the Appendix, Table A3.



*Excludes one patient on antimicrobials with unknown specialty

Figure 3.10 *Prescribing rate of patients on one or more antimicrobials by specialty in acute hospitals**

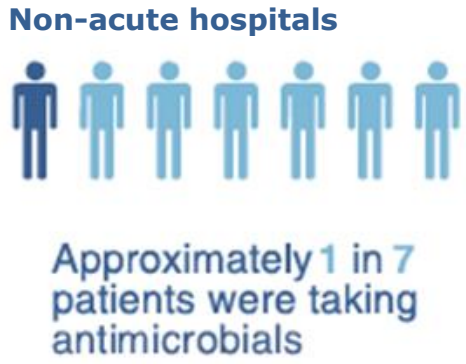
The number of antimicrobials prescribed per patient in acute hospitals in Wales 2017 is described in Table 3.17. Seven out of ten patients who were prescribed antimicrobials were receiving one antimicrobial. Of those prescribed antimicrobials 26% were receiving 2 antimicrobials and 5% three or more antimicrobials during the 2017 survey in Wales. A direct comparison cannot be made between the 2017 and 2011 data as there were differences in the number of antimicrobials that could be recorded between both surveys.

Table 3.17 *Number of antimicrobials prescribed per patient in acute hospitals in Wales for 2017 and 2011*

No. of antimicrobials prescribed per patient	2017		2011	
	No. of patients	% of patients	No. of patients	% of patients
0	4214	65.8	4432	67.3
1	1520	23.8	1425	21.6
2	567	8.9	593	9.0
3	82	1.3	112	1.7
4	16	0.3	19	0.3
5	1	0.0	6	0.1
6*	-	-	0	0.0
7*	-	-	0	0.0
8*	-	-	1	<0.1

*In the 2017 PPS, only five antimicrobials could be recorded for each patient.

Prevalence of antimicrobial prescribing in non-acute hospitals 2017



A total of 181 patients in non-acute hospitals were prescribed one or more antimicrobials at the time of the survey. The overall prevalence was 14.6% (95% CI: 12.7-16.6). There was no significant change ($p<0.05$) in the prescribing rate compared to 2011 (Table 3.18)

The prevalence of antimicrobial prescribing in the non-acute hospitals is shown in Table 3.18.

Table 3.18 *Prevalence of antimicrobial usage in Wales 2017 in the non-acute sector*

Hospital type	No. patients	No. patients on AMs	AMR prevalence (%)	95% CI	2011: AMR prevalence (%)
Non-acute	1243	181	14.6	(12.7-16.6)	13.5 (12.2-14.9)

Figure 3.11 shows the prescribing rates of patients on one or more antimicrobials by specialty in non-acute hospitals. Medicine had the highest antimicrobial usage rate (18.7%). The lowest antimicrobial usage rates were in long term care (6.7%) and surgery (9.4%).

Details on antimicrobial prescribing rates in non-acute hospitals by patient specialty can be found in the Appendix, Table A4.

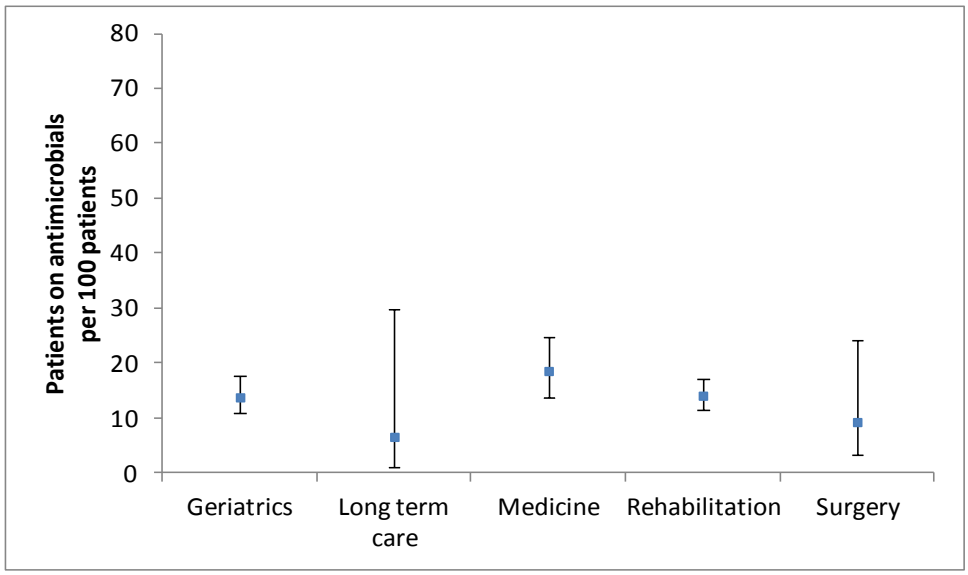


Figure 3.11 *Prescribing rate of patients on one or more antimicrobials by specialty in non-acute hospitals*

The number of antimicrobials prescribed per patient in non-acute hospitals in Wales 2017 is described in Table 3.19. Six out of seven patients who were prescribed antimicrobials were receiving one antimicrobial. Of those prescribed antimicrobials, 10% were receiving 2 antimicrobials and less than 1% three or more antimicrobials during the 2017 survey in Wales. A direct comparison cannot be made between the 2017 and 2011 data as there were differences in the number of antimicrobials that could be recorded between both surveys.

Table 3.19 Number of antimicrobials prescribed per patient *in non-acute hospitals in Wales for 2017 and 2011*

No. of antimicrobials prescribed per patient	2017		2011	
	No. of patients	% of patients	No. of patients	% of patients
0	1062	85.4	2168	86.5
1	161	13.0	290	11.6
2	19	1.5	45	1.8
3	1	0.1	3	0.1
4	0	0.0	0	0.0
5	0	0.0	0	0.0

Characteristics of antimicrobials prescribed in Welsh hospitals 2017

A total of 3171 antimicrobials were recorded in the 2017 PPS in Wales. The number and percentage of prescriptions by indication within the acute and non-acute hospitals is described in Table 3.20. The majority of antibiotics prescribed were for the treatment of infections in both the acute and non-acute hospitals. In 2017 the proportion of total prescriptions that were for community acquired infections was over three times higher in acute hospitals (58.1%) than non-acute hospitals (18.3%). Over a quarter of antibiotics were prescribed for hospital acquired infections (26.2%) within acute hospitals compared with 61.9% in non-acute hospitals. The proportion of prescriptions for medical prophylaxis in non-acute hospitals was over twice that for acute hospitals (15.8% and 7.3%, respectively). The indications for prescriptions in 2017 were similarly distributed to the 2011 PPS for both acute and non-acute hospitals (Table 3.21). As a proportion of overall prescribing, treatment of hospital acquired infections within non-acute hospitals has increased since 2011 while there has been a small decrease in the prescribing of medical prophylaxis within acute hospitals.

Table 3.20 Distribution of antimicrobials by indication for prescribing for acute and non-acute hospitals in Wales 2017

Indication		Acute		Non-acute	
		No. of prescriptions	% of prescriptions	No. of prescriptions	% of prescriptions
Treatment of infection	Community acquired	1726	58.1	37	18.3
	Hospital acquired	777	26.2	125	61.9
	Long term care acquired	34	1.1	0	0.0
	Total	2537	85.4	162	80.2
Prevention of infection	Medical prophylaxis	218	7.3	32	15.8
	Surgical prophylaxis	156	5.3	1	0.5
	Total	374	12.6	33	16.3
Other	Other / Unknown	58	2.0	7	3.5
Total overall		2969	100.0	202	100.0

Table 3.21 Distribution of antimicrobials by indication for prescribing for acute and non-acute hospitals in Wales 2011

Indication		Acute		Non-acute	
		No. of prescriptions	% of prescriptions	No. of prescriptions	% of prescriptions
Treatment of infection	Community acquired	1599	52.1	76	19.5
	Hospital acquired	867	28.2	209	53.6
	Long term care acquired	38	1.2	1	0.3
	Total	2504	81.5	286	73.3
Prevention of infection	Medical prophylaxis	321	10.4	57	14.6
	Surgical prophylaxis	142	4.6	5	1.3
	Total	463	15.1	62	15.9
Other	Other / Unknown	105	3.4	42	10.8
Total overall		3072	100.0	390	100.0

Antimicrobials for treatment of infection

Antimicrobials for treatment in acute hospitals

A total of 2537 antimicrobials were prescribed for the treatment of infection in acute hospitals in Wales 2017. Table 3.22 details the number and percentage of prescriptions by diagnosis in 2017 and a comparison with the 2011 survey. The most common reason for treatment of infection was for respiratory tract within acute hospitals accounting for 5 in 17 antimicrobials being prescribed. Respiratory tract infections included bronchitis, pneumonia and cystic fibrosis. Specifically, 76% of respiratory antimicrobials prescribed were for pneumonia. Treatment of skin / bone/ soft tissue infections were also common with 21.9% of antibiotics being prescribed for this diagnosis category. Treatment of UTI with antimicrobials accounted for 11.7% of prescriptions. Treatment of the diagnosis site of eye had the least antimicrobials prescribed (0.2%) in acute hospitals.

Prescribing by diagnosis site could also be divided into hospital and community acquired. The data are not shown but in summary, for hospital acquired infections respiratory diagnosis resulted in the highest prescribing (31%). Skin / soft tissue / bone accounted for 20% and systemic 17%. For community acquired infections respiratory diagnosis also resulted in the highest prescribing (29%). Skin / soft tissue / bone and GI infections accounted for 23% and 17% prescribing, respectively. UTIs accounted for 13% and 11% prescribing for hospital and community acquired infections, respectively.

The diagnoses for which antimicrobials were prescribed were ranked very similarly in the 2017 survey compared to those in the 2011 PPS, with the most common diagnoses making up similar proportions of prescriptions in both surveys.

Table 3.22 *Prescriptions by diagnosis for treatment of infection in acute hospitals in Wales 2017*

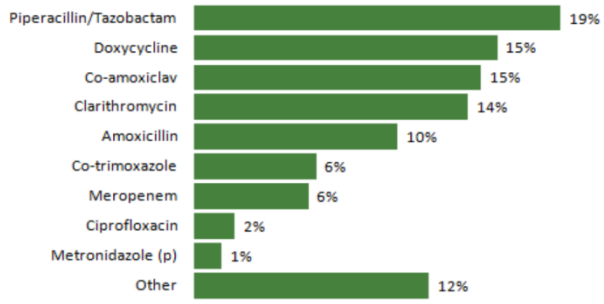
	2017		2011	
Diagnosis	No. prescriptions	% of prescriptions	No. prescriptions	% of prescriptions
Respiratory	747	29.4	851	28.1
Skin/bone/soft tissue	555	21.9	575	19.0
Gastrointestinal	400	15.8	426	14.1
Systemic	321	12.6	416	13.8
UTI	297	11.7	414	13.7
ENT	70	2.8	181	6.0
Cardiovascular	63	2.5	52	1.7
Reproductive tract	47	1.9	78	2.6
CNS	26	1.0	30	1.0
Other/unknown	7	0.3	-	-
Eye	4	0.2	2	0.1
Total	2537	100.0	3025	100.0

Details of the top 10 antimicrobials prescribed for the treatment of the most common infections are provided on the next page.

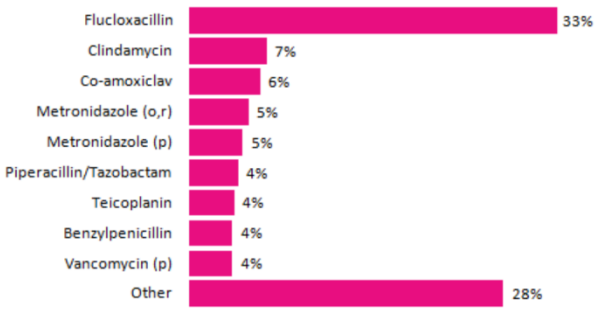
Top 10 antimicrobials for treating infections in Welsh acute care hospitals

Data is shown for the top 10 antimicrobials used to treat the top 5 diagnoses. Includes healthcare associated infections (HAI) using ECDC definitions,community onset infections (COI) and long-term care infections (LI). Excludes propylaxis.

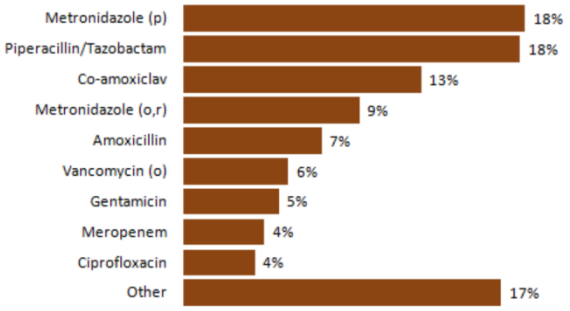
Respiratory tract infections

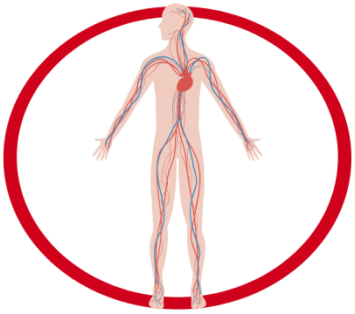


Skin/soft tissue, bone & joint infections

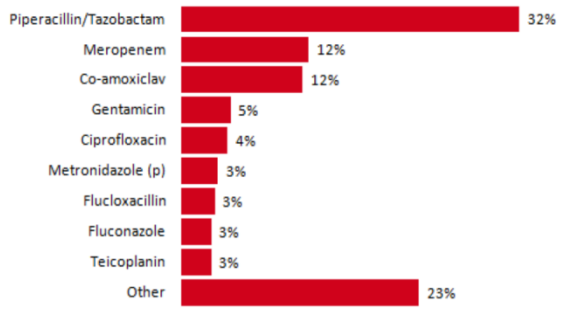


Gastrointestinal infections

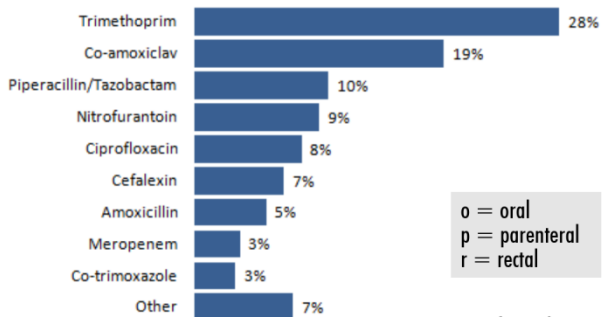




Systemic infections



Urinary tract infections



To provide detail on the antimicrobials prescribed for the treatment of infection a pareto chart was produced (Figure 3.12). In the figure the number of each antimicrobial prescribed is shown as well as the cumulative percentage of antimicrobials. The most commonly prescribed antimicrobial was piperacillin / tazobactam (14.9%). This was followed by co-amoxiclav (11.9%), flucloxacillin (8.0%), doxycycline (5.8%) and 5.6% for amoxicillin and metronidazole (parenteral). These antimicrobials accounted for over 50% of the total prescribing in acute hospitals.

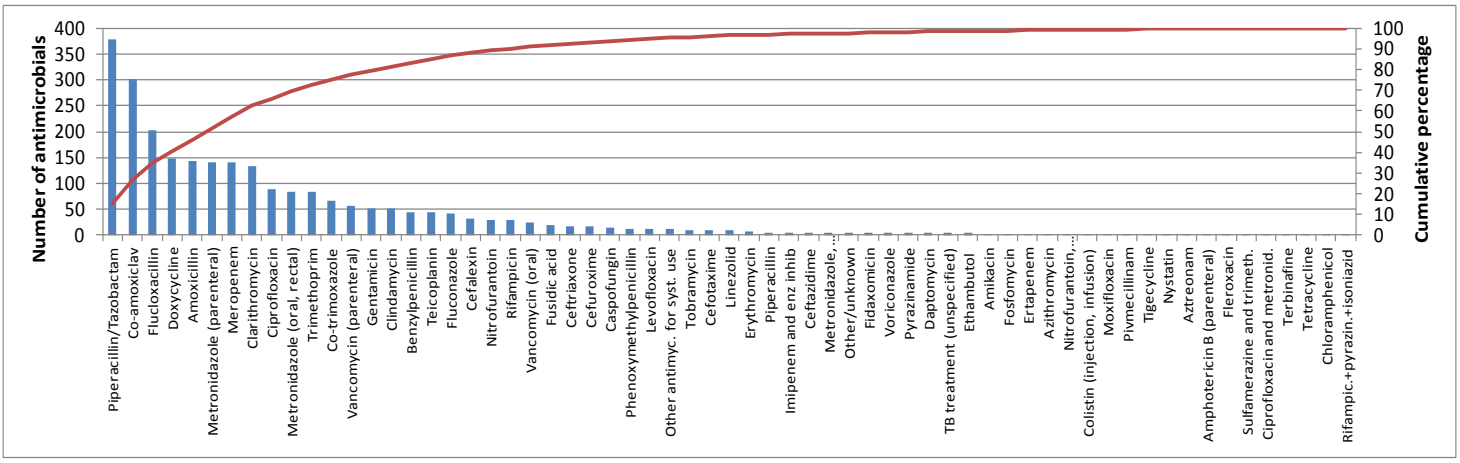


Figure 3.12 *Number and cumulative percentage of antimicrobials prescribed for the treatment of infection in acute hospitals in 2017*

Figure 3.13 details the distribution of antimicrobial groups prescribed for the treatment of infections in acute hospitals in 2017 with a comparison with the 2011 survey in Wales. In acute hospitals, combinations of penicillins including beta-lactamase inhibitors were the largest antimicrobial group, making up 25% of prescriptions. The usage profile was similar to the 2011 survey, except there was proportionally greater use of the sulfonamides and trimethoprim group and decreases in the use of the groups: cephalosporins (second generation) and intestinal antibiotics.

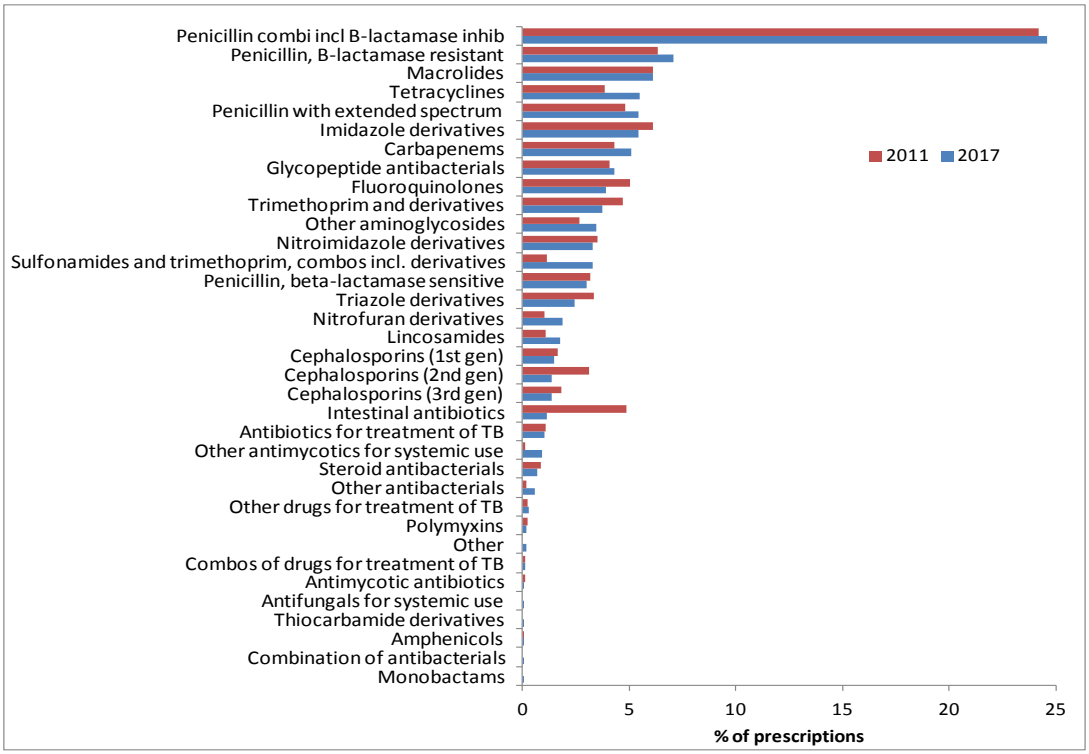


Figure 3.13 *Usage profiles of antimicrobial groups as a proportion of total prescriptions in acute hospitals*

The duration of oral and parenteral antimicrobial treatment for an infection on the day of the survey is described in Table 3.23. Approximately 45% of antimicrobials were administered orally, 55 % parenterally and less than 1% by inhalation. In acute hospitals, patients on oral or parenteral antimicrobials for treatment of infections were most often on day two of treatment on the day of the survey (21%). Antimicrobials prescribed orally where day of treatment was between 1 and 7 accounted for 84% of antimicrobials prescribed. Antimicrobials prescribed parenterally where day of treatment was longer than 3 days accounted for 53% of antimicrobials prescribed.

Table 3.23 *Day of antimicrobial treatment for infections at time of survey by route in acute hospitals*

Day of treatment	No. oral antimicrobials	% of oral antimicrobials	No. parenteral antimicrobials	% of parenteral antimicrobials
1	123	10.8	154	11.1
2	240	21.0	294	21.2
3	166	14.5	209	15.1
4	118	10.3	165	11.9
5	116	10.1	123	8.9
6	104	9.1	108	7.8
7	91	8.0	96	6.9
8	32	2.8	46	3.3
9	15	1.3	33	2.4
10+	138	12.1	157	11.3
Total	1143	100.0	1385	100.0

Figure 3.14 shows the infection types where parenteral antimicrobials were prescribed for more than three days. Where parenteral antimicrobials were given for more than three days in acute hospitals, the majority of diagnoses were skin/bone/soft tissue (23.9%), respiratory (23.4%) and GI infections (20.5%).

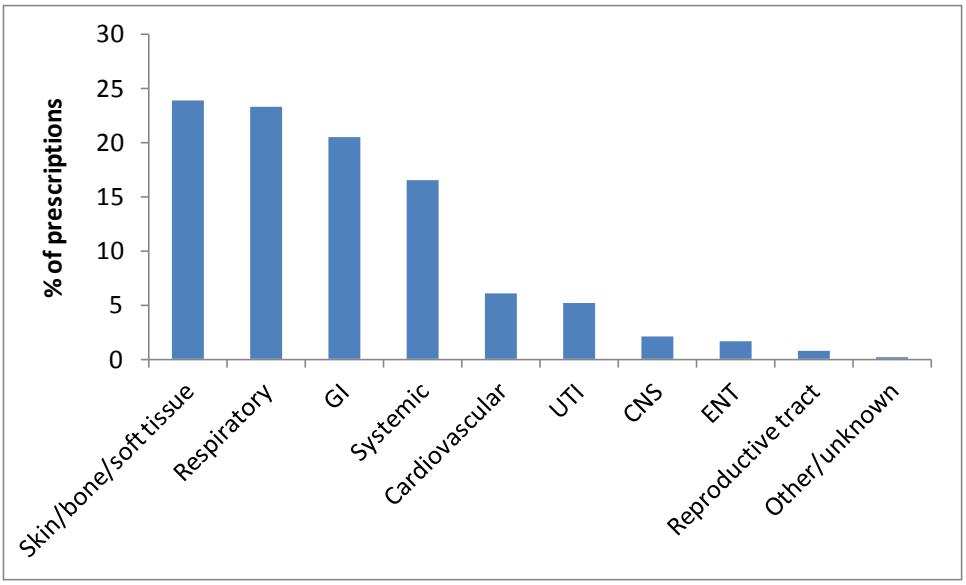


Figure 3.14 *Antimicrobial diagnoses for cases with more than three days of parenteral antimicrobial administration in acute hospitals*

Figure 3.15 shows the infection types where oral antimicrobials were prescribed for more than seven days. Skin/bone/soft tissue infections made up the majority of cases where antimicrobials were given orally for more than seven days in acute hospitals (56.8%). Respiratory and GI infections accounted for 13.5% and 12.4%, respectively.

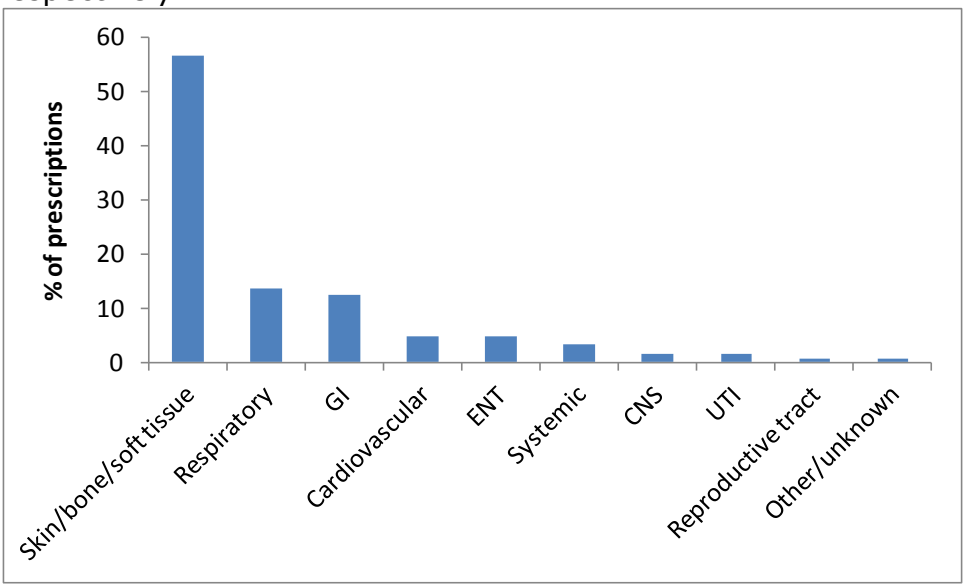


Figure 3.15 *Antimicrobial diagnoses for cases where antimicrobials were given orally for more than seven days in acute hospitals*

Data were captured on whether the reason for prescribing was documented. This could be noted on the drug chart or within the patient / medical notes. The reason for prescribing was documented for 95.9% of the antimicrobials prescribed in acute hospitals.

Antimicrobials for treatment in non-acute hospitals

A total of 162 antimicrobials were prescribed for the treatment of infection in non-acute hospitals in Wales 2017. Table 3.24 details the number and percentage of prescriptions by diagnosis in 2017 and a comparison with the 2011 survey. The most common reason for treatment of infection was for respiratory tract within non-acute hospitals accounting for 35.2% of antimicrobials being prescribed. Respiratory tract infections included bronchitis, pneumonia and cystic fibrosis. Specifically, 65% of respiratory antimicrobials prescribed were for pneumonia Treatment of UTIs was also common with 34.6% of antibiotics being prescribed for this diagnosis category.

Prescribing by diagnosis site could also be divided into hospital and community acquired. For hospital acquired infections UTIs resulted in the highest prescribing (42%). Respiratory accounted for 30% and skin / soft tissue / bone 15%. For community acquired infections respiratory diagnosis resulted in the highest prescribing (51%). Skin / soft tissue / bone and UTIs accounted for 24% and 11% prescribing, respectively (Data not shown).

In non-acute hospitals, the most common antimicrobial diagnoses for infections in 2017 were respiratory, UTI and skin/bone/soft tissue, whereas in 2011 they were UTI, skin/bone/soft tissue and respiratory. This was largely due to a decrease in the proportion of skin/bone/soft tissue diagnoses and an increase in the proportion of respiratory diagnoses. Like acute hospitals, non-acute hospitals also saw a fall in prescriptions for ENT diagnoses.

Table 3.24 *Prescriptions by diagnosis for treatment of infection in the non-acute sector in Wales 2017*

	2017		2011	
Diagnosis	No. prescriptions	% of prescriptions	No. prescriptions	% of prescriptions
Respiratory	57	35.2	81	22.2
UTI	56	34.6	136	37.3
Skin/bone/soft tissue	28	17.3	96	26.3
Gastrointestinal	7	4.3	14	3.8
Systemic	7	4.3	9	2.5
ENT	5	3.1	26	7.1
CNS	2	1.2	0	0.0
Cardiovascular	0	0.0	0	0.0
Eye	0	0.0	0	0.0
Reproductive tract	0	0.0	3	0.8
Total	162	100.0	365	100.0

A pareto chart detailing the antimicrobials prescribed for the treatment of infection is shown in Figure 3.16. In the figure the number of each antimicrobial prescribed is shown as well as the cumulative percentage of antimicrobials. The most commonly prescribed antimicrobial was doxycycline (14.8%). This was followed by co-amoxiclav (10.5%), nitrofurantoin (9.9%), trimethoprim (9.3%) and 8.0% for amoxicillin and piperacillin / tazobactam. These antimicrobials accounted for over 50% of the total prescribing in non-acute hospitals.

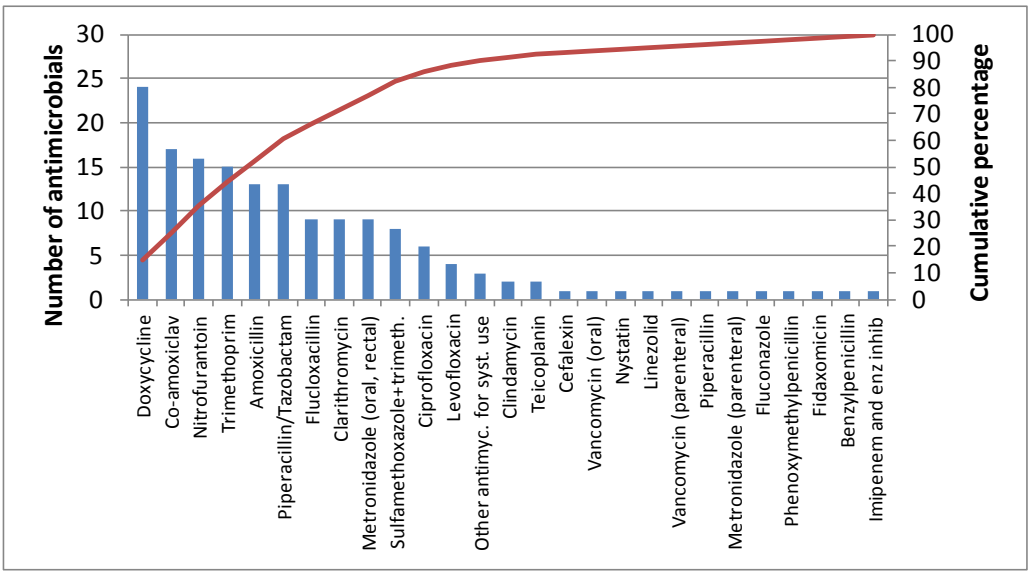


Figure 3.16 *Number and cumulative percentage of antimicrobials prescribed for the treatment of infection in non-acute hospitals in 2017*

Figure 3.17 provides detail on the usage profile of antimicrobial groups as a proportion of total prescriptions in non-acute hospitals. Penicillin combinations including beta-lactamase inhibitors were the most frequently prescribed antimicrobial making up 14% of antimicrobial prescriptions, which was very similar to the 2011 survey. Tetracyclines and nitrofuran derivatives had both increased since the 2011 survey. There were also a number of rarely used groups in 2017 that were not used at all in non-acute in 2011. The number of prescriptions for trimethoprim and derivatives, beta-lactamase resistant penicillin and intestinal antibiotics had all decreased compared to 2011.

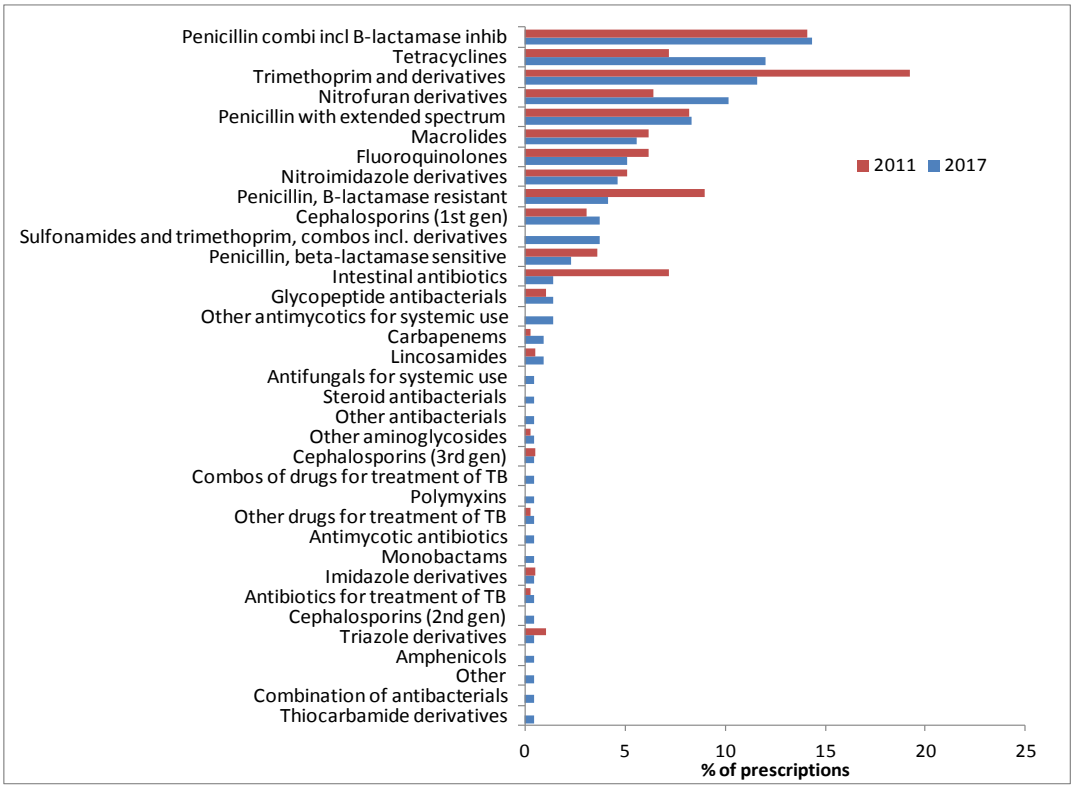


Figure 3.17 *Usage profiles of antimicrobial groups as a proportion of total prescriptions in non-acute hospitals*

The duration of oral and parenteral antimicrobial treatment for an infection on the day of the survey is described in Table 3.25. Approximately 81% of antimicrobials were administered orally and 19% parenterally. In non-acute hospitals the distribution by day of treatment for both oral and parenteral antimicrobials for infections was more evenly distributed between days 1-7 than in acute hospitals (Table 3.25). Antimicrobials prescribed orally where day of treatment was between 1 and 7 accounted for 86% of antimicrobials prescribed. Antimicrobials prescribed parenterally where day of treatment was longer than 3 days accounted for 70% of antimicrobials prescribed.

Table 3.25 *Day of antimicrobial treatment for infections at time of survey by route in non-acute hospitals*

Day of treatment	No. oral antimicrobials	% of oral antimicrobials	No. parenteral antimicrobials	% of parenteral antimicrobials
1	13	9.8	1	3.3
2	18	13.6	3	10.0
3	20	15.2	5	16.7
4	12	9.1	2	6.7
5	22	16.7	5	16.7
6	8	6.1	6	20.0
7	20	15.2	1	3.3
8	3	2.3	0	0.0
9	2	1.5	0	0.0
10+	14	10.6	7	23.3
Total	132	100.0	30	100.0

Data were capture on whether the reason for prescribing was documented. This could be noted on the drug chart or within the patient / medical notes. The reason for prescribing was documented for 92.0% of the antimicrobials prescribed in non-acute hospitals.

Antimicrobials for prevention of infection: Medical prophylaxis

Medical prophylaxis prescribing in acute hospitals

A total of 218 antimicrobials were prescribed as medical prophylaxis in acute hospitals during the 2017 survey. The top 10 antimicrobials prescribed are detailed in Table 3.26 accounting for approximately 82% of antimicrobials. Azithromycin was the top antimicrobial prescribed as medical prophylaxis (13.3%). Other antimicrobials prescribed included trimethoprim (11.5%), co-trimoxazole (11.0%) and nitrofurantoin (10.1%).

Table 3.26 *Details of the top 10 antimicrobials prescribed for medical prophylaxis in acute hospitals in Wales 2017*

Infection site	No. infections	% of medical prophylactic antimicrobials
Azithromycin	29	13.3
Trimethoprim	25	11.5
Co-trimoxazole	24	11.0
Nitrofurantoin	22	10.1
Fluconazole	18	8.3
Phenoxymethylpenicillin	16	7.3
Gentamicin	14	6.4
Benzylpenicillin	12	5.5
Cefalexin	10	4.6
Ciprofloxacin	8	3.7
Total of top 10	178	81.7

A pareto chart describing all antimicrobials prescribed as medical prophylaxis is provided in Figure 3.18.

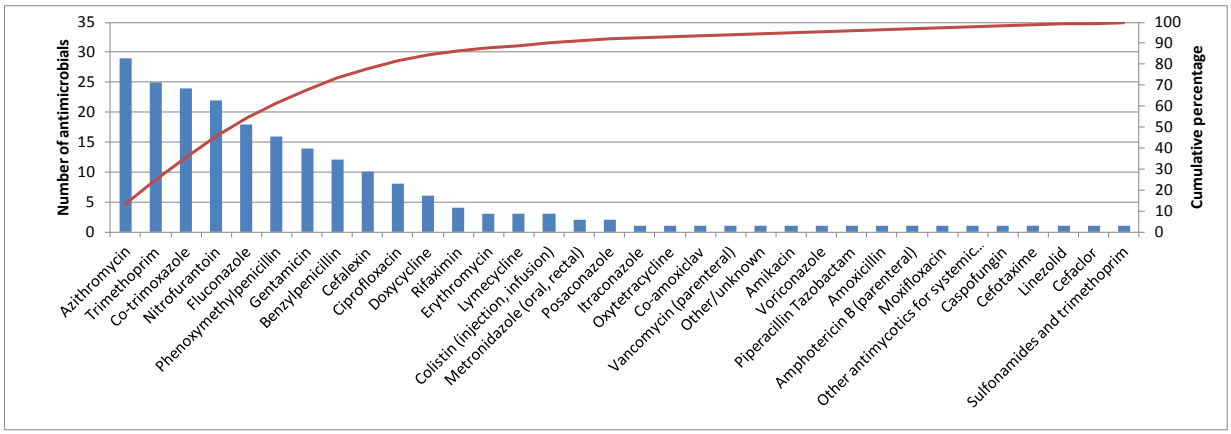


Figure 3.18 *Number and cumulative percentage of antimicrobials prescribed as medical prophylaxis in acute hospitals in Wales 2017*

The reason for prescribing was documented for 83.5% of the antimicrobials prescribed as medical prophylaxis in acute hospitals. Documentation included on the drug chart or within the patient / medical notes.

Medical prophylaxis prescribing in non-acute hospitals

A total of 32 antimicrobials were prescribed as medical prophylaxis in non-acute hospitals during the 2017 survey. A pareto chart describing all antimicrobials prescribed as medical prophylaxis is provided in Figure 3.19. Trimethoprim (21.9%), cefalexin (21.9%) and nitrofurantoin (18.8%) were the most commonly prescribed antimicrobials.

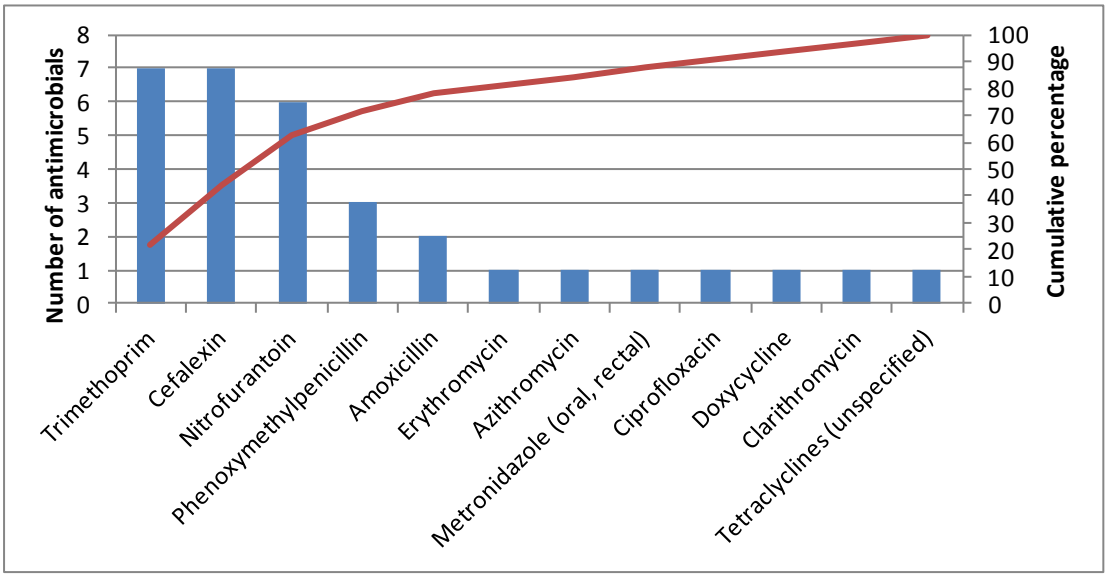


Figure 3.19 *Number and cumulative percentage of antimicrobials prescribed as medical prophylaxis in non-acute hospitals in Wales 2017*

The reason for prescribing was documented only for 37.5% of the antimicrobials prescribed as medical prophylaxis in non-acute hospitals.

Antimicrobials for prevention of infection: Surgical prophylaxis

Surgical prophylaxis prescribing in acute hospitals

A total of 156 antimicrobials were prescribed as surgical prophylaxis in acute hospitals during the 2017 survey. The top 10 antimicrobials prescribed are detailed in Table 3.27 accounting for approximately 89% of antimicrobials. Co-amoxiclav and teicoplanin were the top antimicrobial prescribed as surgical prophylaxis (16%). Other antimicrobials prescribed included cefuroxime (15.4%), gentamicin (13.5%) and metronidazole (parenteral) (10.3%).

Table 3.27 *Details of the top 10 antimicrobials prescribed for surgical prophylaxis in acute hospitals in Wales 2017*

Infection site	No. infections	% of surgical prophylactic antimicrobials
Co amoxiclav	25	16.0
Teicoplanin	25	16.0
Cefuroxime	24	15.4
Gentamicin	21	13.5
Metronidazole (parenteral)	16	10.3
Amoxicillin	8	5.1
Flucloxacillin	6	3.8
Metronidazole (oral, rectal)	6	3.8
Cefotaxime	4	2.6
Tazocin	4	2.6
Total of top 10	139	89.1

A pareto chart describing all antimicrobials prescribed as surgical prophylaxis is provided in Figure 3.20.

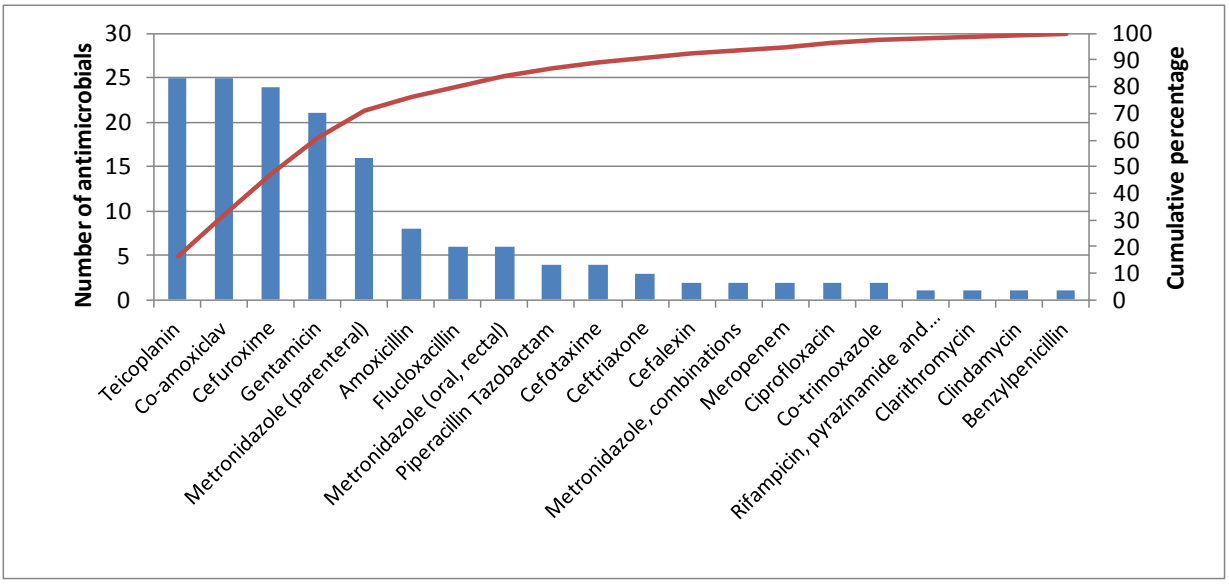


Figure 3.20 *Number and cumulative percentage of antimicrobials prescribed as surgical prophylaxis in acute hospitals in Wales 2017*

The reason for prescribing was documented for 85.3% of the antimicrobials prescribed as surgical prophylaxis in acute hospitals. The duration of prescribing of surgical prophylaxis within acute hospitals is provided in Figure 3.21. A single dose was prescribed in 50% of cases with over 32% of prescribing for more than 1 day of prophylaxis.

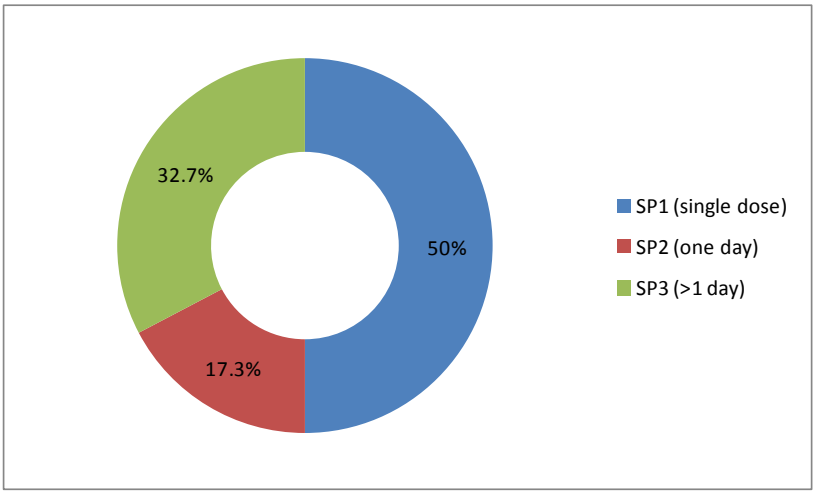


Figure 3.21 *Duration of surgical prophylaxis prescribed within acute hospitals in 2017*

Surgical prophylaxis prescribing in non-acute hospitals

Gentamicin was the only antimicrobial prescribed as surgical prophylaxis within the non-acute sector (n=1).

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

A total of 631 broad spectrum antimicrobials associated with an increased risk of *C. difficile* infection were prescribed during the 2017 survey in acute hospitals. The antimicrobials prescribed (number and percentage) in the 2017 survey in acute hospitals are described in Table 3.28. Penicillins (combinations including b-lactamase inhibitor) was the antimicrobial group with the highest prescribing. Specifically the antimicrobial prescribed from this group was co-amoxiclav (n=336, 53.2%). Fluoroquinolones were commonly prescribed (18.6%) as well as lincosamides (8.2%) and cephalosporins (1st generation) (7.0%).

Table 3.28 *Distribution of broad spectrum antimicrobials associated with an increased risk of C. difficile in acute hospitals in Wales (2017)*

Antimicrobial group	Antimicrobial	No. of antimicrobials	% of antimicrobials
Penicillins, combinations inc. B-lactamase inhibitor	Co-amoxiclav	336	53.2
Fluoroquinolones	Ciprofloxacin	100	15.8
	Levofloxacin	13	2.1
	Fleroxacin	1	0.2
	Moxifloxacin	3	0.5
Lincosamides	Clindamycin	52	8.2
Cephalosporins (1st gen)	Cefalexin	44	7.0
Cephalosporins (2nd gen)	Cefuroxime	40	6.3
	Cefaclor	1	0.2
Cephalosporins (3rd gen)	Ceftriaxone	21	3.3
	Cefotaxime	15	2.4
	Ceftazidime	5	0.8
	Total	631	100.0

Table 3.29 provides details on the number and percentage of antimicrobials with an increased risk of *C. difficile* infection by indication. The majority of antimicrobials associated with *C. difficile* risk were prescribed for the treatment of infection (85.4%) with the majority of treatment for community acquired infection as the indication (64.2%). Surgical prophylaxis accounted for 9.7% of prescribing and medical prophylaxis 3.5%.

Table 3.29 *Details of the indication of prescribing for antimicrobials with an increased risk of C. difficile infection in 2017*

Indication for prescribing	Number of antimicrobials prescribed	% of antimicrobials prescribed
Community acquired	405	64.2
Hospital acquired	125	19.8
Long-term care acquired	9	1.4
Surgical prophylaxis	61	9.7
Medical prophylaxis	22	3.5
Other/unknown	9	1.4
Total	631	100.0

The most common diagnosis site treated with antimicrobials with an increased risk of *C. difficile* was respiratory tract, which made up over a quarter of the prescriptions. UTI and skin / bone / soft tissue made up approximately 19% of prescriptions each. Details on the prescribing rate by diagnosis site are provided in Table 3.30. The table provides the number of prescriptions for treatment of infections only (excludes prophylaxis).

Table 3.30 *Details of the diagnosis site for the treatment of infection with antimicrobials associated with increased risk of C. difficile*

Diagnosis	Number of antimicrobials prescribed	% of antimicrobials prescribed
Respiratory	139	25.8
UTI	101	18.7
Skin/bone/soft tissue	100	18.6
Systemic	74	13.7
GI	71	13.2
Reproductive tract	20	3.7
ENT	15	2.8
CNS	12	2.2
Cardiovascular	4	0.7
Eye	2	0.4
Other/unknown	1	0.2
Total	539	100.0

Process indicators

During the 2017 survey each Health Board was requested to provide information of various indicators associated with IP&C and antimicrobial stewardship structure and processes within Wales. This is the first time that such data has been collected by ECDC and is based on systematic reviews of evidence in the published literature [12]. These indicators provide an opportunity to review the way the I&PC and stewardship programmes are organised within EU countries and allow for benchmarking across Europe. A summary of the data collected is detailed in Table 3.31. Responses in the table were associated with hospital activity, staffing, laboratory routines, infection isolation capacity and antimicrobial stewardship.

In summary, activity data collated shows the average length of stay within acute hospitals to be 3 days. Staffing levels included 166 WTE nurses per 100 beds on average. A total 326 ICU nurses (WTE / 100 beds) were noted with 1.8 IP&C nurses (hospital levels ranged from 0.5 to 5.8) and 0.08 Infection Control Doctors (WTE / 250 beds). The staffing levels in Wales should be reviewed in context of other European countries following publication of the 2016 / 2017 ECDC PPS. Laboratory services in Wales provide a full microbiology clinical testing service, including during weekends. The number of single room and those with en suite facilities were reported at below 50% thus facilitating isolation of patients difficult when required. This is in contrast to many other European hospitals and newly built hospitals in Wales. An antimicrobial stewardship indicator was included that asked if hospitals had a process to review antimicrobials within 72 hours. A total 47.6% of hospitals had such a process review on all wards (n=10/ 21), 28.6% (n=6) on selected wards and 9.5% (n= 2) on ICU.

Due to limited time and resource in collating the indicator data, results should be treated with caution and will not be discussed further in the discussion section of the report.

Table 3.31 *Details of Infection Prevention & Control and antimicrobial stewardship structure and process indicators in Welsh acute hospitals in 2017*

	Indicator	Value
Activity	Number of acute hospitals	21
	Number of acute hospitals with ICUs	16
	Total beds	7848
	Discharges in one year	827 634
	Patient days in one year	2 451 003
	Average length of stay (days)	3.0
Staffing	Nurses WTE/100 beds	166 (based on 18/21 hospitals)
	ICU nurses WTE/100 beds	326
	Infection prevention and control nurses WTE/250 beds	1.8
	Infection control doctors WTE/250 beds	0.08
Laboratory	Availability of microbiology clinical testing on Saturdays	21/21 hospitals
	Availability of microbiology clinical testing on Sundays	21/21 hospitals
	Availability of microbiology screening testing on Saturdays	21/21 hospitals
	Availability of microbiology screening testing on Sundays	20/21 hospitals
	Blood culture sets tested per 1000 patient days	42
	Stool tests for C. difficile infection per 1000 patient days	15
Isolation capacity	Percent of beds that were single rooms	22%
	Percent of single rooms that have en-suite	41%
Antimicrobial stewardship	Antimicrobial stewardship roles WTE/250 beds	0.58
	Process to review antimicrobials in 72 hours	All wards=10 hospitals Selected wards=6 hospitals ICU only =2 hospitals No/unknown=3 hospitals

Validation of the 2017 PPS data in Wales

The validation exercise collected data on 969 patients in ten hospitals, who had already been sampled in the primary data collection. The results are presented in Table 3.32, which details the sensitivity and specificity of the primary data collected in Wales. When compared to the validation dataset, the primary PPS data had a high sensitivity and specificity in identifying patients as having HAIs or being on antimicrobials.

Table 3.32 *Sensitivity and specificity results for the validation exercise*

	Sensitivity % (95% CI)	Specificity % (95% CI)
Patient has one or more HAI (Y/N)	93.6 (85.7-97.9)	99.8 (99.2-100.0)
Patient on one or more antimicrobials (Y/N)	98.4 (96.3-99.5)	100.0 (-)

HAIs

In acute hospitals 352 out of 6400 patients had HAIs in the primary survey. According to the validation results, the primary survey had 93.6% sensitivity so it missed an estimated 6.4% of patients with HAIs (approximately 23 patients). The validation results show the primary survey had a specificity of 99.8% so it falsely identified 0.2% of patients as having HAIs (approximately 1 patient).

Adjusting the acute hospital primary survey data for these estimated false negatives and false positives gives an estimate of 375 patients with HAIs, so 5.9% of patients had one or more HAIs (95% CI: 5.3 to 6.5), compared to the pre-adjusted figure of 5.5% (95% CI: 5.0 to 6.1). The validation exercise only sampled acute hospital data and it may not be comparable for use to non-acute hospital data.

Antimicrobials

In acute hospitals 2186 out of 6400 patients were receiving antimicrobials in the primary survey. According to the validation results, the primary survey had 98.4% sensitivity so it missed an estimated 1.6% of patients who were receiving antimicrobials (approximately 35 patients). The specificity was 100% so zero patients were incorrectly identified as receiving antimicrobials.

Adjusting the acute hospital primary survey data for the estimated false negatives gives an estimate of 2221 patients receiving antimicrobials, so 34.7% of patients were receiving one or more antimicrobials (95% CI: 33.5-35.9), compared to the pre-adjusted figure of 34.2% (95% CI: 33.0 to 35.3).

Discussion

The aims and objectives of the 2017 PPS in Wales were as set out below:

- Determine the HAI prevalence as well as the type of infections causing the greatest burden of disease within acute and non-acute hospitals
- To estimate the percentage of community onset infections (COI) contributing to the total burden of infection within acute hospitals
- Determine the prevalence of device usage and estimate device related infections
- Measure antimicrobial prescribing and report on types of antimicrobials prescribed
- Identify priority areas for infection reduction, antimicrobial stewardship and quality improvement interventions to reduce AMR and HAIs.
- Contribute to ECDC EU-wide prevalence survey results for 2016 / 2017

It was important to include both acute and non-acute hospitals in this PPS in Wales, as Health Boards and Trusts in Wales are responsible for IP&C and antimicrobial stewardship across both healthcare sectors as well as the community.

In summary, the findings of the 2017 survey indicate a HAI prevalence of 5.5% in acute hospitals in Wales, showing a burden equivalent to one in every eighteen patients with an infection associated with a healthcare setting. The prevalence of healthcare infections within non-acute hospitals was 6% with one in every seventeen patients having an infection. Approximately 45% of patients had one or more devices in situ during the survey within acute hospitals and a lower prevalence of 20% in non-acute hospitals. More than a third of patients were receiving at least one antimicrobial at the time of the survey in the acute sector (34.2%) and one in seven within the non-acute sector (14.6%). This correlates with the annual AMR PPS in Wales [13]. Pneumonia was the highest reported infection within acute hospitals accounting for over 19% of reported infections. This was followed by UTI (15.9%) and SSI (11.3%). In non-acute hospitals UTIs accounted for over 45% of infections reported, followed by skin / soft tissue (13.3%) and pneumonia (12.0%).

The results from the 2017 survey were compared with the previous survey conducted in Wales in 2011. In summary the HAI prevalence within the acute sector was higher in 2017 than in 2011 (prevalence of 4.3%). One in every twenty three patients had a HAI in the 2011 survey. The HAI prevalence in the non-acute sector was unexpectedly higher than the acute sector figure in 2017 and has almost doubled since the 2011 survey (3.2%). Anecdotally, this may be related to attempts to shift care out to non-acute hospitals to manage the ever increasing pressure on acute beds thus making the 'non-acute' hospitals more acute in their care. Overall the percentage of patients with one or more devices in situ has not changed since the 2011 survey in acute hospitals, however, device usage has increased within the non-acute sector since 2011 (13.7% 2011 compared with 20% 2017). The prevalence of antimicrobial prescribing (acute and non-acute hospitals) has not significantly changed since 2011.

Although the same top three infections were reported in 2011 for the acute sector, their ranking has changed with SSI top in 2011 (23.7%) followed by UTI

and pneumonia. As in 2017, UTIs were the top reported infection within the non-acute sector in 2011 accounting for over 36% of infections.

The prevalence of infection in the acute hospital setting was highest in ICU (17.7%) and this is comparable to 2011 results (12.8%). ICU was the specialty with the highest antimicrobial usage rate (51.1%) and was comparable to 2011 (55.2%). The HAI prevalence / antimicrobial usage is consistent with the sickest patients with much co-morbidity being in this specialty [14]. In non-acute hospitals the specialty with the highest infection prevalence and antimicrobial usage was medicine and rehabilitation with infection prevalence of 8.8% and 8.2% and antimicrobial usage of 13.8% and 11.6%, respectively. The results were similar to those in the 2011 survey. The results would correspond to the patient mix within a community hospital setting of an ageing population.

To determine the accuracy of reporting of infections and prescribing data, validation of the data was undertaken for the acute hospitals only. Within Wales a validation team was able to validate infection and prescribing data for 969 patients and allow for an adjusted prevalence. As a result the adjusted HAI prevalence was estimated as 5.9% (95% CI: 5.0 to 6.1) compared with 5.5% and the antimicrobial prescribing rate was estimated as 34.7% (95% CI: 33.5 to 35.9) compared with 34.2%. Results from the validation show the data collected for 2017 to be accurate. A comparison with 2011 cannot be made as validation was not conducted. For this reason, the data for 2011 should be treated with some caution because the lack of validation means the accuracy of the 2011 data is unknown.

Survey population

Since 2011 there has been a change in the population within Wales, specifically in the 65 and over age group. Since 2011 this age group has increased by 12% [15]. The median age within acute hospitals in 2017 was 74 and 83 within non-acute hospitals. Comparison with the 2011 PPS survey showed a 4% increase in patients sixty five and over within the acute hospitals and a 13% increase within non-acute hospitals. A change in the demographics of the population will certainly have implications on infection risks especially within an aging population that is predicted within future years [16]. Importantly, the survey would suggest that an aging population will put extra pressure on service delivery within acute, and especially, non-acute hospitals.

In addition, since the survey in 2011 there is almost half the number of non-acute hospitals available for care and inclusion in the PPS. Only 34 were surveyed in 2017 compared to 66 in 2011. As a result the population surveyed was also reduced by half. Interestingly we did not have a significant increase in the population or number of hospitals surveyed within the acute sector. This may suggest increased management of care outside of hospital settings.

Changes to the survey methodology

The 2017 PPS survey was conducted during the summer month (June) compared with November in 2011. There is evidence of seasonality for some HAIs such as RTIs peaking in winter months and central line BSIs peaking in summer months [17]. Despite this, the finding of the 2017 survey was that pneumonia was a greater

burden of HCAI in the June survey than in the 2011 survey conducted in November. The increase seen is likely to be due to the definition changes therefore we feel that making a direct comparison of the 2011 and 2017 surveys is difficult. Since the last survey there has been an amendment to at least one infection definition, in particular, pneumonia. Only one definitive chest x-ray was required in patients with no underlying cardiac or pulmonary disease compared to two in the last survey [6].

In the current survey Wales opted to use a web tool (developed by ICNet) [7] for data capture instead of paper based surveillance. This allowed for built-in validation of the data captured and access to an 'infection checker'. The latter enabled the data collector to work through a series of questions to determine if an infection was present or not. The checker would determine if the questions answered met an ECDC definition of infection. In this way there was better consistency of infection diagnosis across Wales and a quick and easy way of determining the infection status of patients. Pharmacists and infection control nurses responded positively to the system due to decreased workload for data entry and this in turn led to increased accuracy of the data captured. Some further development to this system is required, however the tool created will be of ongoing benefit to infection control teams, pharmacists and PHW. Work is currently being undertaken so that the system is available for infection control staff and pharmacists to perform independent, ad-hoc PPS and receive automated reports, without input from PHW or ICNet.

In addition, this survey allowed the opportunity for staff completing the form to access electronic results, for example, laboratory / diagnostic results and chest x-rays. This additional data provided evidence of infection required to meet an ECDC definition of infection. As a result there was an opportunity to diagnose more infections during this survey, resulting in an increase or perhaps a better measure of the infection prevalence.

Risk factors for HAI and antimicrobials

Risk factors for HAI

In acute hospitals patients admitted for longer than seven days had an increased prevalence of HAIs (Appendix: Tables A5, A6). Patient age had an association with HAI prevalence with the lowest prevalence of HAIs in 0-15 year olds (Appendix: Tables A5, A6). Males had a significantly higher HAI prevalence than females. However this risk factor was not associated with increased prevalence when included in logistic regression modeling. (Appendix: Table A5).

ICU had the highest prevalence of HAIs (17.7%), which may be related to the higher prevalence of invasive devices on ICU compared to other specialties (Appendix: Tables A5, A6). Some of the apparent HAI risk associated with certain specialties, particularly ICU, may have been due to the severity of co-morbidities within those specialties. The McCabe score could be used to measure and account for such co-morbidities (Scottish report), but this was not collected because there were questions over how reliably the scoring was applied in the 2011 PPS in Wales. Having surgery since admission was also associated with a higher risk of

HAIs, but further analysis by surgery type was not possible because the type of surgery was frequently not specified (Appendix: Tables A5, A6).

In non-acute hospitals the univariate analysis did not identify any risk factors as being associated with increased HAI prevalence (Appendix: Table A9).

Risk factors for antimicrobials

In acute hospitals patients in their first seven days of admission had the highest antimicrobial prevalence (39.4%) (Appendix: Table A7) showing an association between length of stay and prevalence (Appendix: Table A8).

Males were significantly more likely to be on antimicrobials than females (Appendix: Tables A7, A8). When other risk factors were taken into account patients in the 0-15 age group were associated with a lower prevalence of antimicrobial use than other age groups (Appendix: Tables A7, A8) and this correlates with the lower HAI prevalence within this age group.

ICU and paediatrics had the highest antimicrobial usage rate (51.0% and 40.5% respectively). Patient specialty was found to have a significant association with antimicrobial usage (Appendix: Tables A7, A8), again similar to the association with HAI prevalence.

For non-acute hospitals, no risk factors were included in a multivariable model because the univariate analysis did not find them to be significant in determining the antimicrobial prevalence (Appendix: Table A9).

The burden of healthcare associated infection in Wales

Burden of community onset infections

During the survey we estimated the total burden of infections within acute hospitals in Wales. This was achieved through capturing data on four specific infection types, namely, UTI, BSI, GI and pneumonia. The additional data captured allowed for the proportion of acute HAIs to be compared with community onset infections (COIs). The latter are infections that originate within the community but it is not possible to determine if they are all healthcare related. Although not all healthcare related, they do contribute to the total burden as they require treatment and care, usually including antimicrobial therapy. When the burden of COIs within acute hospitals was determined almost 70% of UTIs, GIs and pneumonia recorded were attributed as community onset. If only acute HAIs were considered there would be a gross under estimation of the burden of patients being treated for an infection within acute hospitals in Wales.

Estimation of the total burden of infection is important when estimating the financial and economic burden of infection to the NHS [18]. Admission of patients with COIs will adds to the demands on NHS staff, increases the risk of spread of infections, are associated with an increased length of stay and additional costs due to treatment with antimicrobials.

Characteristics of infections in detail within acute hospitals

In the 2017 survey the overall burden of the top five infections were estimated. These included pneumonia, UTI, SSI, BSI and GI within acute hospital settings.

Pneumonia

Pneumonia was identified as the top infection within acute hospitals in the 2017 survey with almost 20% of infections noted. Of concern is the fact that the proportion of infections caused by pneumonia has increased by approximately 7% since the 2011 survey. The overall prevalence of pneumonia within acute hospitals was 3.5%. Only 3 in 10 of patients had a pneumonia infection that was hospital acquired showing a strong association with the community. The major causative organism for pneumonia was *Pseudomonas aeruginosa* (21%). However, this data should be treated with caution as not all pneumonia was microbiologically diagnosed. Only a small proportion of microbiologically diagnosed pneumonia was attributed to ICU and the majority to the medical specialty.

A total of one in five of all antimicrobials prescribed were for the treatment of pneumonia. The most commonly prescribed antimicrobials were piperacillin / tazobactam (22%), clarithromycin (16%) and co-amoxiclav (16%).

In Wales there is no incidence survey for pneumonia in the acute sector apart from ventilator associated pneumonia on ICU [19]. A recent study by Baker and Quinn (2018)[20] highlighted the significant burden of non-ventilator healthcare associated pneumonia in the US acute care hospital settings. Over 70% of such infections were acquired outside of ICU with patients of all ages carrying some risk[20]. In the 2017 survey in Wales only approximately 40% of patients with pneumonia infection within the acute sector were intubated prior to development of infection. There is a need to prioritise and better understand the burden of non-ventilator healthcare associated pneumonia in Wales and to focus interventions to prevent both healthcare associated pneumonias and those originating in the community. For example, oral care has been associated with good evidence of benefit as an intervention, as has early mobilisation of patients to improve clearance of respiratory secretions [20;21]. Pneumonia is a major burden of infection across our healthcare services, our results concur with results from Scotland and England [10;11].

UTI

The overall prevalence of UTI within acute hospitals was 2.7%. Two thirds of UTIs were associated with the community. UTIs were the second highest infection type within the acute sector accounting for 16% of HAIs. The commonest microorganism associated with UTIs was E*. coli*. This would co-inside with increasing E. *coli* bacteraemia trends in Wales and corresponding UK countries [11]. In 2017 / 2018 a new reduction expectation to reduce *E.coli* blood stream infections was introduced by the Welsh Government. This is in direct response to delivering the UK commitment to halve Gram negative bacteraemias by 2020/21 [1] and will be a priority for Health Boards and Trusts in Wales. In addition, the HAI /

AMR programme carries out antimicrobial reporting to track antimicrobial resistance trends in Wales, including E. *coli* resistance and will provide valuable prescribing and AMR data (ref the report).

A total 50% of patients with a healthcare UTI in the acute sector had a catheter in situ within seven days prior to infection. The percentage catheterisation was lower when all UTI were considered (including COI) suggesting patients are being treated within the acute sector for UTIs that are not necessarily hospital acquired and device related. UTIs were more commonly associated with females and elderly patients and resistance in specimens from the elderly has been reported as particularly high at 47.4% for females [22].

A total of one in ten of all antimicrobials prescribed were for the treatment of UTI. The most commonly prescribed antimicrobial for a lower UTI was trimethoprim (37%) and co-amoxiclav (29%) for an upper UTI.

UTIs remain at a similar prevalence in 2017 as compared with the 2011 survey. Although many interventions have been introduced to reduce such infections within Health Boards in Wales, this survey would suggest that these have not been effective yet. There is more urgency to the work to reduce the burden of UTI now due to the increasing antimicrobial resistance being seen in urinary isolates and in E*. coli* bloodstream infection isolates. There is a requirement to implement multimodal interventions to reduce the burden of healthcare associated UTI in all patients, especially with focus in the community and prescribing within primary care. Interventional work will continue in Wales such as hydration initiatives, CAUTI bundles, urine sampling and appropriate prescribing of antimicrobials as well as addressing E. *coli* infections related to surgery.

SSI

The total prevalence of SSI within the acute sector was 0.6%. The majority of infections were deep seated as would be expected for treatment within a major acute hospital. The most common causative organisms were *S. aureus* and E. *coli*. In the 2017 survey SSIs were associated with general and orthopaedic / traumatology surgical specialties. The majority of infections being treated were as a result of readmissions to hospital and readmission surgery with only 27% of patients having had surgery since admission to hospital. Although SSIs have reduced there is still a burden on the NHS to treat and manage serious infections including at times the need for further surgery. This has cost implications for the NHS and an additional burden of morbidity and mortality for the patient [3].

A total of 4% of all antimicrobials prescribed were prescribed for the treatment of an SSI. The most commonly prescribed antimicrobials could be split into skin and soft tissue infections and bone / joint infections. flucloxacillin (21%) was most commonly prescribed for skin / soft tissue infections whilst rifampicin (18%) was most commonly prescribed for bone / joint infections.

The proportion of SSI cases has more than halved since the 2011 survey. There has been an extensive SSI programme of work conducted by Public health Wales [23] to reduce such infections particularly associated with caesarean section surgery and hip and knee surgery in Wales. In addition the 1000 Lives plus programme has introduced various quality improvement interventions to reduce SSI infection

in general [24]. It is important that the NHS in Wales takes forward the good work already done to reduce SSI in these specialties and apply this throughout the other surgical specialties. This should include adherence to the WHO bundle compliance, application of NICE/CDC guidelines and appropriate antimicrobial prophylaxis [25;26].

BSI

The overall prevalence of BSI within acute hospitals was 1.1% with a prevalence of 0.6% specifically noted as HAI. A total 9% of all antimicrobials prescribed were for the treatment of a BSI. The most commonly prescribed antimicrobial for treatment was piperacillin / tazobactam. The commonest causative organism was again *E. coli* with *S. aureus* ranked second. The median age of patients with infection was 72. A total of 75% of patients with a HAI- BSI had a vascular catheter in-situ 48 hours prior to detection of infection. This would suggest an association of BSIs with device usage as a risk factor with opportunities to reduce the burden of disease through improvements in device management. Over 21% of BSIs were associated with a UTI and *E. coli* is the commonest causative organism recorded for these infections. Therefore reducing the burden of UTIs is a means of reducing the burden of *E. coli* BSIs also.

GI

The total prevalence of GIs in acute hospitals was 2.0%. Community onset infections accounted for a prevalence of 1.4%, thus accounting for 70% of GIs reported and suggesting that such infections were being treated for patients transferred from the community. Overall, a quarter of patients with a GI were being treated for C. *difficile* within acute hospitals. Other GIs being treated were intra-abdominal infections and gastroenteritis (excluding CDI). Although only 3 in 10 of all GIs were hospital acquired, 68% of these were recorded as C. *difficile*. The infections affected males and females equally with a median age of 69. C. *difficile* is one organism used as an indicator of the burden of infection. In Wales, *C. difficile* forms part of a HAI reduction expectation across Health boards and Trusts and decreases in infection rates have been achieved [27]. However, there is a need to undertake further work to strive to reduce risk factors that will prevent the development of *C.difficile* related disease. This includes interventions around modifying antimicrobial policies and implementing strict antimicrobial stewardship, environmental cleanliness, bundle compliance and adhering to hand hygiene guidance.

A total of 14% of all antimicrobials prescribed were for the treatment of a GI. Treatment was split into the diagnosis sites of intra-abdominal sepsis and GIs. Piperacillin / tazobactam (21%) and metranadazole (parenteral) (21%) were commonly prescribed for the former infections and vancomycin (oral) (27%) for the latter infections. Health Boards and Trusts in Wales need to ensure appropriate prescribing of antimicrobials and antacids across all healthcare settings.

Infections within non-acute hospitals

Within the non-acute hospitals 75 HAIs were recorded during the 2017 survey. UTI was the most common infection accounting for 45% of all infections noted. Other common infections included skin / soft tissue and pneumonia. There has been a 9% increase in UTIs when comparing the 2017 with 2011 survey. Interestingly the prevalence of pneumonia has more than doubled. Again this corresponds to the findings within the acute sector and is further evidence for investigation of such infections within a community setting. The increase in UTIs may be linked again with an aging population where patients in the community move from acute care to non-acute and vise versa for treatment and as speculated, there may be an attempt to shift care out to non-acute hospitals to manage the increasing pressure on acute beds.

There is a need to focus on the broader burden of infection and antimicrobial resistance across all healthcare settings and across the population and especially in older people. Furthermore a review of the resources required for preventing infections and antimicrobial resistance is required with a particular focus on addressing prevention and management in the community.

Microbiology

Many of the HAI epidemiological case definitions used within the PPS can be met without positive microbiology and are based on clinical confirmation or signs and symptoms. The distribution of organisms captured within this survey is not likely to represent all causative organisms causing infections with acute and non-acute sectors in Wales. As a result, interpretation of microbiology results should be treated with caution.

Microbiology data captured during the 2017 survey showed *E. coli* to be the commonest organism identified from the infections documented, followed by *S. aureus*. As previously mentioned the increase in *E. coli* bacteraemias in Wales is of concern, as in common with the rest of the UK there is an associated increase in antimicrobial resistance within these isolates [22]. Reduction in the burden of Gram negative BSIs is a specific target related to the UK antimicrobial resistance strategy and as previously mentioned, forms part of a reduction expectation in Wales.

Prevalence of device usage in hospitals in Wales

Approximately 9 in 20 patients had one or more devices in situ within acute hospitals during the survey (45%). There has been a significant decrease in the use of urinary catheters since the survey in 2011 (16.2% 2017; 19.2% 2011) in the acute hospitals. However there has been a significant increase in urinary catheter use in the non-acute sector (17.1% 2017; 12.1% 2011). In particular, over 20% of patients under geriatric medicine had a urinary catheter in situ. This may suggest an increase in the care of elderly patients due to the ageing population coupled with a shift in care from acute sector hospital settings. The highest specialty for device use in general in acute hospitals was ICU, as expected. PVC had the highest device usage within acute hospitals (prevalence of 36%) with the highest prevalence within ICU, gynaecology and surgery. Within non-acute hospitals PVC usage had a prevalence of 3.5% and was the second

highest of devices being in situ. The survey indicates the need for further work around catheter use across all healthcare settings.

Although pneumonia accounted for the highest infection type within the acute sector only 31% of all infections were as a result of intubation. Specifically when looking at acute HAI, four out of ten patients with a HAI were intubated within 48 hours of the survey being conducted. In 2007 the 1000 Lives Programme in conjunction with the National Leadership and Innovation Agency for Healthcare [28] developed a care bundle to reduce ventilated associated pneumonia (VAP) in critical care. Since this time the VAP care bundle has been fully embedded within all units in Wales. It is for this reason that it is probable that intubated pneumonia accounts for less than 50% of pneumonia infection within the acute sector.

In general, there is a need to improve medical device management across the healthcare sector to prevent sepsis and BSIs. Audit or surveillance of device usage should be monitored along with compliance with care bundles (PVC, CVC, VAP) and ANTT [29]. Medical device management should also include the STOP campaign, NEWS and SEPSIS 6 [30].

Prevalence of antimicrobial prescribing in hospitals in Wales

A total of 2186 patients were prescribed one or more antimicrobials at the time of the survey within acute hospitals in 2017. The antimicrobial prescribing prevalence was 34.2% and showed no significant change since 2011 (32.7%). Approximately 70% of patients were receiving one antimicrobial within the acute sector. In non-acute hospitals 181 antimicrobials were prescribed with a prevalence of 14.6%. Highest prescribing was noted in medicine. Again, the majority of patients were receiving one antimicrobial (85%) at the time of the survey. Further detail on the prescribing results from the 2017 PPS survey is discussed below.

Characteristics of antimicrobials prescribed

The majority of antimicrobials prescribed were for the treatment of infections in both acute and non-acute hospitals (80% and over). Over half of infections being treated with antimicrobials within the acute sector were indicated for community acquired infections (58.1%). Within non-acute hospitals only 18% of prescriptions were for the treatment of community acquired infections with the majority indicated in the treatment of hospital acquired infections. Treatment of hospital acquired infections as a proportion of overall prescribing has increased within non-acute hospitals since the survey in 2011 (61.9% 2017; 53.6% 2011).

Antimicrobials for treatment of infection

The most common reason for treatment with antimicrobials within acute hospitals was respiratory infections. Within acute hospitals five in every seventeen antimicrobials prescribed (29.4%) were for respiratory tract infections (RTIs). The latter category of infections included bronchitis, pneumonia and cystic fibrosis. Respiratory infections resulted in the highest prescribing of antimicrobials for both hospital and community acquired infections (31% and 29%) within acute hospitals. Specifically, 76% of respiratory infections being treated with

antimicrobials were pneumonia. This statistic was similar within non-acute hospitals. Pneumonia as the top infection requiring antimicrobial treatment is consistent with the top infection diagnosed within acute hospitals during the survey. Other infections more commonly being treated within acute hospitals included skin / bone / soft tissue infections (21.9%) and UTIs (11.7%).

The prescribing rates noted in the 2017 survey were similar to that of the 2011 PPS. The top three antimicrobials prescribed for RTI were piperacillin / tazobactam (19%), doxycycline; co-amoxiclav (15%) and clarithromycin (14%). For UTIs the top antimicrobials prescribed included trimethoprim (28%), co-amoxiclav (19%) and piperacillin / tazobactam (10%). When considering prescribing overall the top antimicrobial prescribed during the 2017 survey was piperacillin / tazobactam followed by co-amoxiclav and flucloxacillin. When considering antimicrobial prescribing groups, combinations of penicillins including beta-lactamase inhibitors were the largest group accounting for 25% of prescriptions within acute hospitals. The usage profiles in 2017 were similar to 2011 except there was proportionally greater use of co-trimoxazole and decreases in the use of cephalosporins (2nd generation) and intestinal antibiotics.

Over half of antimicrobials were administered parenterally with the majority of patients on day 2 of treatment. However over 50% of such administrations was longer than 3 days. Treatment of over 3 days was attributed to skin / bone and soft tissue infections, RTI and GI. In total 84% of oral antimicrobials were prescribed between 1 and 7 days. A similar prescribing pattern was noted as with parenteral antimicrobials when oral antimicrobials were prescribed beyond seven days.

Within non-acute hospitals, the most common reason for antimicrobial treatment was for RTIs (35.2%), with pneumonia as the main RTI. Treatment of UTIs was also common with 34.6% of antimicrobials being prescribed for this infection category. For hospital acquired infections, UTIs resulted in the highest prescribing (42%) followed by RTI (30%). This differed to the results within acute hospitals where RTIs had the highest prescribing rates (31%). The prescribing data on UTIs is in concordance with the infection results within the non-acute hospitals where UTI was the top infection. For community acquired infections RTIs accounted for the greatest prescribing (51%).

When considering prescribing overall the top antimicrobial prescribed during the 2017 survey was doxycycline (14.8%) This was followed by co-amoxiclav (10.5%), nitrofurantoin (9.9%), trimethoprim (9.3%) and 8.0% for amoxicillin and piperacillin / tazobactam. These antimicrobials accounted for over 50% of the total prescribing in non-acute hospitals.

When considering antimicrobial prescribing groups, combinations of penicillins including beta-lactamase inhibitors were the most frequently prescribed antimicrobial making up 14% of antimicrobial prescriptions, which was very similar to the 2011 survey. Tetracyclines and nitrofuran derivatives had both increased since the 2011 survey (7.2%; 6.4% in 2011 compared with 12%; 10.2% in 2017, respectively). The number of prescriptions for trimethoprim and derivatives, beta-lactamase resistant penicillin and intestinal antibiotics had all decreased compared to 2011.

The route of antimicrobial prescribing differed within non-acute hospitals compared with acute hospitals. Approximately 81% of antimicrobials were prescribed orally in non-acute hospitals with day of treatment between 1 and 7 days accounting for 86% of antimicrobials prescribed. For parenteral antimicrobials approximately 70% were prescribed longer than 3 days, which was higher than in acute hospitals.

Antimicrobials for prevention of infection (medical and surgical prophylaxis)

The top antimicrobial prescribed for medical prophylaxis within acute hospitals was azithromycin (13.3%). Other antimicrobials prescribed included trimethoprim (11.5%), co-trimoxazole (11.0%) and nitrofurantoin (10.1%). In non-acute hospitals similar medical prophylaxis antimicrobials were prescribed. However, cefalexin replaced co-trimoxazole.

Co-amoxiclav and teicoplanin were the top antimicrobials prescribed as surgical prophylaxis within acute hospitals (16% each). Other antimicrobials prescribed included cefuroxime (15.4%), gentamicin (13.5%) and metronidazole (parenteral) (10.3%). Both co-amoxiclav and cefuroxime are associated with an increased risk of CDI, therefore reducing exposure to these antimicrobials is recommended [10]. A single dose of surgical prophylaxis was provided in 50% of cases within acute hospitals with over 32% of prescribing for more than one day of prophylaxis. The latter is significantly lower than in the 2011 survey where it was given on 52.4% of occasions. Surgical prophylaxis is only required for a single pre-operative dose [10]. Further investigation of prophylaxis dosing is required in Wales to build-on the current reduction obtained. Further data will be available from the annual AMR PPS (2017) for comparison.

Use of antimicrobials associated with an increased risk of C.difficile infections

A total of 631 broad spectrum antimicrobials associated with an increased risk of *C. difficile* infection were prescribed during the 2017 survey in acute hospitals. Penicillins (combinations including B-lactamase inhibitor) was the antimicrobial group with the highest prescribing. Specifically, the antimicrobial prescribed from this group was co-amoxiclav (53.2%). Fluoroquinolone, lincosamides and cephalosporins (1st generation) were also commonly prescribed. The majority of antimicrobials prescribed associated with a risk of *C. difficile* were for the treatment of community-acquired infections (64.2%). The most common diagnosis site for treatment with such infections included RTI (over a quarter), UTI and skin / bone / soft tissue.

Summary

The results of the 2017 PPS in Wales will inform our future quality improvement interventions to reduce antimicrobial resistance, infections and healthcare associated infections. The current HAI / AMR programme in Wales has various incidence surveillance schemes in place to monitor infection and prescribing rates in Wales. The programme has various work streams around infection reduction and reducing antimicrobial prescribing. An annual AMR PPS is conducted in Wales to provide hospitals with an indication of prescribing rates and antimicrobial

prescribing patterns over time [31]. In addition the programme has recently collaborated with the 1000 Lives programme (Public Health Wales) who have expertise in quality improvement methodology. The collaborative will utilise the PPS data to prioritise interventional work and utilise the incidence data to monitor outcome measures.

The Welsh Government 3 year AMR delivery plan has various task & finish group work streams. In particular results from this survey along with the annual AMR PPS will be used to inform the UTI and IP&C task and finish groups. Furthermore Wales has recently taken part in the ECDC PPS within long term care facilities (HALT 3) [32]. Data from this survey will further enhance evidence around infection burden especially when considering LRT infections and UTIs. Data around prescribing will be combined to further enhance details on treatment and prevention of infection, especially around prophylaxis for UTIs and RTIs.

The PPS data would suggest that further work is required to better understand the required interventions to reduce pneumonia both within the acute sector and within the community. Currently there is no incidence surveillance to monitor such infections. Work is already taking place to reduce the burden of UTIs, which also contributes to the burden of *E. coli* BSI. This work should continue to address the high burden of UTI seen within both the acute and non-acute care hospitals. Although SSIs have reduced since the survey in 2011 they still remain the third highest cause of HAI within acute hospitals. The HAI /AMR programme is currently developing an expanded SSI programme in conjunction with 1000 Lives colleagues to reduce preventable SSIs across a broader range of specialties, which lead to prolonged hospital stay or readmission.

The prescribing data from the ECDC PPS will be used in conjunction to the annual Welsh AMR PPS to better understand prescribing patterns within the acute and non-acute sector in Wales. Specifically, the data will be used to understand prescribing patterns in the treatment of infections as mentioned above but to also understand antimicrobial prescribing associated with preventing infection, particularly around duration of surgical prophylaxis.

Conclusion

These findings indicate that there is an increased burden of infection within the acute and non-acute care settings in Wales and no change in prescribing rates since the previous survey over five years ago. It is for this reason that the HAI / AMR agenda remains a priority in Wales. It is essential therefore that the findings from this survey are utilised to focus the work of the NHS in Wales on priority areas for quality improvement programmes to reduce infections and antimicrobial resistance for the benefit of the population of Wales.

The following quality improvement priorities will be used to address antimicrobial resistance and HAIs in Wales:

Quality improvement priorities to address antimicrobial resistance and HAIs in Wales

- Prioritise and implement interventions to reduce the burden of non-ventilator healthcare associated pneumonia (such as mouth care bundles, mobility strategies, patient positioning)
- Implement multimodal interventions to reduce the burden of healthcare associated UTI in all patients (hydration initiatives, CAUTI bundles, urine sampling, appropriate prescribing of antimicrobials)
- Spread evidence based practice to reduce surgical site infections across all surgical specialties (WHO bundle compliance, application of NICE/CDC guideline, appropriate antimicrobial prophylaxis)
- Improve medical device management across the healthcare sector to prevent sepsis and blood stream infection (PVC/CVC bundles, STOP campaign, NEWS and SEPSIS 6)
- Focus on broader burden of infection and antimicrobial resistance across all healthcare settings and across the population and especially in older people
- Review the resources required to prevent infections and antimicrobial resistance with a particular focus on the need to address prevention and management in the community
- Spread current best practices for reducing HCAI using a whole health economy approach (cross specialty and care setting boundary work to implement change)
- Strive to reduce risk factors that will prevent the development of *C.difficile* disease (modifying antimicrobial policies and implementing strict antimicrobial stewardship, environmental cleanliness, bundle compliance and adhering to hand hygiene guidance).
- Improving isolation facilities and capacity for managing patients with MDRO
- Collaborate with 1000 lives programme to share best practice in HCAI reduction and antimicrobial prescribing (improve QI knowledge of staff, collaborative working across organisations)
- Integrate a public health approach to the prevention of infection by engaging patients and public in their care (national/local promotion of flu vaccine, keeping well to prevent infection)
- Continue driving compliance with HCAI code of practice (adhering to the Nine standards of Code) [33]

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Appendix

Table A1: HAI prevalence by specialty: Acute hospitals

General specialty	Specialty	No. patients	No. patients with HAIs	Prevalence (%)	95% CI
Geriatrics	Geriatrics	453	22	4.9	(3.2-7.2)
Obs/gynae	Gynaecology	82	2	2.4	(0.7-8.5)
	Obstetrics	239	2	0.8	(0.2-3.0)
ICU	Mixed intensive/critical care	4	3	75.0	(30.1-95.4)
	ICU (neonates)	69	3	4.3	(1.5-12.0)
	ICU general	81	18	22.2	(14.5-32.4)
	ICU (paediatrics)	3	1	33.3	(6.2-79.2)
Medicine	Bone marrow transplant	5	1	20.0	(3.6-62.5)
	Cardiology	272	11	4.0	(2.3-7.1)
	Dermatology	2	0	0.0	(0.0-65.8)
	Endocrinology	84	5	5.9	(2.6-13.2)
	Gastroenterology	165	4	2.4	(0.9-6.1)
	General	2165	94	4.3	(3.6-5.3)
	Haematology	48	3	6.3	(2.2-16.8)
	Infectious diseases	20	2	10.0	(2.8-30.1)
	Nephrology	92	10	10.9	(6.0-18.9)
	Neurology	56	4	7.1	(2.8-17.0)
	Oncology	85	9	10.6	(5.7-18.9)
	Other	179	9	5.0	(2.7-9.3)
	Pneumology	76	1	1.3	(0.2-7.1)
	Medical traumatology	2	0	0.0	(0.0-65.8)
Paediatrics	General	127	3	2.4	(0.8-6.7)
	Neonates	36	0	0.0	(0.0-9.6)
Psychiatry	Psychiatry	1	0	0.0	(0.0-79.3)
Rehabilitation	Rehabilitation	174	7	4.0	(2.0-8.1)
Surgery	Burns care	6	1	16.7	(3.0-56.3)
	Cardio	64	9	14.1	(7.6-24.6)
	Cardio and vascular	3	0	0.0	(0.0-56.2)
	Digestive tract	38	5	13.2	(5.8-27.3)
	ENT	72	6	8.3	(3.9-17.0)
	General	640	51	8.0	(6.1-10.3)
	Maxillo-facial	20	2	10.0	(2.8-30.1)
	Neurosurgery	37	4	10.8	(4.3-24.7)
	Surgery for cancer	8	0	0.0	(0.0-32.4)
	Ophthalmology	4	0	0.0	(0.0-49)
	Orthopaedics	352	18	5.1	(3.3-7.9)
	Orthopaedics/trauma	412	29	7.0	(4.9-9.9)
	Other	2	0	0.0	(0.0-65.8)
	Paediatric general	28	1	3.6	(0.6-17.7)
	Plastic and reconstructive	13	1	7.7	(1.4-33.3)
	Thoracic	7	0	0.0	(0.0-35.4)
	Traumatology	2	0	0.0	(0.0-65.8)
	Transplantation	11	0	0.0	(0.0-25.9)
	Urology	94	4	4.3	(1.7-10.4)
	Vascular	63	7	11.1	(5.5-21.2)
Other	Other	3	0	0.0	(0.0-56.2)
Unknown	Unknown	1	0	0.0	(0.0-79.3)

Table A2: HAI prevalence by specialty: Non-acute hospitals

General specialty	Specialty	No. patients	No. patients with HAIs	Prevalence (%)	95% CI
Geriatrics	Geriatrics	382	16	4.2	(2.6-6.7)
Long term care	Long term care	15	1	6.7	(1.2-29.8)
Medicine	Dermatology	4	0	0.0	(0.0-49.0)
	General	117	9	7.7	(4.1-14.0)
	Neurology	18	3	16.7	(5.8-39.2)
	Other	54	3	5.6	(1.9-15.1)
Rehabilitation	Rehabilitation	621	42	6.8	(5.0-9.0)
Surgery	General	1	0	0.0	(0.0-79.3)
	Neurosurgery	4	0	0.0	(0.0-49.0)
	Orthopaedics/trauma	27	0	0.0	(0.0-12.5)

Table A3: Antimicrobial prevalence by specialty, acute hospitals

General specialty	Specialty	No. patients	No. patients on antimicrobials	Prevalence (%)	95% CI
Geriatrics	Geriatrics	453	135	29.8	(25.8-34.2)
Obs/gynae	Gynaecology	82	24	29.3	(20.5-39.9)
	Obstetrics	239	46	19.3	(14.8-24.7)
ICU	Mixed intensive/critical care	4	2	50.0	(15.0-85.0)
	ICU (neonates)	69	18	26.1	(17.2-37.5)
	ICU general	81	44	54.3	(43.5-64.7)
	ICU (paediatrics)	3	2	66.7	(20.8-93.8)
Medicine	Bone marrow transplant	5	5	100.0	(56.5-100.0)
	Cardiology	272	73	26.8	(21.9-32.4)
	Dermatology	2	2	100.0	(34.2-100.0)
	Endocrinology	84	32	38.1	(28.5-48.8)
	Gastroenterology	165	60	36.4	(29.4-43.9)
	General	2165	730	33.7	(31.8-35.7)
	Haematology	48	27	56.3	(42.3-69.3)
	Infectious diseases	20	10	50.0	(29.9-70.1)
	Nephrology	92	41	44.6	(34.8-54.7)
	Neurology	56	12	21.4	(12.7-33.8)
	Oncology	85	38	44.7	(34.6-55.3)
	Other	179	55	30.7	(24.4-37.8)
	Pneumology	76	40	52.6	(41.5-63.5)
	Medical traumatology	2	0	0.0	(0.0-65.8)
Paediatrics	General	127	61	48.0	(39.5-56.7)
	Neonates	36	5	13.9	(6.1-28.7)
Psychiatry	Psychiatry	1	0	0.0	(0.0-79.3)
Rehabilitation	Rehabilitation	174	21	12.1	(8.0-17.8)
Surgery	Burns care	6	2	33.3	(9.7-70.0)
	Cardio	64	23	35.9	(25.3-48.2)
	Cardio and vascular	3	0	0.0	(0.0-56.2)
	Digestive tract	38	15	39.5	(25.6-55.3)
	ENT	72	29	40.3	(29.7-51.8)
	General	640	292	45.6	(41.8-49.5)
	Maxillo-facial	20	10	50.0	(29.9-70.1)
	Neurosurgery	37	8	21.6	(11.4-37.2)
	Surgery for cancer	8	4	50.0	(21.5-78.5)
	Ophthalmology	4	0	0.0	(0.0-49.0)
	Orthopaedics	352	106	30.1	(25.6-35.1)
	Orthopaedics/trauma	412	125	30.3	(26.1-34.9)
	Other	2	1	50.0	(9.4-90.6)
	Paediatric general	28	8	28.6	(15.3-47.1)
	Plastic and reconstructive	13	5	38.5	(17.7-64.5)
	Thoracic	7	1	14.3	(2.6-51.3)
	Traumatology	2	0	0.0	(0.0-65.8)
	Transplantation	11	3	27.3	(9.8-56.6)
	Urology	94	41	43.6	(34.0-53.7)
	Vascular	63	29	46.0	(34.3-58.2)
Other	Other	3	0	0.0	(0.0-56.2)
Unknown	Unknown	1	1	100.0	(20.6-100.0)

Table A4: Antimicrobial prevalence by specialty, non-acute hospitals

General specialty	Specialty	No. patients	No. patients on antimicrobials	Prevalence (%)	95% CI
Geriatrics	Geriatrics	382	53	13.9	(10.8-17.7)
Long term care	Long term care	15	1	6.7	(1.2-29.8)
Medicine	Dermatology	4	2	50.0	(15.0-85.0)
	General	117	22	18.8	(12.8-26.8)
	Neurology	18	3	16.7	(5.8-39.2)
	Other	54	9	16.7	(9.0-28.7)
Rehabilitation	Rehabilitation	621	88	14.2	(11.6-17.1)
Surgery	General	1	1	100.0	(20.6-100.0)
	Neurosurgery	4	0	0.0	(0.0-49.0)
	Orthopaedics/trauma	27	2	7.4	(2.1-23.4)

Risk factor analysis

Table A5: HAI univariate logistic regression, acute hospitals
(45 patients with missing risk factor data removed)

Risk factor	Category	No. patients	Patients with HAI	Prevalence (%)	95% CI	Odds ratio	OR 95% CI	Category p-value	Risk factor p-value
Sex	Female	3396	160	4.7	(4.1-5.5)				0.004
	Male	3001	191	6.4	(5.6-7.3)	1.4	(1.1-1.7)	0.004	
Age group	0-15	331	8	2.4	(1.2-4.7)				0.007
	16-29	268	9	3.4	(1.8-6.3)	1.4	(0.5-3.7)	0.492	
	30-49	563	28	5.0	(3.5-7.1)	2.1	(1.0-4.7)	0.066	
	50-64	926	67	7.2	(5.7-9.1)	3.1	(1.5-6.6)	0.003	
	65-79	2037	118	5.8	(4.9-6.9)	2.5	(1.2-5.1)	0.014	
	80+	2275	122	5.4	(4.5-6.4)	2.3	(1.1-4.7)	0.025	
Patient specialty	Geriatrics	452	21	4.7	(3.1-7.0)				<0.001
	Gynaecology	81	2	2.5	(0.7-8.6)	0.5	(0.1-2.3)	0.383	
	Obstetrics	239	2	0.8	(0.2-3.0)	0.2	(0.0-0.7)	0.019	
	ICU	237	42	17.7	(13.4-23.1)	4.4	(2.5-7.7)	<0.001	
	Medicine	3212	147	4.6	(3.9-5.4)	1.0	(0.6-1.6)	0.947	
	Other	3	0	0.0	(0.0-56.2)	1.0			
	Paediatrics	163	3	1.8	(0.6-5.3)	0.4	(0.1-1.3)	0.126	
	Psychology	1	0	0.0	(0.0-79.3)	1.0			
	Rehab	174	7	4.0	(2.0-8.1)	0.9	(0.4-2.1)	0.736	
	Surgery	1837	128	7.0	(5.9-8.2)	1.5	(1.0-2.5)	0.075	
Length of stay (days)	0-7	3290	90	2.7	(2.2-3.3)				<0.001
	8-14	1038	72	6.9	(5.5-8.6)	2.7	(1.9-3.6)	<0.001	
	15-21	558	54	9.7	(7.5-12.4)	3.8	(2.7-5.4)	<0.001	
	22-28	369	31	8.4	(6.0-11.7)	3.3	(2.1-5.0)	<0.001	
	29-35	261	19	7.3	(4.7-11.1)	2.8	(1.7-4.7)	<0.001	
	36+	884	86	9.7	(7.9-11.9)	3.8	(2.8-5.2)	<0.001	
Surgery since admission	No	5161	238	4.6	(4.1-5.2)				<0.001
	Yes	1198	108	9.0	(7.5-10.8)	2.1	(1.6-2.6)	<0.001	

Table A6: HAI multivariable logistic regression, acute hospitals
(45 patients with missing risk factor data removed)

Risk factor	Category	Odds ratio	OR lower 95% CI	OR upper 95% CI	Category p-value	Risk factor p-value
Age group	0-15					0.039
	16-29	4	1.3	13	0.019	
	30-49	5.1	1.8	14	0.002	
	50-64	5.1	1.9	13.3	0.001	
	65-79	4.4	1.7	11.4	0.002	
	80+	4.3	1.6	11.2	0.003	
Patient specialty	Geriatrics					<0.001
	Gynaecology	0.8	0.2	3.8	0.824	
	Obstetrics	0.4	0.1	2	0.287	
	ICU	6.7	3.6	12.4	<0.001	
	Medicine	1.1	0.7	1.8	0.611	
	Other	1				
	Paediatrics	1.5	0.3	8	0.666	
	Psychology	1				
	Rehabilitation	0.6	0.3	1.6	0.332	
	Surgery	1.5	0.9	2.6	0.110	
Length of stay (days)	0-7					<0.001
	8-14	2.6	1.9	3.6	<0.001	
	15-21	3.9	2.7	5.7	<0.001	
	22-28	3.1	2	4.9	<0.001	
	29-35	3	1.8	5.1	<0.001	
	36+	4.2	3.1	5.9	<0.001	
Surgery since admission	No					0.011
	Yes	1.5	1.1	2.1	0.011	

Table A7: Antimicrobials univariate logistic regression, acute hospitals
(45 patients with missing risk factor data removed)

Risk factor	Category	No. patients	Patients with HAI	Prevalence (%)	95% CI	Odds ratio	OR 95% CI	Category p-value	Risk factor p-value
Sex	Female	3396	1072	31.6	(30.0-33.2)				<0.001
	Male	3001	1113	37.1	(35.4-38.8)	1.3	(1.2-1.4)	<0.001	
Age group	0-15	331	105	31.7	(26.9-36.9)				<0.001
	16-29	268	77	28.7	(23.6-34.4)	0.9	(0.6-1.2)	0.429	
	30-49	563	212	37.7	(33.8-41.7)	1.3	(1.0-1.7)	0.074	
	50-64	926	339	36.6	(33.6-39.8)	1.2	(1.0-1.6)	0.111	
	65-79	2037	753	37.0	(34.9-39.1)	1.3	(1.0-1.6)	0.066	
	80+	2275	700	30.8	(28.9-32.7)	1.0	(0.7-1.2)	0.726	
Patient specialty	Geriatrics	452	134	29.6	(25.6-34.0)				<0.001
	Gynaecology	81	23	28.4	(19.7-39.0)	0.9	(0.6-1.6)	0.820	
	Obstetrics	239	46	19.3	(14.8-24.7)	0.6	(0.4-0.8)	0.003	
	ICU	237	121	51.0	(44.7-57.3)	2.5	(1.8-3.4)	0.000	
	Medicine	3212	1099	34.2	(32.6-35.9)	1.2	(1.0-1.5)	0.055	
	Other	3	0	0.0	(0.0-56.2)	1.0			
	Paediatrics	163	66	40.5	(33.3-48.2)	1.6	(1.1-2.3)	0.012	
	Psychology	1	0	0.0	(0.0-79.3)	1.0			
	Rehab	174	21	12.1	(8.0-17.8)	0.3	(0.2-0.5)	<0.001	
	Surgery	1837	675	36.7	(34.6-39.0)	1.4	(1.1-1.7)	0.005	
Length of stay (days)	0-7	3290	1297	39.4	(37.8-41.1)				<0.001
	8-14	1038	343	33.0	(30.3-36.0)	0.8	(0.7-0.9)	<0.001	
	15-21	558	173	31.0	(27.3-35.0)	0.7	(0.6-0.8)	<0.001	
	22-28	369	96	26.0	(21.8-30.7)	0.5	(0.4-0.7)	<0.001	
	29-35	261	72	27.6	(22.5-33.3)	0.6	(0.4-0.8)	<0.001	
	36+	884	205	23.2	(20.5-26.1)	0.5	(0.4-0.6)	<0.001	
Surgery since admission	No	5161	1711	33.2	(31.9-34.5)				<0.001
	Yes	1198	459	38.3	(35.6-41.1)	0.8	(0.7-0.9)	0.001	

Table A8: Antimicrobials multivariable logistic regression, acute hospitals
(45 patients with missing risk factor data removed)

Risk factor	Category	Odds ratio	OR lower 95% CI	OR upper 95% CI	Category p-value	Risk factor p-value
Sex	Female					<0.001
	Male	1.2	1.1	1.4	<0.001	
Age group	0-15					<0.001
	16-29	2	1.2	3.1	0.005	
	30-49	2.7	1.8	4.2	<0.001	
	50-64	2.4	1.6	3.6	<0.001	
	65-79	2.6	1.7	3.9	<0.001	
	80+	2.3	1.5	3.4	<0.001	
Patient specialty	Geriatrics					<0.001
	Gynaecology	0.7	0.4	1.2	0.231	
	Obstetrics	0.5	0.3	0.8	0.002	
	ICU	2.8	2	4	<0.001	
	Medicine	1.1	0.9	1.4	0.415	
	Other	1				
	Paediatrics	3	1.8	5.2	<0.001	
	Psychology	1				
	Rehabilitation	0.4	0.2	0.6	<0.001	
	Surgery	1.2	0.9	1.5	0.165	
Length of stay (days)	0-7					<0.001
	8-14	0.7	0.6	0.9	<0.001	
	15-21	0.7	0.6	0.8	<0.001	
	22-28	0.5	0.4	0.7	<0.001	
	29-35	0.6	0.4	0.8	<0.001	
	36+	0.5	0.4	0.6	<0.001	

Table A9: HAI univariate logistic regression, non-acute hospitals.
A multivariable logistic regression model of HAI risk factors was not made because no risk factors had a p-value less than 0.05.

Risk factor	Category	No. patients	Patients with HAI	Prevalence (%)	95% CI	Odds ratio	OR 95% CI	Category p-value	Risk factor p-value
Sex	Female	718	41	5.7	(4.2-7.7)				0.672
	Male	525	33	6.3	(4.5-8.7)	1.1	(0.7-1.8)	0.672	
Age group	0-15	5	2	40.0	(11.8-76.9)				0.243
	16-29	16	0	0.0	(0.0-19.4)	1	-	-	
	30-49	31	1	3.2	(0.6-16.2)	0.1	(0.0-0.7)	0.028	
	50-64	92	6	6.5	(3.0-13.5)	0.1	(0.0-0.8)	0.025	
	65-79	327	19	5.8	(3.8-8.9)	0.1	(0.0-0.6)	0.012	
	80+	772	46	6.0	(4.5-7.9)	0.1	(0.0-0.6)	0.011	
Specialty	Geriatrics	382	16	4.2	(2.6-6.7)				0.255
	Long term	15	1	6.7	(1.2-29.8)	1.6	(0.2-13.2)	0.645	
	Medicine	193	15	7.8	(4.8-12.4)	1.9	(0.9-4.0)	0.077	
	Rehab	621	42	6.8	(5.0-9.0)	1.7	(0.9-3.0)	0.093	
	Surgery	32	0	0.0	(0.0-10.7)	1	-	-	
Length of stay (days)	0-7	224	9	4.0	(2.1-7.5)				0.561
	8-14	181	10	5.5	(3.0-9.9)	1.4	(0.6-3.5)	0.478	
	15-21	147	13	8.8	(5.2-14.5)	2.3	(1.0-5.6)	0.060	
	22-28	113	8	7.1	(3.6-13.4)	1.8	(0.7-4.9)	0.231	
	29-35	104	6	5.8	(2.7-12.0)	1.5	(0.5-4.2)	0.482	
	36+	474	28	5.9	(4.1-8.4)	1.5	(0.7-3.2)	0.301	
Surgery since admission	No	1213	71	5.8	(4.7-7.3)				0.350
	Yes	30	3	10.0	(3.5-25.6)	1.8	(0.5-6.0)	0.350	

Table A10: Antimicrobials univariate logistic regression, non-acute hospitals.
Only 'length of stay' met the criteria for inclusion in the multivariable logistic regression model, so this risk factor alone was used when calculating adjusted antimicrobial rates for non-acute hospitals.

Risk factor	Category	No. patients	Patients with HAI	Prevalence (%)	95% CI	Odds ratio	OR 95% CI	Category p-value	Risk factor p-value
Sex	Female	718	93	12.9	(10.7-15.6)				0.061
	Male	525	88	16.8	(13.8-20.2)	1.4	(1.0-1.9)	0.061	
Age group	0-15	5	2	40.0	(11.8-76.9)				0.212
	16-29	16	0	0.0	(0.0-19.4)	1	-	-	
	30-49	31	4	12.9	(5.1-28.9)	0.2	(0.0-1.8)	0.155	
	50-64	92	17	18.5	(11.9-27.6)	0.3	(0.1-2.2)	0.257	
	65-79	327	56	17.1	(13.4-21.6)	0.3	(0.1-1.9)	0.205	
	80+	772	102	13.2	(11.0-15.8)	0.2	(0.0-1.4)	0.108	
Patient specialty	Geriatric	382	53	13.9	(10.8-17.7)				0.363
	Long term	15	1	6.7	(1.2-29.8)	0.4	(0.1-3.4)	0.437	
	Medicine	193	36	18.6	(13.8-24.7)	1.4	(0.9-2.3)	0.136	
	Rehab	621	88	14.2	(11.6-17.1)	1	(0.7-1.5)	0.896	
	Surgery	32	3	9.4	(3.2-24.2)	0.6	(0.2-2.2)	0.478	
Length of stay (days)	0-7	224	46	20.5	(15.8-26.3)				0.020
	8-14	181	33	18.2	(13.3-24.5)	0.9	(0.5-1.4)	0.561	
	15-21	147	20	13.6	(9.0-20.1)	0.6	(0.3-1.1)	0.09	
	22-28	113	12	10.6	(6.2-17.6)	0.5	(0.2-0.9)	0.025	
	29-35	104	16	15.4	(9.7-23.5)	0.7	(0.4-1.3)	0.269	
	36+	474	54	11.4	(8.8-14.6)	0.5	(0.3-0.8)	0.001	
Surgery since admission	No	1213	176	14.5	(12.6-16.6)				0.745
	Yes	30	5	16.7	(7.3-33.6)	1.2	(0.4-3.1)	0.741	

Prevalence by hospital

Table A11: HAI prevalence, acute hospitals.
*Adjusted rate based on multivariable logistic regression model shown in Table A6 Model includes risk factors: Age group, patient specialty, length of stay, surgery since admission.

Health board	Hospital	No. patients	Patients with HAIs	Prevalence (%)	95% CI	Adjusted HAI rate (%)*
ABMU	Morriston	612	44	7.2	(5.4-9.5)	5.7
	Neath Port Talbot	142	7	4.9	(2.4-9.8)	4.6
	Princess Of Wales	354	23	6.5	(4.4-9.6)	6.6
	Singleton	307	17	5.5	(3.5-8.7)	6.7
	ABMU	1415	91	6.4	(5.3-7.8)	6.0
Aneurin Bevan	Nevill Hall	358	16	4.5	(2.8-7.1)	5.4
	Royal Gwent Hospital	615	31	5.0	(3.6-7.1)	5.7
	St Woolos Acute	62	3	4.8	(1.7-13.3)	7.1
	Aneurin Bevan	1035	50	4.8	(3.7-6.3)	5.7
BCU	Abergele Hospital	5	0	0.0	(0.0-43.5)	0.0
	Llandudno	67	2	3.0	(0.8-10.3)	3.1
	Wrexham Maelor	441	24	5.4	(3.7-8.0)	5.8
	Ysbyty Glan Clwyd	399	12	3.0	(1.7-5.2)	3.7
	Ysbyty Gwynedd	365	16	4.4	(2.7-7.0)	4.8
	BCU	1277	54	4.2	(3.3-5.5)	4.7
Cardiff	University Hospital Llandough	371	13	3.5	(2.1-5.9)	3.1
	University Hospital of Wales	758	62	8.2	(6.4-10.4)	6.8
	Cardiff	1129	75	6.6	(5.3-8.3)	5.6
Cwm Taf	Prince Charles	254	11	4.3	(2.4-7.6)	4.6
	The Royal Glamorgan	341	17	5.0	(3.1-7.8)	5.0
	Cwm Taf	595	28	4.7	(3.3-6.7)	4.8
Hywel Dda	Bronglais General	120	7	5.8	(2.8-11.6)	6.2
	Glangwili	354	19	5.4	(3.5-8.2)	5.0
	Prince Philip	187	8	4.3	(2.2-8.2)	5.0
	Withybush General	220	10	4.5	(2.5-8.2)	4.6
	Hywel Dda	881	44	5.0	(3.7-6.6)	5.0
Velindre	Velindre	23	3	13.0	(2.5-8.2)	18.3
	Velindre	23	3	13.0	(4.5-32.1)	18.3
All Wales		**6355**	**345**	**5.4**	**(4.9-6.0)**	**-**

Table A12: Antimicrobial prevalence, acute hospitals.
*Adjusted rate based on multivariable logistic regression model shown in Table A8. Model includes risk factors: Sex, age group, patient specialty, length of stay.

Health board	Hospital	No. patients	Patients on antimicrobials	Prevalence (%)	95% CI	Adjusted antimicrobial rate (%)*
ABMU	Morriston	612	212	34.6	(31.0-38.5)	31.9
	Neath Port Talbot	142	22	15.5	(10.5-22.3)	20.0
	Princess Of Wales	354	124	35.0	(30.2-40.1)	35.7
	Singleton	307	89	29.0	(24.2-34.3)	31.2
	ABMU	1415	447	31.6	(29.2-34.1)	31.8
Aneurin Bevan	Nevill Hall	358	131	36.6	(31.8-41.7)	34.6
	Royal Gwent Hospital	615	239	38.9	(35.1-42.8)	37.3
	St Woolos Acute	62	9	14.5	(7.8-25.3)	39.5
	Aneurin Bevan	1035	379	36.6	(33.7-39.6)	36.3
BCU	Abergele Hospital	5	1	20.0	(3.6-62.5)	16.9
	Llandudno	67	9	13.4	(7.2-23.6)	17.2
	Wrexham Maelor	441	137	31.1	(26.9-35.5)	33.8
	Ysbyty Glan Clwyd	399	160	40.1	(35.4-45)	38.6
	Ysbyty Gwynedd	365	151	41.4	(36.4-46.5)	40.0
	BCU	1277	458	35.9	(33.3-38.5)	36.5
Cardiff	U.H. Llandough	371	102	27.5	(23.2-32.3)	29.6
	U.H. Wales	758	253	33.4	(30.1-36.8)	32.4
	Cardiff	1129	355	31.4	(28.8-34.2)	31.5
Cwm Taf	Prince Charles	254	90	35.4	(29.8-41.5)	34.1
	The Royal Glamorgan	341	120	35.2	(30.3-40.4)	34.2
	Cwm Taf	595	210	35.3	(31.6-39.2)	34.1
Hywel Dda	Bronglais General	120	49	40.8	(32.5-49.8)	41.6
	Glangwili	354	129	36.4	(31.6-41.6)	35.7
	Prince Philip	187	73	39.0	(32.3-46.2)	40.2
	Withybush General	220	58	26.4	(21.0-32.6)	25.5
	Hywel Dda	881	309	35.1	(32.0-38.3)	34.8
Velindre	Velindre	23	10	43.5	(21.0-32.6)	39.8
	Velindre	23	10	43.5	(25.6-63.2)	39.8
	All Wales	**6355**	**2168**	**34.1**	**(33.0-35.3)**	**-**

Table A13: HAI prevalence, non-acute hospitals
*Adjusted HAI prevalence is not reported because no potential risk factor variables were found to significantly associated with HAI risk

Health Board	Hospital	No. patients	Patients with HAIs	Prevalence (%)	95% CI
ABMU	Gorseinon	43	1	2.3	(0.4-12.1)
	Maesteg General	20	1	5.0	(0.9-23.6)
	ABMU	63	2	3.2	(0.9-10.9)
Aneuran Bevan	Chepstow	32	2	6.3	(1.7-20.1)
	County	55	7	12.7	(6.3-24.0)
	Monnow Vale	17	0	0.0	(0.0-18.4)
	Rhymney Integrated Health	10	0	0.0	(0.0-27.8)
	St Woolos Community	31	0	0.0	(0.0-11.0)
	Ysbyty Aneurin Bevan	76	0	0.0	(0.0-4.8)
	Ysbyty Ystrad Fawr	150	12	8.0	(4.6-13.5)
	Aneuran Bevan	371	21	5.7	(3.7-8.5)
BCU	Alltwen Hospital	18	1	5.6	(1.0-25.8)
	Chirk	28	0	0.0	(0.0-12.1)
	Deeside	43	2	4.7	(1.3-15.5)
	Denbigh	39	0	0.0	(0.0-9.0)
	Eryri	21	1	4.8	(0.9-22.7)
	Mold	38	1	2.6	(0.5-13.5)
	Penrhos Stanley Hospital	32	3	9.4	(3.2-24.2)
	BCU	219	8	3.7	(1.9-7.0)
Cardiff	Barry	22	1	4.5	(0.8-21.8)
	Rookwood	42	3	7.1	(2.5-19.0)
	St Davids	72	2	2.8	(0.8-9.6)
	Cardiff	136	6	4.4	(2.0-9.3)
Cwm Taf	Ysbyty Cwm Cynon	105	14	13.3	(8.1-21.1)
	Ysbyty Cwm Rhondda	107	1	0.9	(0.2-5.1)
	Cwm Taf	212	15	7.1	(4.3-11.3)
Hywel Dda	Amman Valley	26	0	0.0	(0.0-12.9)
	Llandovery	16	1	6.3	(1.1-28.3)
	Park House Court Nursing Home	10	0	0.0	(0.0-27.8)
	South Pembrokeshire	39	0	0.0	(0.0-9.0)
	Tregaron	12	1	8.3	(1.5-35.4)
	Hywel Dda	103	2	1.9	(0.5-6.8)
Powys	Breconshire War Memorial	29	3	10.3	(3.6-26.4)
	Bronllys	15	2	13.3	(3.7-37.9)
	Knighton	10	3	30.0	(10.8-60.3)
	Llandrindod Wells	21	5	23.8	(10.6-45.1)
	Llanidloes	13	1	7.7	(1.4-33.3)
	Newtown	11	1	9.1	(1.6-37.7)
	Victoria War Memorial Welshpool	20	3	15.0	(5.2-36.0)
	Ystradgynlais Community	20	2	10.0	(2.8-30.1)
	Powys	139	20	14.4	(9.5-21.2)
All Wales		**1243**	**74**	**6.0**	**(4.8-7.4)**

Table A14: Antimicrobial prevalence, non-acute hospitals.
*Adjusted prevalence is based on logistic regression model of length of stay

Health Board	Hospital	No. patients	Patients on antimicrobials	Prevalence (%)	95% CI	Adjusted prevalence (%)*
ABMU	Gorseinon	43	3	7.0	(2.4-18.6)	6.4
	Maesteg General	20	2	10.0	(2.8-30.1)	10.5
	ABMU	63	5	7.9	(3.4-17.3)	7.5
Aneuran Bevan	Chepstow	32	2	6.3	(1.7-20.1)	6.6
	County	55	8	14.5	(7.6-26.2)	14.1
	Monnow Vale	17	2	11.8	(3.3-34.3)	11.7
	Rhymney Integrated Health	10	0	0.0	(0.0-27.8)	0.0
	St Woolos Community	31	4	12.9	(5.1-28.9)	9.3
	Ysbyty Aneurin Bevan	76	6	7.9	(3.7-16.2)	7.6
	Ysbyty Ystrad Fawr	150	34	22.7	(16.7-30.0)	21.9
	Aneuran Bevan	371	56	15.1	(11.8-19.1)	14.2
BCU	Alltwen Hospital	18	3	16.7	(5.8-39.2)	16.0
	Chirk	28	2	7.1	(2.0-22.6)	7.6
	Deeside	43	4	9.3	(3.7-21.6)	9.8
	Denbigh	39	5	12.8	(5.6-26.7)	12.0
	Eryri	21	0	0.0	(0.0-15.5)	0.0
	Mold	38	8	21.1	(11.1-36.3)	20.6
	Penrhos Stanley Hospital	32	6	18.8	(8.9-35.3)	15.4
	BCU	219	28	12.8	(9.0-17.9)	12.4
Cardiff	Barry	22	4	18.2	(7.3-38.5)	18.5
	Rookwood	42	4	9.5	(3.8-22.1)	11.3
	St Davids	72	5	6.9	(3.0-15.3)	8.0
	Cardiff	136	13	9.6	(5.7-15.7)	10.9
Cwm Taf	Ysbyty Cwm Cynon	105	25	23.8	(16.7-32.8)	25.3
	Ysbyty Cwm Rhondda	107	16	15.0	(9.4-22.9)	15.5
	Cwm Taf	212	41	19.3	(14.6-25.2)	20.3
Hywel Dda	Amman Valley	26	1	3.8	(0.7-18.9)	3.9
	Llandovery	16	3	18.8	(6.6-43.0)	19.7
	Park House Court Nursing Home	10	1	10.0	(1.8-40.4)	10.4
	South Pembrokeshire	39	3	7.7	(2.7-20.3)	7.9
	Tregaron	12	2	16.7	(4.7-44.8)	14.8
	Hywel Dda	103	10	9.7	(5.4-17.0)	9.8
Powys	Breconshire War Memorial	29	3	10.3	(3.6-26.4)	11.1
	Bronllys	15	4	26.7	(10.9-52.0)	25.6
	Knighton	10	3	30.0	(10.8-60.3)	28.7
	Llandrindod Wells	21	5	23.8	(10.6-45.1)	28.0
	Llanidloes	13	3	23.1	(8.2-50.3)	24.7
	Newtown	11	2	18.2	(5.1-47.7)	18.2
	Victoria War Memorial Welshpool	20	4	20.0	(8.1-41.6)	19.9
	Ystradgynlais Community	20	4	20.0	(8.1-41.6)	21.2
	Powys	139	28	20.1	(14.3-27.6)	21.0
All Wales		**1243**	**181**	**14.6**	**(12.7-16.6)**	-