Health Protection Scotland

NHS National Services Scotland

NHS SCOTLAND NATIONAL HAI PREVALENCE SURVEY

VOLUME 1 of 2

FINAL REPORT

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By Health Protection Scotland

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SCOTTISH EXECUTIVE

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EXECUTIVE SUMMARY

Healthcare Associated Infections (HAI) are infections which are not present at the time the patient's healthcare begins, but which arise afterwards. There is evidence from several countries that HAIs are avoidable (1, 2) and costly to the health service and to patients (3). HAIs are also a source of discomfort, disability and distress to the individuals affected.

Health Protection Scotland (HPS) was commissioned by the Scottish Executive Health Department (SEHD) Healthcare Associated Infection Task Force (HAITF) to develop and document a methodology for establishing the burden of HAI and, using this methodology, to undertake a national survey of healthcare associated infection (HAI) in Scotland.

The survey of 13754 inpatients took place from October 2005 to October 2006. The hospitals surveyed included all acute hospitals in Scotland and a representative sample of non-acute hospitals in Scotland. This document reports the results of this first National Prevalence Survey of HAI in acute and non-acute hospitals in Scotland.

The results indicate that the overall prevalence was 9.5% (95%CI 8.8-10.2) for acute hospitals and 7.3% (95%CI 6.0-8.6) for non-acute hospitals.

The highest prevalence of HAI in acute hospital inpatients was found in the specialties; Care of the Elderly (11.9%), Surgery (11.2%), Medicine (9.6%) and Orthopaedics (9.2%). The lowest prevalence was found in obstetrics (0.9%)

The most common types of HAI in acute hospital inpatients were: Urinary Tract Infections (17.9%) (of all HAI), Surgical Site Infections (15.9%) and Gastrointestinal Infections (15.4%). The most frequently occurring organisms responsible for HAI where these data were available were *Staphylococcus aureus* (n=141) (of which Meticillin Resistant *Staphylococcus aureus* (MRSA) made 93 cases and Meticillin Sensitive *Staphylococcus aureus* (MSSA) (n=48)) and *Clostridium difficile* (n=95).

Most prevalence surveys concentrate on a subset of HAI types these often include the four HAI types: pneumonias, urinary tract infections, surgical site infections and blood stream infections. This survey found an overall prevalence in these infection types of 5%. However this survey also found that these types of HAI were not the most common and accounted for only about half of all the HAI identified.

In non-acute hospitals one in ten inpatients in the two specialties (combined), Medicine (11.4%) and Care of the Elderly (7.8%) were found to have a HAI and one in twenty inpatients in the Psychiatry specialty (5.0%) was found to have a HAI.

In non-acute hospital patients Urinary Tract Infections were frequent (28.1% of all HAI), but as frequent in non-acute hospitals were Skin and Soft Tissue Infection;

(26.8% of all HAI), combined these two HAI types affected four percent of all the inpatients in non-acute hospitals.

The most common organism recorded non-acute hospitals where these data were available was *Staphylococcus aureus* (n=15), of which approximately a third were MRSA (n=6). Almost all of the *Clostridium difficile* (n=13) (92%) infections were found in patients in the Care of the Elderly and General Medicine specialties.

The additional Length Of Stay (LOS) associated with HAI in acute hospitals ranged from 3.2 days in Obstetrics to 13.7 days in Care of the Elderly. Patients with HAI have a LOS 70% greater than patients without.

Costs of HAI in Scotland were estimated to be £183 million per year. The cost of HAI in individual specialties ranges from £2 million per year (Obstetrics and Urology) to £49 million (Medicine). Focussing on priority areas could make significant cost savings. If a third of all HAI were prevented, a £55 million cost saving could be made.

Priority areas for future targeted incidence surveillance are: Catheter Associated Urinary Tract Infection (CAUTI), Surgical Site Infection (SSI), Gastro Intestinal infection (GI) specifically (*C.difficile*), skin and soft tissue (SST) (related to Peripheral vascular catheters (PVCs) and Central Vascular Catheters (CVCs)), and Blood stream infections (relating to CVCs). Specialty specific prevalence surveillance should be considered with regard to the above noted targeted areas in medicine and care of the elderly. Special studies on HAI attributed morbidity and mortality should be undertaken in Scotland.

The results of the survey provide the SEHD with baseline information on the prevalence of HAI in Scotland, and can be used as a basis for developing national policy and local HAI prevention and control strategies.

The rigorous methodology developed for this survey can be used at intervals to evaluate trends in HAI, locally and nationally. This methodology is available as Volume 2: Protocol for NHS Scotland National HAI Prevalence Survey (Separate Document).

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1 BACKGROUND

Healthcare Associated Infections (HAI) are infections which are not present at the time the patient's healthcare begins, but which arise afterwards. There is evidence from several countries that HAIs are avoidable (1, 2) and costly to the health service and to patients (3). HAIs are also a source of discomfort, disability and distress to the individuals affected and can be fatal in some circumstances.

In Scotland, the Ministerial HAI Task Force, led by the Chief Nursing Officer (CNO), is developing measures to reduce the burden of HAI. It required good, representative baseline and trend information on the burden and cost of HAI in Scotland in order to assess the impact of the measures that are put in place to reduce HAI and to assist in the development of future policy.

In 2004, the Scottish Executive Health Department (SEHD), through the Ministerial HAI Task Force (HAITF), asked the Scottish Surveillance of Healthcare Associated Infection Programme (SSHAIP) Team at the Health Protection Scotland (HPS) to develop proposals for a national survey, which would provide baseline information on the extent of HAIs, in patients admitted to acute and non-acute hospitals in Scotland.

Two approaches to HAI surveillance were possible, an incidence survey or a prevalence survey. HPS therefore had to consider which of these two approaches was more efficient and cost-effective as a means of providing national data on the full extent of HAI in Scotland.

A point prevalence HAI survey, in which a ward in each hospital is surveyed in a day, appeared to be a feasible proposition and of acceptable cost if all HAI in a large number of acute and non-acute hospitals in Scotland were to be monitored.

A protocol was prepared, costed and presented to the SEHD in September 2004. At a meeting of the Ministerial HAI Task Force in December 2004, this protocol for a pilot and definitive survey was accepted. Funding was approved on 10 March 2005.

The team at HPS were asked to undertake a pilot study in three hospitals. The aim of the pilot study was to test the feasibility of a national survey and ensure that the methodology proposed was robust and accurate. HPS were asked to proceed to the main study as soon as possible after the completion of the pilot. The pilot survey took place between 23 May 2005 and 1 August 2005.

Following completion of the pilot a report was prepared for the SEHD and minor refinements were made to the initial protocol and costs (4). The Main Survey Protocol is described in Volume 2. The main survey began in October 2005. Those hospitals, which had volunteered to participate in the pilot survey, were re-surveyed and included in the main survey.

2 INTRODUCTION

2.1 Approaches to surveillance of HAI

2.1.1 Incidence

In an incidence survey, information on an event, e.g. HAI, in a selected population is gathered by regular observation of that population over a period of time. The frequency of observation depends on the frequency and duration of the event. The time during which data collection is undertaken also depends on the frequency with which the event occurs. A sufficient number of events have to be observed relative to the population size to provide a robust estimate of the rate of the event. Some HAI are very uncommon. To monitor all HAIs in a large number of hospitals, observation over a year in all the hospitals would probably be required. Trained researchers would have to be present in each hospital, several times a week, to accurately monitor the occurrence of a range of HAI. HPS was aware that an incidence study of all HAIs had been undertaken in one hospital in England and had proved extremely expensive (3). The majority of studies that attempt to estimate incidence of HAI have focussed on particular patient groups or types of infection. Few studies have tried to estimate the incidence of all types of HAI due to the very expensive nature of this approach. As with prevalence, incidence rates vary considerably according to the type of patient or specialty under review.

The cost of an incidence study of a large number of Scottish hospitals in order to provide an estimate of HAI prevalence nationally was therefore considered to be prohibitive.

2.1.2 Prevalence

In prevalence surveys the number of specified events is counted in a specified population at a point in time (point prevalence) or over a short period (period prevalence). A HAI prevalence survey could be undertaken by a small number of trained researchers covering a large number of hospitals. Large well-conducted surveys, such as the current one, are helpful in establishing baseline values for HAI and in estimating the burden at a given point or period in time. When repeated, well-designed surveys can also provide useful data on infection trends and the efficacy of infection prevention and control measures. However, the results are usually of more limited value than those obtained from incidence studies, which determine the rate of new cases. Prevalence studies are therefore probably best used as an adjunct to other surveillance methods, or in situations where it is not possible to use incidence as an approach to HAI surveillance. Most of the information relating to HAI which has informed policy over the last 25 years has been derived from prevalence surveys. Two national prevalence surveys were undertaken in the United Kingdom in 1980 and 1994 (5, 6). Table 2-1 summarises the advantages and disadvantages of prevalence and incidence surveys.

Table 2-1: *Advantages and disadvantages of prevalence and incidence surveys*

	HAI Incidence Surveys	HAI Prevalence Surveys
Advantages	1. The presence of data collectors on the ward facilitates the collection of a larger data set in a timely manner e.g. LOS data are collected directly 2. Frequent observation of the inpatients makes it easier to detect the emergence of a HAI. All the symptoms, signs and results of special investigations can be recorded 3. The CDC definitions of nosocomial infections (HAI), which are used worldwide, are incidence definitions 4. Individual exposure to risk factors can be recorded over time and analysed with regard to HAI incidence	1. The presence of data collectors on the ward facilitates the collection of a larger data set in a timely manner 2. As a result of reduced staff time prevalence surveys are more cost effective 3. Do not require the presence of a data collector on a ward for a prolonged period therefore causes minimal disruption to ward 4. Allow prevalence of risk factors in a population to be observed
Disadvantages	1. Requires a data collector to visit every ward included in the survey frequently throughout the period of the survey 2. As a result of the time required for data collectors incidence surveys are costly 3. The frequent presence of data collectors is likely to be more disruptive to patient management on the ward 4. Due to the costly nature of the surveys most incidence surveys concentrate on a specific type of infection or specific subset of patients and are therefore a prohibitively expensive way to investigate HAI at a national level	1. Because observations take place once over a short period they present only a snap-shot and do not represent the HAI situation over a long period 2. Do not allow any relationship between risk factors and HAI to be established 3. Because the data collection occurs over one day, often microbiological test results are unavailable 4. HAI prevalence surveys are biased towards the collection of data from inpatients who are in hospitals for longer periods.

2.1.3 Importance of post-discharge surveillance

Most incidence surveys focus on infections that occur during the inpatient period. Research indicates that between 20% and 70% of surgical wound infections may present after discharge (7). Little is known about other types of post-discharge infection. These infections, however, are associated with high economic costs to both NHS and patients themselves that continue long after the original event (3).

Despite the cost and time required to do post-discharge surveillance, factors such as advancing technologies, changes in patient management (leading to shorter lengths of stay), and the advent of day case surgery, underscore the need for post-discharge surveillance to be undertaken as an integral part of the overall incidence surveillance programme. Prevalence surveys of inpatient HAI by their very nature, do not include post discharge information. It is important to note that in the Scottish National HAI Prevalence Survey 2005-2006 only HAI diagnosed during inpatient stay are included in the total count of infections.

2.1.4 History of HAI surveillance to date

In the late 1960s epidemiologists in the USA found that feedback of information about Staphylococcal infection epidemics in hospitals could change the behaviour of the doctors, nurses and other personnel in such a way as to reduce infection rates (8). A large multi-centre study, called the SENIC study, in the 1970s by Haley et al (9) suggested that four components were required to reduce nosocomial infection: surveillance, control, an Infection Control Nurse to collect data and a physician actively involved. Hospitals that employed all of these elements could reduce the incidence of HAI by 32% over a 5-year period.

In the time since the SENIC study, components of HAI surveillance programmes, both within the US and UK, were decided upon empirically. With changing hospital environments, patterns of care and new infection risks, it was not known what proportions of nosocomial infections were preventable. Furthermore it was unclear how much infection control programs reduced the incidence of nosocomial infections and, if they did, which particular components were responsible for achieving the results.

Since the SENIC study (10) was published, there has been a steady promotion of the benefits of targeted incidence based surveillance over hospital-wide prevalence based surveillance. Targeted surveillance focuses preventive effort and resources on high-risk patient groups (for example surgical patients), units (for example Intensive Care Units (ICU)), or infection sites (for example Blood Stream Infection (BSI)). It has the potential to yield more meaningful data as case finding is more accurate if targeted in a specific area, and risk adjustment is more feasible for targeted units (11).

To more effectively link surveillance to prevention of HAI and reduce the financial burden of hospital-wide surveillance, Haley (12) proposed the system of surveillance by objectives, with hospitals focusing on their priority HAI problems based on morbidity, mortality and cost, and developing a specific surveillance and control strategy directed at reducing HAI.

One of the most important HAI incidence studies carried out in recent years was that of the Public Health Laboratory Service (3) by Plowman et al. This study of the socio-economic burden of HAI carried out in a single hospital in England was the first to carry out hospital wide (n=4000) incidence surveillance over one-year period (1994-1995), establishing the burden by HAI type. The study found an overall HAI rate of 7.8% (95% CI; 7.0-8.6%), with each HAI costing £3154 on average to treat. The authors extrapolated the findings from this study to the whole NHS and they estimated that the mean cost to the hospital sector was £931 million (95% CI; £780-£1081 million) per annum. In 2001 Walker (13) used the incidence rate described in the Plowman report (3) and extrapolated the costs to all English hospital activity during 1999/2000 pro rata to Scotland and estimated the cost to be £186 million in Scotland.

The prevalence surveys carried out in the UK to date (5, 6) have contributed to the evidence base and enabled prioritisation for targeted incidence surveillance. However the most recent study at the time the present survey was initiated was more than 12 years old (6).

As a result of the published HAI prevalence studies and the SENIC study, many countries, including the UK, recognised the importance of HAI as an outcome indicator and have established targeted surveillance programmes for measurement of HAI. The programmes

have been set up on a country by country basis and in the majority of cases have adopted the US Centre for Disease Control (CDC) definitions for HAI (14). These definitions were developed as part of the National Nosocomial Infection Surveillance (NNIS) programme, in the 1970s, which was the first national programme of targeted HAI surveillance to be established worldwide. Since this time, although not without criticism, the NNIS definitions of HAI (14) have been internationally accepted.

Most current HAI surveillance programmes worldwide are incidence-based prospective studies, either of organism, specialty or HAI type specific, with the aim of:

- Promoting the concept of surveillance for HAI prevention and control by offering hospitals an efficient and effective tool for data collection and analysis as well as technical and scientific assistance in its implementation.
- Allowing each hospital to compare its own incidence figures over time within the hospitals and with those of other hospitals, and thereby evaluate its prevention and control activities.
- Obtaining a national perspective of the incidence of HAIs, trends over time, sites, risk factors, patient outcomes, major pathogens and antimicrobial resistance.

The targeted surveillance approach offers flexibility for healthcare institutions' own identified priorities. A potential limitation of this approach is undetected infection outbreaks in non-targeted healthcare areas. Haley (15) recommends that infection control teams should train ward staff to be alert for, and report, clustering of infections, which should then be investigated further by the infection control team, but no system for national surveillance of outbreaks is described in the literature.

The development of HAI outbreak surveillance is a relatively new concept. Outbreaks of HAI vary widely with respect to the organism(s) involved, the numbers and types of patients affected, the severity and consequences of the resulting morbidity, and the nature of the infection control measures implemented. No comprehensive national or international data are routinely available on the numbers and types of outbreaks of HAI that occur in different countries, including the UK, or data on the impact and implications for the health services.

2.2 Literature review of surveys of the prevalence of HAI

Prevalence surveys aim to identify all inpatients with a HAI within a specified time period. They require clear definitions of a prevalent HAI and the characteristics of different types of HAI. The former includes a statement of which inpatients might have HAI (e.g. those admitted for ≥48hrs and who have an infection which meets the agreed survey HAI case definition or who have some of the symptoms and signs and are receiving antimicrobial treatment for a HAI). The CDC Nosocomial Infection[1] case definitions for each type of infection are those most commonly used worldwide. In order to ensure that data are accurate and robust, investigators should be trained to apply definitions rigorously and consistently and their application of the case definitions should be validated.

Comparisons of the results of prevalence surveys undertaken in different locations or in the same location at different times are difficult. In the published literature, case definitions vary (see Appendix Table 1-1 page 160). In addition, the prevalence rates of HAI recorded depend on a number of factors (including inpatient age, case severity and specialty mix), reflecting differing patient vulnerability to infection and differences in admission policies and inpatient management policies and practices at the time of the survey. The LOS of hospital inpatients will also affect the likelihood of diagnosing HAI and/or the risk of HAI in inpatients. Hospital size is an important factor known to affect prevalence rates (16) and probably reflects variation in some or all of the factors listed above.

Comparison of the results of the large number of HAI prevalence surveys that have been published (5, 6, 17-24) is therefore difficult. These studies have been undertaken in different countries, at different times, using differing case definitions and data collection methods. Often important details of the methods used are unavailable and it is not clear how well data collectors have been trained. This limits the comparability of results from different surveys (19). In Appendix Table 1-1 (page 160) the results of selected prevalence surveys are presented – these are multi-hospital (≥4) surveys undertaken from 1990 onwards in Europe. Only the most recent survey reported from an individual country has been included in the table, except for surveys undertaken in the UK where all three national surveys have been included. The table highlights differences in methodology that affect the comparability of results. The published prevalence of patients with HAI ranges between 3.6% (Germany (19)) and 11.6% (Switzerland (23)).

In 1980 Meers et al (5) reported on the first UK national prevalence survey of HAI in acute hospitals. A prevalent HAI was defined for this survey as 'an infection found to be active or under treatment at the time of the survey which was not present on admission to hospital'. Definitions were applied by a large number of varying members of local infection control teams in the 43 participating hospitals and the resulting reliability and validity of data collection is unknown. Infection Control Teams (ICTs) in hospitals volunteered to participate therefore there is a potential for volunteer and selection bias.

1 Nosocomial is a term which is used to describe Healthcare Associated Infection (HAI). The term is used in the US. The term Healthcare Associated Infection or HAI will be used throughout this report.

The second UK national prevalence survey (6) was undertaken in 157 volunteer acute hospitals over the period May 1993 to July 1994. For this survey Meers' definition of prevalence was adopted but a 'UK' set of HAI definitions was used.

Most recently, Smyth et al (25-28) have provided preliminary results of a 2006 survey in the England, Northern Ireland, Wales and the Republic of Ireland. This involved a total of 273 acute hospitals, 190 in England, 23 in Wales, 15 in Northern Ireland and 45 in the Republic of Ireland. HAI case definitions applied were CDC Nosocomial Infection Definitions. The prevalence of infection varied between 4.9% in the Republic of Ireland to 8.2% in England. This variation is potentially explained by differences in methodology, volunteer bias, patient population and different hospital types included.

Gastmeier's 1998 study (19) aimed to adopt an extremely rigorous methodology with respect to the definitions of a 'prevalent' infection and the use of CDC HAI case definitions. The four investigators were external to the 72 participating hospitals and were very carefully trained. A validation study was also undertaken and showed a high level of sensitivity (89%) and specificity (99.3%) in HAI diagnosis compared with a 'gold standard' diagnosis. The prevalence of patients with HAI recorded was 3.5%, a lower rate than most other studies, including those in the UK.

The current Scottish survey reported here has aimed to be rigorous and consistent and to that end, the survey has used CDC HAI case definitions (14), trained data collectors independent of the hospitals, continuous evaluation of their performance through regular meetings, and formal validation of the application of the case definitions throughout the survey.

2.2.1 The current Scottish Surveillance of Healthcare Associated Infection Programme (SSHAIP) programme content

The Scottish Surveillance of Healthcare Associated Infection Programme (SSHAIP) team was established to facilitate national surveillance of healthcare associated infection (HAI). The SSHAIP team is based at Health Protection Scotland (HPS).

HDL(2006)38 requires all NHS boards to undertake three specific mandatory HAI surveillance programmes (outlined on Table 8-2). The framework also outlined a programme of voluntary surveillance. Infection control teams are encouraged to target surveillance in locally identified priority areas and to use at least two of the other voluntary programmes.

This prevalence survey builds on the SSHAIP portfolio of work (29) and aims to inform the future targeted incidence surveillance programmes.

Table 2-2: *Summary of SSHAIP surveillance programmes*

Surveillance Programmes	Mandatory	Voluntary
Staphylococcus aureus bacteraemia (MRSA and MSSA)	✓	
Surveillance of surgical site infection (SSI) of hip arthroplasty and caesarean section procedures. Additional categories can be selected from a list of ten commonly performed clean surgical procedures	✓	
Surveillance of *Clostridium difficile* associated disease (CDAD)	✓	
Catheter Associated Urinary Tract Infection (CAUTI) Surveillance		✓
Ventilator Associated Pneumonia (VAP) or Blood Stream Infection (BSI) in Intensive Care Units (ICU)		✓
HAI outbreak surveillance		✓

KEY SUMMARY POINTS

- Prevalence studies of HAI report existing HAI cases at a given point in time
- There are important differences in survey methodology, including the sampling procedures, and the definitions of HAI used in the published literature. There are therefore limitations in the comparability of the results from different prevalence studies
- The studies reviewed here are the key papers within the literature in this field. The Scottish survey has been based on the methodologies from these previous surveys and the definitions and epidemiological techniques, which have been proven to be robust, accurate and cost effective

3 AIMS

The aims of the survey were:

- To provide the HAITF with baseline information on the total prevalence of HAI in Scottish hospitals and its burden in terms of health service utilisation and costs. This information would be available to guide priority setting in the development of strategy and policy.
- To develop a consistent methodology for prevalence surveys which when repeated at intervals would allow the impact of measures taken nationally to reduce the burden of HAI to be evaluated through an analysis of trends.

4 OBJECTIVES

The objectives of the study were to address the following questions:

1. What is the overall prevalence of HAI and of the specific types of HAI in adult inpatients in acute and non-acute hospitals in Scotland?
2. What is the impact of HAI in terms of length of stay on NHS activity?
3. What are the hospitals costs associated with HAI in Scotland and how much cost saving might be anticipated as a result of HAI control?
4. Is it possible to use the prescription of antimicrobials 48 hours after admission to hospital as predictor for HAI?
5. How do incidence estimates obtained from prevalence measured in this survey compare with the results of ongoing targeted incidence surveys?
6. What are the priority areas for targeted surveillance of incidence?
7. What are the priority areas for interventions to prevent and control HAI?
8. What is the acceptability, feasibility and cost of undertaking prevalence surveys in Scottish hospitals?
9. What is a suitable methodology for repeated prevalence surveys, which will give comparable information?

5 METHODOLOGY

5.1 Organisational aspects

Funding for the project was approved on 10 March 2005. In the original protocol, approval was anticipated for the pilot study in December 2004 and for the main study in January 2005. There was therefore a slight delay in the recruitment process and the start of the pilot survey.

A pilot point prevalence study was undertaken in three acute hospitals between May and August 2005. These hospitals included a large teaching hospital, a large district general and a small district general hospital in three different NHS board areas in three geographical locations (East, West and South of Scotland), whose MRSA bacteraemia rates, as reported through the HPS mandatory surveillance programme represented the upper, lower and average of rates reported in Scotland. These were selected in order to test the methodology in a range of different hospital settings before undertaking the national prevalence survey. The results of the pilot study were reported in September 2005 (4). As a result of the pilot study it was concluded that the plans and methodology for the main study were feasible with minor refinements to the protocol and plans.

A Project Team consisting of a project manager, project administrator, data manager and initially four data collectors was recruited by HPS to work full time on the project. The team was overseen by a Project Steering Group consisting of the project director, project consultants, SEHD, public and key stakeholders from the NHS boards, (Appendix Table 12-3 page 236).

A letter from the CNO to all Chief Executives, Medical Directors, Nursing Directors and Directors of Public Health informed all hospitals in Scotland that 'as part of the Ministerial HAI strategy in 2005, SEHD has commissioned Health Protection Scotland (HPS) to carry out a national prevalence survey of HAI' (30). In this letter a request was made to the Caldicott Guardians of each hospital for their permission for the data collectors from HPS to access medical notes. By June 2005 signed approval had been obtained from all the eligible hospitals.

A Data Collection Protocol for use by the data collectors was prepared and tested during the pilot survey. The hospitals surveyed in the pilot survey were re-visited in the main survey in order to ensure consistency in the data collection methodology for all hospitals.

Intensive training sessions were held for data collectors at which the rationale for the survey and for the methodology was discussed. Due to the importance of using consistent HAI case definitions throughout the survey, several training sessions for the data collectors used case studies (31) (provided courtesy of Petra Gastmeier of the KISS Project, Germany and the SSHAIP team at HPS) for training in the diagnosis of HAI according to the CDC definitions. Training in the use of the data collection tool was also undertaken. During the training of data collectors for the pilot study the need for more detailed understanding of microbiology reports and definitions of surgical procedures was identified. This was addressed during further training of these four and three additional data collectors before the main survey.

An Information Pack was prepared and sent to the nominated link member of the infection control team (ICT) at each hospital being surveyed. The pack included a handout for hospital staff that outlined the rationale, methods and implications of the survey and the standard HPS

patient information leaflets used to inform patients about their rights and how their personal information is protected, posters were also supplied to the hospital giving the basic methods of the survey and photographs of the data collectors. The poster contained a space where the date of the team visits could be entered. Information packs and posters were distributed by the nominated link contact to individual ward staff who were thereby prepared and informed in advance of the arrival on the ward of external data collectors.

At regular meetings of data collectors and the project manager during data collection in the pilot survey, practical problems in data collection, data entry and HAI diagnosis were reported and discussed. Two detailed and numbered Issues Logs; one relating to Data Definitions and practical (non-IT) issues in data collection and the other to the 'Data Collection Tool (IT)' were kept by the Project Manager and updated at each meeting. These lists were used as an agenda for the meetings and used to record conclusions and refinements that were included in the main study plans and protocol. Issues lists were maintained throughout the main survey.

Shortly after the initiation of the Scottish National HAI Prevalence Survey, the Department of Health (DoH) in England commissioned the Hospital Infection Society (HIS) in collaboration with Infection Control Nurse Association (ICNA) to carry out a prevalence survey in England. The Departments of Health in Wales, Northern Ireland and the Republic of Ireland also expressed an interest in collaborating, and HIS invited the Scottish Survey Project Director to join the UK HIS prevalence steering group in order to ensure that the prevalence surveys were carried out using a similar methodology as far as was possible.

5.2 Study design

5.2.1 Definition of acute hospitals

These were defined as per Information and Statistics Division (ISD) classification of hospital type. Hospitals in Scotland were classified as acute hospitals and non-acute hospitals. Acute hospitals were defined using the classification proposed by ISD (32). 'Acute hospitals provide a wide range of specialist care and treatment for patients. Typically, services offered in the NHS acute sector are diverse. They include: consultation with specialist clinicians (consultants, nurses, dieticians, physiotherapists and a wide range of other professionals); emergency treatment following accidents; routine, complex and life saving surgery; specialist diagnostic procedures; and close observation and short-term care of patients with worrying health symptoms'(32). A full list of acute hospitals[1] in Scotland is listed in Appendix Table 4-3 page 178.

1 These hospitals are ISD main category A sub-category 1 to 3

5.2.2 Definition of non-acute hospitals

Non-acute hospitals are hospitals which offer long term care, for psychiatric, elderly or community patients. The majority of their inpatients are cared for within the specialties of Care of the Elderly and Psychiatry (32). A full list of non-acute hospitals[1] is included in Appendix Table 4-4 page 181.

5.2.3 Structure of the survey

The survey consisted of two parts: the 'prevalence survey' (Figure 5-1) of all patients which involved collection of a limited data set and the 'burden study' in which more detailed data were collected so that the burden of HAI in Scotland could be estimated in terms of health service utilisation and costs. A sample of 25% of inpatients was included in the burden study. Inpatients were allocated to the burden or prevalence survey in ward units.

Detailed data were collected from inpatients included in the burden study including inpatients with and without a prevalent HAI. These data included detailed information on surgeries within the last year and prevalence of invasive devices used (Figure 5-2).

All inpatients with a prevalent HAI were included in the LOS analysis and therefore more detailed data was collected for them. Discharge information was collected for inpatients within the burden study and all inpatients with HAI (Figure 5-3). These data have been used to estimate the additional burden (bed days used and cost) of HAI. For a complete listing of the data collected for the prevalence and burden parts of the survey see Appendix Table 2-1 page 162.

All eligible acute adult inpatient beds (a total of 11608 patients) were surveyed in each hospital for the prevalence component of the survey, and a random sample of 25% of wards were included in the burden study. All eligible adult inpatient beds were surveyed in a sample of non-acute hospitals representative of Scottish NHS boards and hospital size (2146 patients in non-acute hospitals). The non-acute sample was included in the burden study, however the non-acute hospitals were not included in the additional LOS calculations. This decision was made due to the observed longer lengths of stay in the non-acute hospitals and it was decided that prevalence was not a sound indicator of additional LOS in non-acute hospitals.

For inpatients in the prevalence survey, detailed data were collected on inpatients with a HAI and a limited dataset on inpatients without HAI. These data were combined with those collected in the burden study to provide age/gender and specialty specific prevalence of inpatients with HAI for each hospital (Figure 5-1).

1 These include ISD main category A sub-category 5 and main category B and C (with the exception of day care facilities)

Figure 5-1: *Diagrammatic representation of the prevalence part of the Scottish National Prevalence Survey*

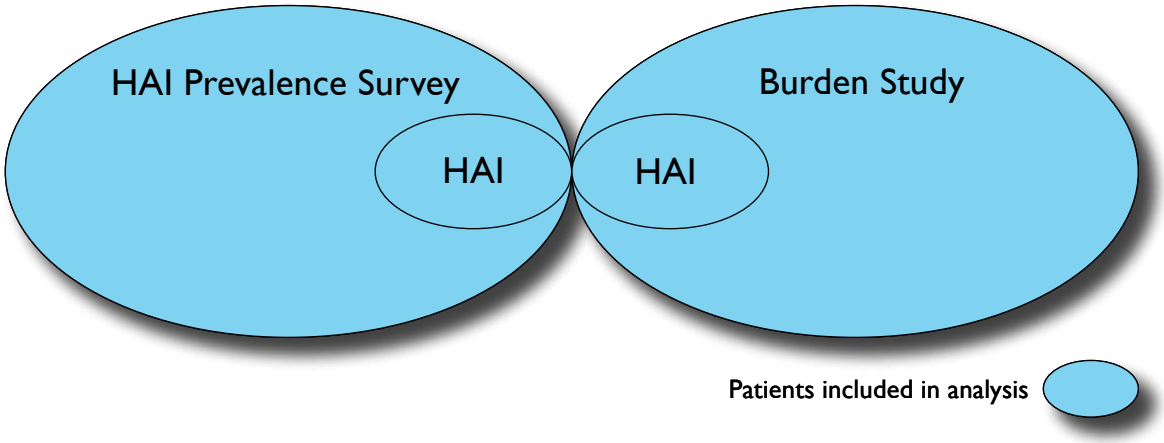


Figure 5-2: *Diagrammatic representation of the burden study part of the Scottish National Prevalence Survey*

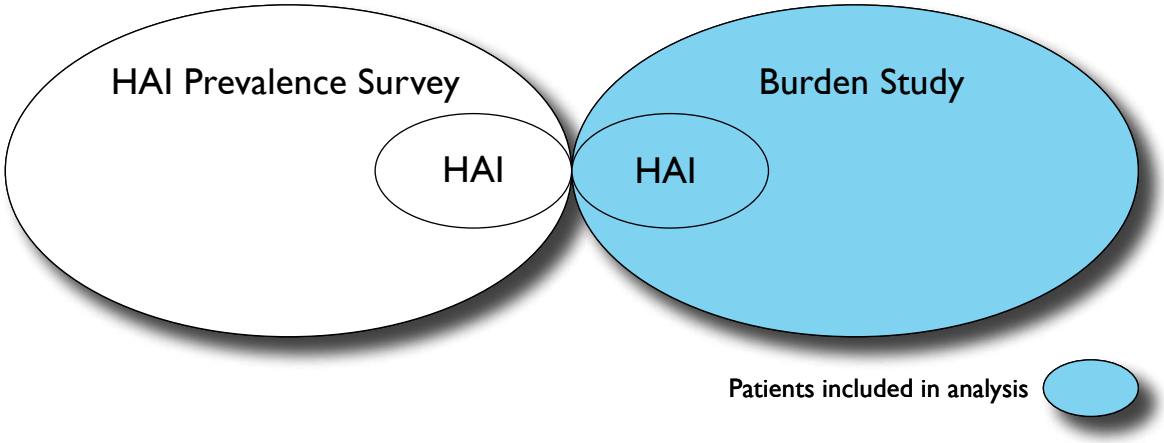
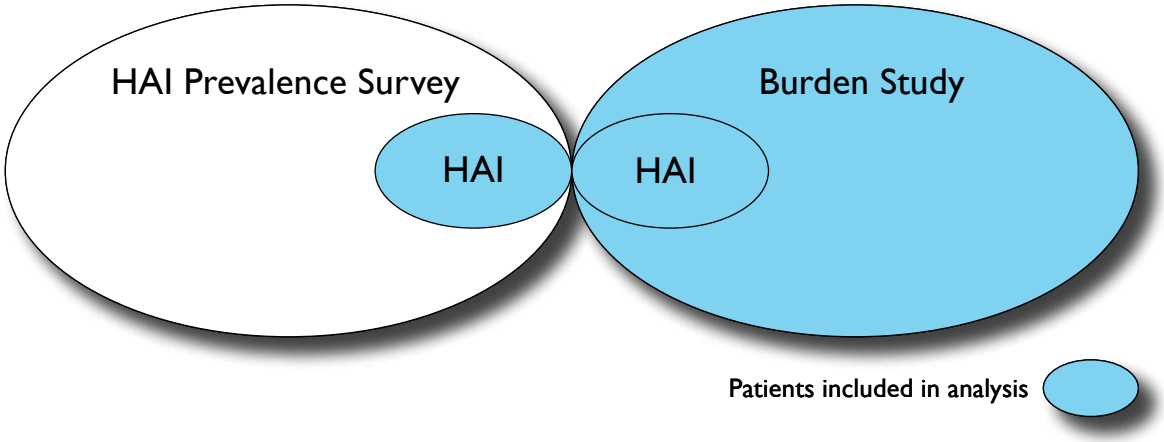
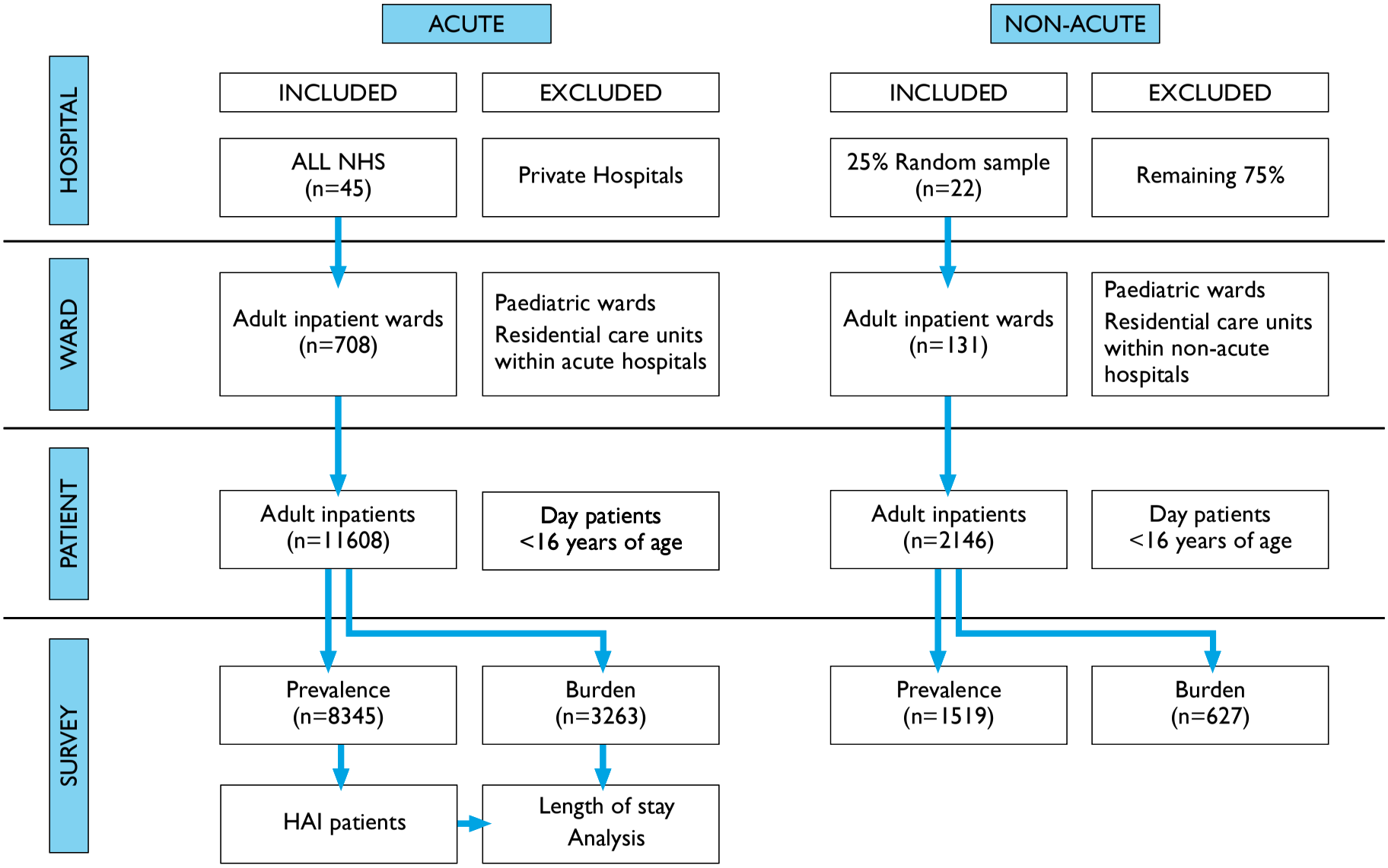


Figure 5-3: *Diagrammatic representation of the LOS analysis part of the Scottish National Prevalence Survey*



Additional work was undertaken to allow sampling of individual hospitals throughout the year of data collection. Hospitals were stratified into small, medium and large acute hospitals, obstetric and teaching hospitals. Detailed plans were made which distributed hospitals into one of four 3-month periods. Each stratum of hospital was represented equally in each three-month period (based on published bed numbers (33)). To do this, an assumption was made that hospitals of a similar size and type contain a similar specialty mix and inpatients with similar case mix. This allowed investigation of a possible seasonal effect on prevalence of HAI, an aspect of prevalence surveillance that has not been addressed previously.

Figure 5-4: *Diagrammatic representation of Scottish national HAI prevalence survey showing inclusion and exclusion criteria for prevalence and burden parts of the survey.*



5.2.4 Eligibility

Infection control contacts from eligible hospitals were asked to provide details of ward type, specialty and age of patients. The final decision on eligibility was made by the project team based on the ward type information supplied to the team by the link infection control nurse. Table 5-1 shows the survey inclusion and exclusion criteria. All patients who occupied beds in the selected wards at a pre-specified time of day were included in the survey and data collection. A record was made of the number of unoccupied beds and beds occupied by ineligible inpatients.

Table 5-1: *Inclusion and exclusion criteria for National HAI prevalence survey*

		Inclusion Criteria	Exclusion Criteria
Hospitals	Acute	All NHS	Independent (Private) Hospitals
	Non-acute	Selected Sample (25%). All included in possible sample	75% not selected
Wards		All wards serving adult inpatients (≥16 years old) except those that meet the exclusion criteria	Wards serving paediatric (<16 years old) inpatients Residential care units within acute hospitals
Patients		All adult patients except those who meet the exclusion criteria	Day patients (Patients admitted for one day for treatment or for diagnostic procedures.) Inpatients (<16 years old)

5.2.5 HAI definitions

In this survey a HAI was an infection which arose ≥48 hours or more after admission to hospital and which was not present or incubating on admission. A prevalent HAI was considered present when the patient had signs and symptoms which met one of the CDC definitions, or had one or more signs or symptoms included in one of the CDC definitions and was being treated for the infection (with therapy). CDC's HAI case definitions (14) were adopted as these are widely used internationally. These definitions comprehensively categorise HAI according to the organ/tissue system affected.

This survey included every type of HAI which can occur and therefore examined the full spectrum of HAI in hospital inpatients which met the survey definitions. HAI are grouped into major CDC categories based on the main physiological systems and surgical interventions. (Appendix Table 3-4 Mapping of specific infection sites to high level HAI page 174 lists the specific HAI within each major category). These broad categories conceal the different types, numbers and severity of specific infections included within the major categories. Some major categories (e.g. Bloodstream Infections, Pneumonias, Surgical Site Infections) are more homogeneous that others (e.g. Eye, Ear, Nose, Throat or Mouth).

5.3 Methods

5.3.1 Data collection on wards

Data collection was undertaken on weekdays. All ward and patient data were entered onto a specially designed database held on a small portable 'tablet' personal computer (PC) while the data collectors were on the ward. All data collection on a ward was completed within one day.

Data collectors followed a standard procedure in their surveillance of a ward (See Figure 5-5) Local nominated link members of the HAI control team introduced the data collectors onto the wards. Prior to commencing the inpatient data collection, data on ward characteristics on the day of data collection (ward type, bed numbers, staff numbers and types) was collected with assistance from the nurse in charge.

The data collectors sought information on eligible inpatients from all relevant sources including case records, all results of special examinations including microbiology reports, X-ray reports, temperature charts, prescribing records, nursing notes and where necessary through discussion with clinical staff and by direct clinical observation. The design of the survey required the data collector to make an initial decision based on this information as to whether the inpatients showed signs of a specific HAI, criteria for which were included and accessible on the PC. They were required to check every sign and symptom included in the relevant CDC HAI definition which was met by a patient they had decided had an HAI. The decision as to the presence or absence of an HAI was that of the data collector. They were able to seek further help from epidemiology consultants at HPS if they had any remaining doubts about the diagnosis of an HAI according to the CDC definition.

In very rare instances eligible inpatients were omitted from the survey because both they and their clinical records were out of the ward for the entire time that the data collectors were present on the ward.

Figure 5-5: *Standard procedure in data collectors' surveillance*

Step 1

- Introduction to ward staff
- Collect bed numbers occupied by inpatients/day patients/empty beds
- Collect staff numbers
- Ask about any standard antimicrobial prophylaxis regime

Step 2

- Mini ward round. This gave an idea of how long the ward is likely to take to survey, look for initial proxy indicators, overall picture of the ward and case complexities etc.
- Review Inpatient Charts
- Review Drug Kardex, make notes on antimicrobials, date started
- Review temperature and wound charts
- Observe patients for invasive devices

Step 3

- Detailed case note review
- Where details of care not clear ask medical or nursing staff

5.3.2 Data management

Data were exported from each data collector's tablet PC on a weekly basis. The export procedure produced Microsoft Excel® files. These were subsequently imported into a Microsoft Access® database. Within the Microsoft Access® database algorithms were used to examine data consistency and validity. Algorithms were used to confirm that the criteria recorded met CDC HAI case definitions. Data quality and the performance of the data collection tool were monitored. A copy of the Data Management Standard Operating Procedure (SOP) is included in Volume 2.

After a delay of a minimum of two months, local nominated link persons at the hospitals were sent a list of selected patient identifiers and were asked to supply the discharge dates of these patients. Data from each data collector were combined into a master Microsoft Access® database file and passed to the statistician. STATA® Version 9 software was used for these analyses. Data were entered in a standard manner as developed during the pilot study (34).

5.3.3 Validation

Inter-Rater Reliability (IRR) validation exercises were undertaken on two occasions during the survey to measure the consistency of data collection between data collectors. A crossover study design was adopted, requiring a sample of patients to be surveyed by the whole data collection team over the course of a single day. While the overall level of IRR was reassuringly high for the selected data items, these exercises revealed limitations to the assessment methodology in a dynamic healthcare setting. The validation recorded a 100% agreement for diagnosis of HAI type.

Repeated testing of data collectors, using a library of replica case notes, drug Kardex and lab reports, was subsequently identified as a superior method for evaluating data collection quality without the problems associated with live, time sensitive patient records. A library of case notes has been developed for use in future HAI prevalence surveys and this will be appropriate for both training and ongoing data quality assessment. This approach will allow reliability and validity to be measured between future data collection team members (see Appendix section on Validation page 228).

5.3.4 Invasive device data collection

Invasive device data was collected for inpatients within the burden study sample.

5.3.5 Surgery data collection

Surgical procedures undergone in the year preceding the survey were collected for all burden study and all patients with HAI. Surgical Site Infections (SSI) with implants according to CDC HAI definitions occur within one year of the surgery, while surgical site infections in the absence of implants occur within 30 days of the surgical procedure.

The decision to collect surgical procedures undergone within one year was made during the pilot survey. It was found that infections following surgery without implants were prevalent for some time, and if only surgery within the last month were recorded, a number of procedures related to infections would be missed. Therefore it was agreed that procedures for the preceding year regardless of surgery type would be recorded.

These inpatients were part of the burden study and were all surveyed while admitted to acute hospitals. The data collection protocol permitted three implant procedures and three non-implant procedures to be recorded per inpatient in one year preceding the date of survey.

5.3.6 Length of Stay (LOS) data collection

The survey collected the following data items which were suitable for LOS analysis: inpatient's age; inpatient's gender; type of hospital; size of hospital; specialty for patient; time of year when admitted (season); whether patient died; HAI status. These factors make useful proxies for the complex mix of factors which affect an inpatients' LOS in hospital.

5.3.7 Prevalence and incidence data collection

Data from the HAI Prevalence survey (all acute, burden study inpatients) were compared to the SSHAIP SSI Incidence Surveillance programme (all procedures between 1 October 2005 and 31 of September 2006). Within the National HAI prevalence survey, burden study surgery types were mapped to same those collected by the SSHAIP SSI surveillance programme.

5.4 Statistical analysis

The data collected in this study have a hierarchical structure. Patients are in wards which are themselves in hospitals. Multilevel models recognise that individuals are not independent of each other e.g. patients within a ward may be more alike than patients sampled randomly from within a hospital. Traditional multiple regression techniques treat the patients as independent observations. A consequence of this is that standard errors of regression coefficients are underestimated and may lead to an overstatement of statistical significance (35).

Regression analysis was carried out in STATA® using the GLLAMM procedure The survey included 13 754 inpatients within 839 wards within a total of 67 hospitals. These analyses show that the ward level had a much greater effect on HAI prevalence than the hospital level. As a result of these analyses it was decided that all subsequent analyses of HAI prevalence should allow for clustering at ward level but not at hospital level.

5.4.1 Prevalence calculations

Prevalence was calculated as the total number of HAI patients divided by the total number of inpatients. Prevalence was calculated for both acute and non-acute hospitals, then prevalence was calculated by age category, gender, hospital type, hospital size and ward type.

5.4.2 95% Confidence intervals

Statistical analyses were carried out using STATA® software, specifically the SVY: MEAN (36) procedure with ward as the primary sampling unit. This produces the slightly wider confidence intervals of HAI prevalence needed to allow for the clustering at ward level.

5.4.3 Box plots

Box plots were used to display values for LOS by specialty. The vertical line in the centre of the box represents the median value and the outer edges of the box refer to the quartiles. The dots outside of the box represent unusually large values for LOS.

5.4.4 Funnel plots

Adjusted prevalence values for HAI are displayed as funnel plots (37) (Figure 6-10 to Figure 6-21). These values are based on the output from the multivariate logistic regression analyses for acute and non-acute hospitals (Table 6-29 and Table 6-31). These analyses provide estimates of the probability of an HAI for each individual inpatient, which are then summed over all relevant inpatients to give the expected number of HAIs (E) for each hospital specialty.

The adjusted rate is calculated by the formula

$$Adj(P) = P*(O/E)$$

where O is the observed number of HAIs in each hospital specialty; E is the expected number of HAIs in each hospital specialty based on age, gender and time of year; P is the overall HAI prevalence rate for that specialty. The resulting adjusted HAI values take into account the effect of age, gender and time of year on HAI prevalence.

The results of the logistic regression indicated that separate funnel plots should be produced for each specialty for both acute and non-acute hospitals (Table 6-29 and Table 6-31). The plots show the adjusted prevalence of HAI for hospital specialties plotted against the number of patients on which the rate is based. The two funnels (one depicted by the dashed line and one by the solid line) on each plot indicate the 95% and 99% confidence limits (CL), calculated from confidence intervals throughout the range of values. Funnel plots have been produced for each specialty where patient numbers and HAI prevalence permits.

5.4.5 Prevalence logistic regression analyses

The logistic analyses (both univariate and multivariate) were carried out in STATA® using the SVY: LOGISTIC procedure with ward as the primary sampling unit (36).

Acute and non-acute hospitals were analysed separately. The dependent variable was HAI status (yes/no). Several explanatory variables (and possible interactions) were investigated including: age category, gender, hospital size (small, medium, large), type of admission (planned or unplanned), hospital type (teaching, general, obstetric), calendar quarter and specialty of the consultant caring for the inpatient.

Choices between competing models were made on the basis of likelihood ratio tests for nested models or Akaike Information Criterion (AIC) for non-nested models (38). The Akaike Information Criterion (AIC) is a measure of the goodness of fit of a model and is an operational way of trading off the complexity of an estimated model against how well the model fits the data. The best model would normally have the lowest AIC value.

Likelihood is the probability that the observations could have occurred given that particular set of parameters. It is often expressed on the log scale (39).

Degrees of freedom is the number of independent units of information relevant to the estimation of the parameters in the model (39).

5.4.6 LOS regression analyses

LOS was ascertained for all eligible inpatients. The additional LOS due to HAI was estimated using a modelling approach taking age, gender, specialty and admission type (planned or unplanned) into account.

Date of discharge for patients who were discharged to 'Another Hospital' or 'Home/Care Home' or were 'Still in Hospital' or had 'Died' were used to calculate LOS as follows.

Equation 1: *Length of stay calculation*

LOS= Date of Discharge/Death* - Date of Admission*

*from/to the hospital where the survey was carried out

Patients who were 'Still in Hospital' or for whom discharge status was 'Not known' were allocated a proxy date of discharge. Patients who were 'Still in Hospital' were given the last date of discharge known for patients from that hospital and patients whose discharge status was 'Not known' were given the census date as the date of discharge. Using these proxy dates, LOS was calculated as shown in Equation 1. The lengths of stay for these patients are unknown but are at least as long as the LOS calculated using the proxy dates. These patients are considered 'censored'.

These analyses were carried out on a subset of patients, those in the burden study and those patients with a HAI. The analyses were carried out in STATA® using the STREG procedure with ward as the primary sampling unit. A lognormal regression model was chosen (40). The lognormal distribution occurs when the log of x is normally distributed and is a good choice when analysing skewed data such as LOS. This method is suitable for censored observations (39).

Many explanatory variables (and possible interactions) were investigated including: age category, gender, hospital size, type of admission, calendar quarter, HAI type and specialty. Choices between competing models were made on the basis of likelihood ratio tests for nested models or AIC for non-nested models.

5.4.7 Kaplan Meier analysis

Kaplan Meier analyses were used to derive curves representing the estimated proportion of inpatients with and without HAI remaining in hospital as LOS increases. The method is suitable for censored observations.

5.4.8 Economic analysis

The additional cost of care of inpatients with HAI was estimated by applying a cost per additional day from the additional LOS of inpatients with HAI. These costs were based on local Scottish healthcare costs (41) and assumptions about relative components of cost as reported in the study by Plowman (3). Statistical analysis determined the additional LOS attributable to HAI.

These data were used to attach a monetary value to that resource use. The term 'value' is more appropriate than 'cost' because the nature of hospital costs is that they are largely fixed irrespective of patient numbers, at least in the short-term. For example, a fully staffed 24-bed ward might have 20 occupied beds and the staffing requirements are estimated accordingly. If a HAI is prevented and a patient goes home early, there will not be fewer staff required as a result of there only being 19 patients. Another patient might be admitted to fill the vacant place – if they are more ill than the patient who went home the total amount of work might even have gone up but staff numbers are still likely to be unaffected. Similar arguments apply to numbers of medical staff, laboratories, porters, laundry staff, catering costs, and so on. Therefore the words 'cost' and 'savings' in this context can be quite misleading – the true value of preventing a HAI (aside from the health of the patient) is to allow someone else to be admitted who otherwise might not have been. This is valuable and we attach a figure to recognise that, but it is not akin to a financial cost that can be saved. The values used reflect the current costs of care from Scottish Health Service Costs (41).

Two analyses were undertaken. Firstly, the overall analysis considered the additional LOS for all acute patients. Secondly the specialty analysis considered the clinical specialties that had been sampled and where there was a statistically significant difference in LOS as a result of an infection. All the data in this section on discharges, LOS and costs were taken from Scottish Health Service Costs for the year ending 31 March 2006, accessed on the ISD Scotland website (41).

5.4.9 Use of prescription of antimicrobials as a proxy indicator of HAI

The possibility that the time of prescription of antimicrobials could be used as a proxy indicator for HAI (42) was investigated using antimicrobial data collected for all patients in the prevalence survey.

To consider this question two groups were compared; group 1 and group 2. Group 1 being the group of inpatients who were prescribed an antimicrobial 48 hours or more after admission to hospital and Group 2 being everyone else. Group 2 includes both those who never had an antimicrobial and those who had all their antimicrobials prescribed within 48 hours of admission.

Prevalence of HAI in group 1 is represented by p_1 and the prevalence of HAI in group 2 is p_2.

The null hypothesis (H0) is that the prevalence in the two groups is the same and the alternative hypothesis (H1) is that they are different.

Formally this is written as: $H0: p_1 = p_2$ v $H1: p_1 \neq p_2$

Subjectively this hypothesis appears logical since if patients were admitted with a community acquired infection it would be expected that they would be given a therapeutic treatment within 48 hours of their admission to hospital.

Statistical analyses were carried out in STATA® using the DIAGT procedure (36). This procedure calculates sensitivity, specificity, and predictive values; together with their 95% CI

5.4.10 Prevalence to incidence calculation

The Rhame and Sudderth (43) model approach was tested, as the other approaches in the published literature assume the duration of infection is known and therefore do not fit with the information collected in this study.

Equation 2: *Formula for calculating cumulative incidence from prevalence data*

$$I = P\left[LA/(LN\text{-}INT)\right] \quad (43)$$

I=Incidence rate

P=Prevalence rate

LA=mean LOS for all inpatients

LN=mean LOS for inpatients who acquire one or more HAI

INT=mean interval between admission and onset of first HAI for those inpatients who acquire one or more HAI

Incidence data were collected from hospitals participating in the SSHAIP incidence surveillance programme, which utilises staff trained in identifying surgical site HAI using CDC criteria. Information was collated from nursing and medical documentation, including temperature and prescription charts. Only data for the time period of the prevalence survey was used from the incidence data. All non-acute hospitals were excluded from the prevalence and SSHAIP data.

6 RESULTS

6.1 Readers notes

6.1.1 Structure of report

This document is one of two volumes. Volume 2 contains the methodology used during the survey. This is included as a stand-alone document.

This document includes an appendix which contains mappings between broad and narrower categories for all the data items and details of how calculations were made. A comprehensive set of disaggregated and additional tables is provided for reference within the Appendices.

Where a disaggregated table within the Appendix is discussed it will be referred to within the text.

After each statement the table or figure the results refer to will be referred to by (Table X)

Acute and non-acute hospitals are in general presented separately. However, where appropriate (e.g. describing the differences in the demographics of the populations), comparisons between the populations in acute and non-acute hospitals have been made.

6.1.2 Standard order of presentation

Data are presented in a standard order. When any deviation is made from this standard order a comment is included to alert the reader.

- Geography
- Numbers
- Age and Gender
- Hospital Type
- Specialty
- Admission Type
- Microbiology
- Antimicrobials
- Invasive Devices
- Surgery
- LOS

6.1.3 Tables

When confidence intervals not able to be calculated, due to small sample sizes, they were replaced with '-' on the tables. Those categories with a denominator of zero are also represented by '-'.

Empty fields in tables comparing multiple categories (e.g. Specialty (Appendix Table 5-9 page 196 and Appendix Table 5-10 page 197), Micro organisms (Appendix Table 5-22 page 206 and Appendix Table 5-24 page 212)) with Infection type categories indicate that there were no cases present. All zeros have been removed to improve readability.

6.1.4 Multiple infections

It is important to note the difference between 'count of inpatients' with each infection type and the 'count of infections' presented in results and the appendix. It should be noted that there is a proportion of patients who have multiple HAI types in Appendix Table 5-3 page 189 and Appendix Table 5-4 page 190, and these have been reported in a separate column. Appendix Table 5-5 page 191 and Appendix Table 5-6 page 193 report the total number of patients with each infection type, including patients with multiple infections. These will contribute to the count in several infection categories, so it is not necessarily appropriate to sum the counts of patients in each infection type.

6.1.5 Rounding

Prevalence percentages have been rounded to one decimal place. As a consequence of this, there will be instances where a column with percentage values does not sum precisely to 100%.

6.1.6 Acronyms

A full list of acronyms is provided in the Appendix Table 11-1 page 233.

Acronyms for infection types

BJ = Bone and Joint
BSI = Blood Stream Infection
CNS = Central Nervous System
CVS = Cardiovascular System
EENTM = Eye, Ear, Nose, Throat or Mouth
GI = Gastrointestinal
LRI = Lower Respiratory Tract Infection other than Pneumonia
PNE = Pneumonia
RSI = Reproductive System Infection
SI = Systemic Infection
SSI = Surgical Site Infection
SST = Skin and Soft Tissue
UTI = Urinary Tract Infection

6.2 The Survey population

6.2.1 Numbers

A total of 13754 inpatients were included in the Scottish National Prevalence Survey: 11608 in all 45 acute hospitals and 2146 in a sample of 22 non-acute hospitals in Scotland (Table 6-1). Bed occupancy was calculated to be approximately 80%, which is consistent with the figure of 81-82% reported by ISD over the last 6 years (33).

Table 6-1: *Summary of survey population by hospital type, in acute and non-acute hospitals*

Hospital Type	Hospitals Visited	Eligible Wards Visited	Total Beds within eligible wards[1]		Inpatients[2] Surveyed	Bed Occupancy[3]
	N	N	N	%	N	%
Acute	45	708	14 838	84.8	11 608	78.8
Non-acute	22	131	2 660	15.2	2146	80.9
Total	**67**	**839**	**17 498**	**100**	**13 754**	**79.2**

1 'Total beds within eligible wards' is the sum of beds available in wards at the time of survey. Beds occupied by ineligible patients have been included in this count.

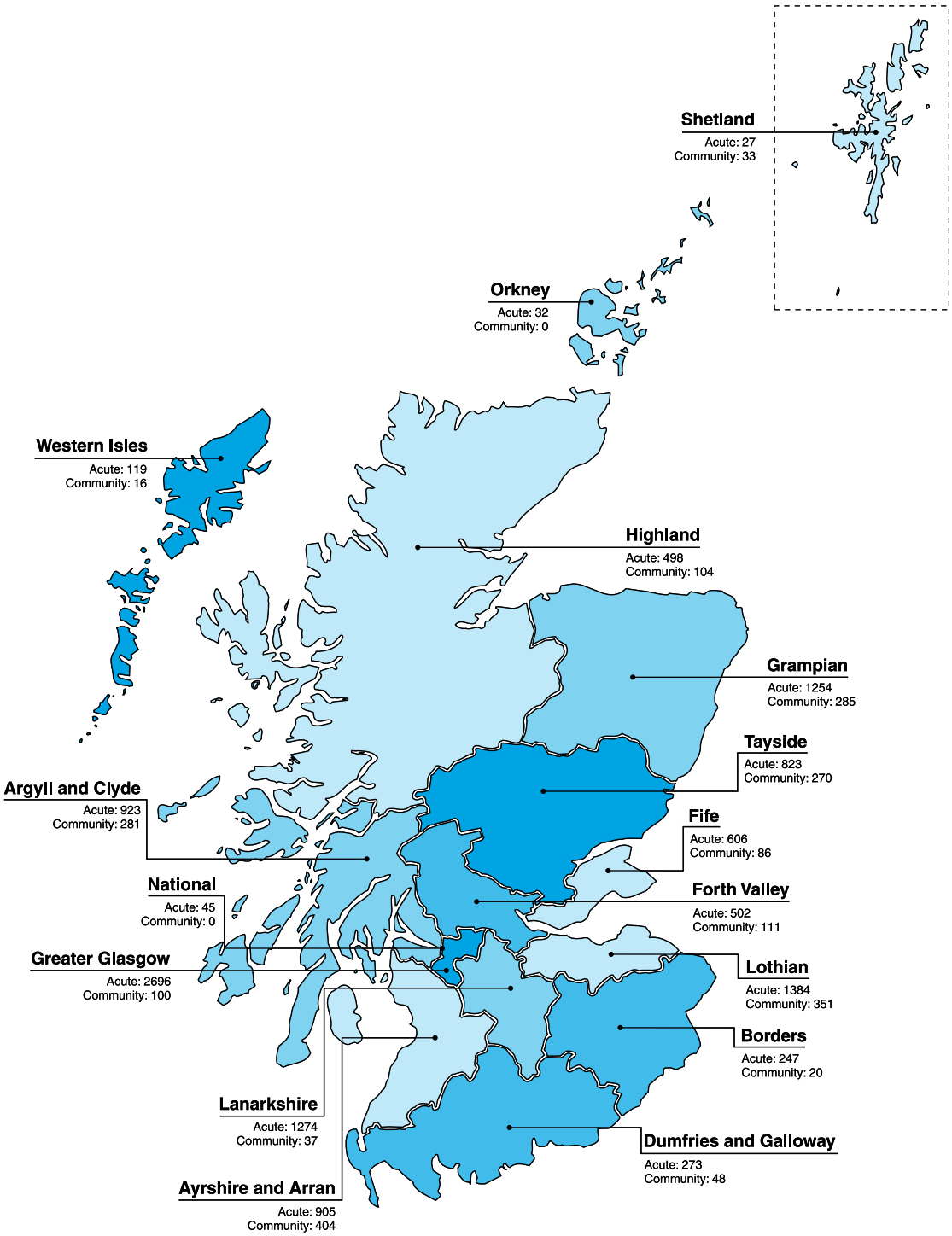
2 'Inpatients surveyed' is a count of all inpatients surveyed for acute and non-acute hospitals. This is distinct from all patients in eligible wards because day patients and those under 16 years of age were not surveyed.

3 'Bed occupancy' is the sum of all occupied beds (inpatients and ineligible patients) as a proportion of total beds within eligible wards.

6.2.2 Geographical distribution

The survey included inpatients in every NHS board[1] in Scotland (Figure 6-1).

Figure 6-1: *Acute and non-acute inpatients surveyed in each Scottish NHS board during the national HAI prevalence survey*



1 Boundary reorganisations took place in April 2006 dividing the former Argyll and Clyde area between NHS Highland and NHS Greater Glasgow. National refers to the National Hospital, Clydebank

6.2.3 Gender and age

In most age categories females outnumbered males in both acute and non-acute hospitals (Figure 6-2 and Figure 6-3, Appendix Table 4-1 page 176 and Appendix Table 4-2 page177). The inpatient population consisted of 58.1% females in acute hospitals and 55.4% in non-acute hospitals. In both types of hospitals, a large proportion of the populations studied were inpatients ≥65 years (63.6% in the acute hospitals and 70.9% in the non-acute hospitals). The mean age of patients in acute hospitals was 65.9 years in males (median 69 years, IQR 56- 79 years) and 67.6 years in females (median 74 years, IQR 56 - 83 years) (see Appendix Table 4-9 page 185). The mean age of patients in non-acute hospitals was 64.4 years in males (median 70 years, IQR 49 - 80 years) and 75.5 years in females (median 81 years, IQR 71 - 86 years). (Appendix Table 4-10 page 186). Standard deviations have not been quoted due to the skewed nature of the age distributions (Figure 6-2 and Figure 6-3).

Figure 6-2: *Acute Hospitals. Inpatients surveyed by age group and gender (n=11608)*

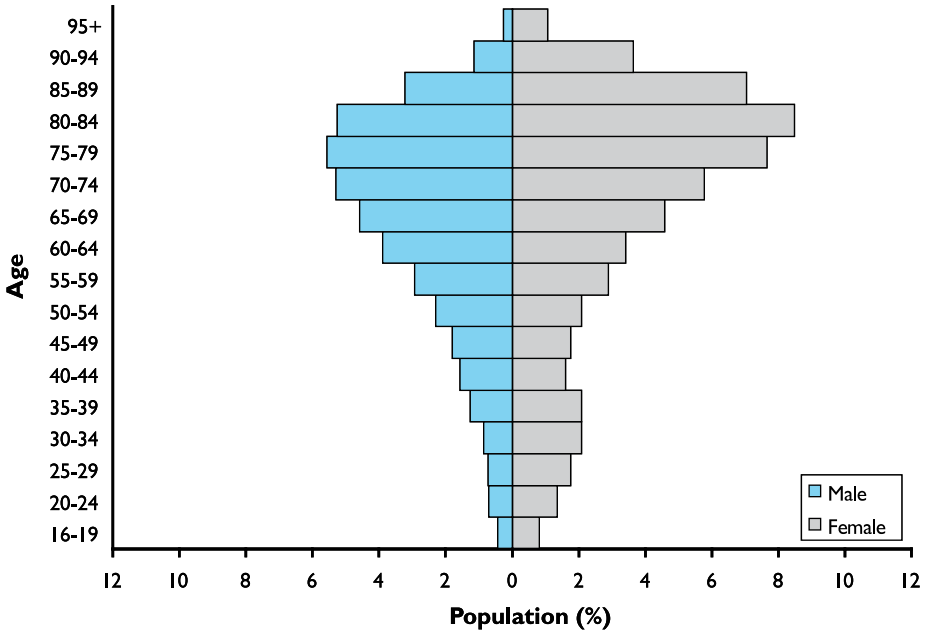
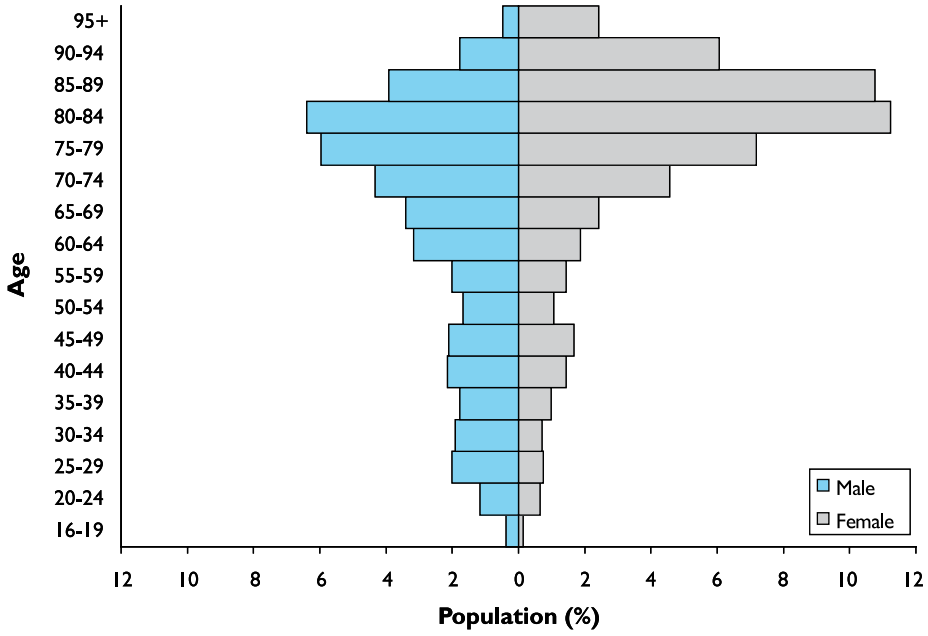


Figure 6-3: *Non-acute Hospitals. Inpatients surveyed by age group and gender (n=2146)*



6.2.4 Hospitals

All 45 acute hospitals in Scotland were included in the survey, including seven teaching hospitals, 34 general hospitals and four obstetric hospitals (Figure 6-2) Hospitals were stratified into acute and non-acute-specific size classes based on anticipated bed numbers. Table 6-3 and Table 6-4 show the number of acute and non-acute hospitals in each size class and the inpatients surveyed. The acute hospitals ranged in size from 12 to 711 eligible inpatients (Appendix Table 4-3 page 178). The 22 non-acute hospitals included in the survey ranged in size from 7 to 285 eligible inpatients (Appendix Table 4-4 page 181). The sample aimed to represent all of the NHS board regions in Scotland.

Table 6-2: *Acute Hospitals. Number of hospitals and eligible inpatients surveyed by hospital type*

Type	Hospitals Surveyed N	Inpatients Surveyed N
General	34	7 877
Teaching	7	3 562
Obstetric	4	169
Total	**45**	**11 608**

Table 6-3: *Acute Hospitals. Number of hospitals and eligible inpatients surveyed by hospital size*

Size	Hospitals Surveyed N	Inpatients Surveyed N
Large (≥ 500 beds)	16	7 467
Medium (250-499 beds)	13	3 435
Small (50-249 beds)	14	676
Very Small (<50 beds)	2	30
Total	**45**	**11 608**

Table 6-4: *Non-acute Hospitals. Number of hospitals and eligible inpatients surveyed by hospital size*

Size	Hospitals Surveyed N	Inpatients Surveyed N
Large (≥ 250 beds)	3	704
Medium (150 -249 beds)	6	862
Small (50-149 beds)	7	452
Very Small (<50 beds)	6	128
Total	**22**	**2 146**

6.2.5 Ward type

Acute hospital wards were categorised into four separate clinical types: general, High Dependency Units (HDU), Intensive Care Units (ICU) and mixed. In some hospitals there were mixed wards with some beds considered HDU and some general within a single ward, these have been classified as mixed wards. More than 95% of acute inpatients were in general wards, while a small proportion (0.7%) resided in mixed wards (Table 6-5). Non-acute hospital wards were all considered to be general wards.

Table 6-5: *Acute Hospitals. Wards and inpatients surveyed by ward type*

Ward Type	Wards Surveyed		Inpatients Surveyed	
	N	%	N	%
General	637	90.0	11 212	96.6
HDU	35	4.9	188	1.6
ICU	29	4.1	129	1.1
Mixed	7	1.0	79	0.7
Total	**708**	**100.0**	**11 608**	**100.0**

6.2.6 Boarders

Patients under the care of a consultant specialty not usually attendant on the ward were recorded as boarders. In acute hospitals, 423 (3.6%) inpatients were boarders, compared with just eight (0.4%) inpatients in non-acute hospitals (Appendix Table 4-11 page 186 and Appendix Table 4-12 page 187). Most boarders, in both acute (77.3%) and non-acute (75.0%) settings, were under the care of consultants specialising in Medicine.

6.2.7 Specialties

The specialty distribution of the survey population was different in acute and non-acute hospitals (Figure 6-4 and Figure 6-5). In acute hospitals, inpatients in two medical specialties i.e. Medicine and Care of the Elderly made up 58.6% and those in the two surgical specialties i.e. Surgery and Orthopaedics made up nearly 28% of the survey group (Table 6-6). In the non-acute hospital sample, inpatients in medical specialties, Medicine (26.2%) and Care of the Elderly (20.3%) and Psychiatry (52.5%) together made up 99% of the sample (Table 6-7). Table 6-6 and Table 6-7 also show that females are in the majority in most of the main specialties which admit both genders, except among psychiatric inpatients in non-acute hospitals, where males outnumber females.

Unplanned admissions to hospital made up 76% of those under surveillance in acute hospitals and 56% of those in non-acute hospitals (Appendix Table 4-7 page 185 and Appendix Table 4-8 page 185). A planned admission occurs when a patient whose name was on the planned waiting list for the specialty, is admitted as planned to the specialty as an inpatient. An unplanned admission occurs when, for clinical reasons, a patient is admitted at the earliest possible time after seeing a doctor (32).

Figure 6-4: *Acute Hospitals. Proportion of inpatients surveyed by specialty and gender (n=11608)*

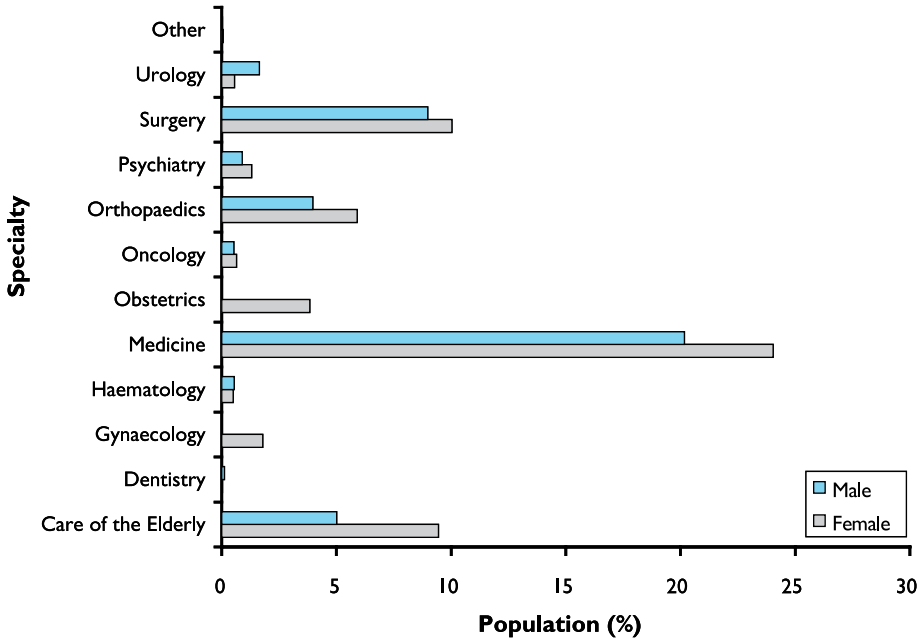


Table 6-6: *Acute Hospitals. Number and percentage of inpatients by specialty and gender (n=11608)*

Specialty	Female		Male		All Inpatients	
	N	%	N	%	N	%
Care of the Elderly	1 096	16.2	581	12.0	1 677	14.4
Dentistry	3	0.0	13	0.3	16	0.1
Gynaecology	208	3.1	0	0.0	208	1.8
Haematology	57	0.8	63	1.3	120	1.0
Medicine	2 791	41.3	2 341	48.2	5 132	44.2
Obstetrics	446	6.6	0	0.0	446	3.8
Oncology	75	1.1	61	1.3	136	1.2
Orthopaedics	685	10.1	460	9.5	1 145	9.9
Psychiatry	152	2.3	104	2.1	256	2.2
Surgery	1 165	17.3	1 042	21.4	2 207	19.0
Urology	65	1.0	190	3.9	255	2.2
Other[1]	7	0.1	3	0.1	10	0.1
Total	**6 750**	**100.0**	**4 858**	**100.0**	**11 608**	**100.0**

1 All inpatients recorded under the 'Other' specialty category were admitted for Homeopathy

Figure 6-5: *Non-acute Hospitals. Proportion of inpatients surveyed by specialty and gender (n=2146)*

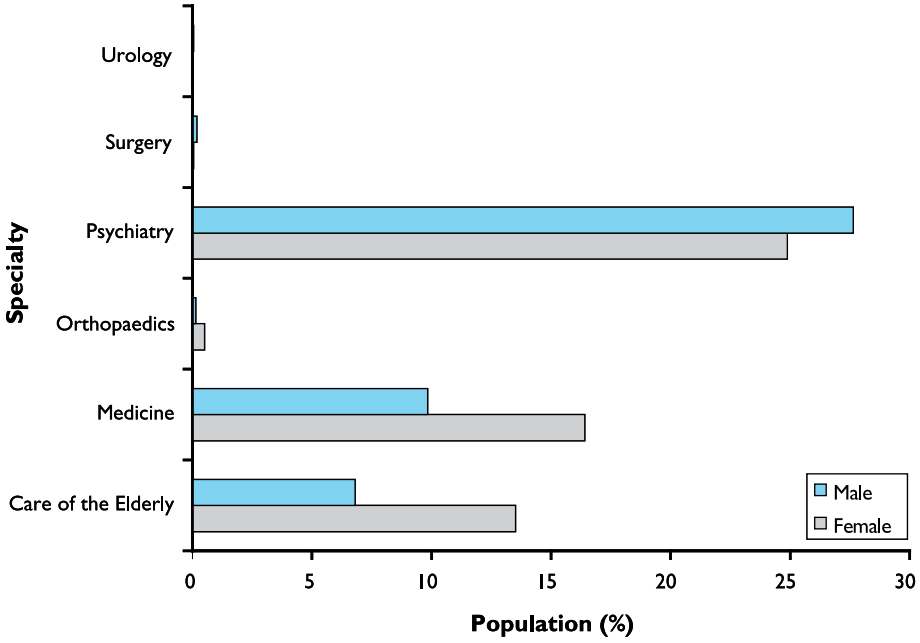


Table 6-7: *Non-acute Hospitals. Number and percentage of inpatients by specialty and gender (n=2146)*

Specialty	Female		Male		All Inpatients	
	N	%	N	%	N	%
Care of the Elderly	290	24.4	146	15.2	436	20.3
Medicine	352	29.6	211	22.0	563	26.2
Orthopaedics	11	0.9	3	0.3	14	0.7
Psychiatry	534	44.9	593	61.9	1 127	52.5
Surgery	1	0.1	4	0.4	5	0.2
Urology	0	0.0	1	0.1	1	0.0
Total	**1 188**	**100.0**	**958**	**100.0**	**2 146**	**100.0**

6.3 The prevalence of HAI

6.3.1 Overall prevalence

In acute hospitals, 1103 of the total of 11608 inpatients were found to have a HAI, giving an unadjusted overall prevalence of inpatients with HAI in acute hospitals of 9.5 % (95% CI 8.8 – 10.2). Of the 1103 inpatients with HAI, 126 (11.4%) had more than one infection (Table 6-8). One thousand, two hundred and forty three (1243) HAIs which met the survey HAI case definition were found to be present, 831 (66.9%) fully meeting the CDC criteria and 966 (77.7%) meeting the criteria of 'one or more symptoms included in the survey definition and on antimicrobial therapy for a HAI', ('with therapy'). Forty-four point six percent of acute hospital cases met both HAI definitions (see Appendix Table 5-1 page 188).

In the non-acute hospital sample 157 of 2146 inpatients were found to have a HAI giving a crude overall prevalence of inpatients with HAI of 7.3% (95%CI 6.0 – 8.6). Seven of the 157 inpatients with HAI had more than one infection (Table 6-9). Of the 164 HAIs that were found to be present, 97 (59.1%) fully met the CDC incidence definitions and 144 (87.8%) met the 'with therapy' definition. Forty-seven percent of cases in non-acute hospitals met both infection definitions (see Appendix Table 5-2 page 188).

Table 6-8: *Acute Hospitals. Numbers and percentages of HAI diagnosed per inpatient (n=11608)*

Count of HAI	Inpatients	
	N	%
0	10 505	90.5
1	977	8.4
2	113	1.0
3	12	0.1
4	1	0.0
Total	**11 608**	**100.0**

Table 6-9: *Non-acute Hospitals. Numbers and percentages of HAI diagnosed per inpatient (n=2146)*

Count of HAI	Inpatients	
	N	%
0	1 989	92.7
1	150	7.0
2	7	0.3
Total	**2 146**	**100.0**

6.3.2 Prevalence of inpatients with HAI by age and gender

In both acute and non-acute hospital groups HAI prevalence increased with age in both genders (Figure 6-6 and Figure 6-7). There appeared to be a marked increase in the proportion of inpatients with HAI among those aged ≥60 years (Appendix Table 5-7 page 194 and Appendix Table 5-8 page 195 for a detailed breakdown of prevalence and five year age categories).

When HAI prevalence in the age bands 16-24 years, 25-44 years, 45-59 years, 60-74 years and ≥ 75 years was examined in acute and non-acute hospitals, HAI prevalence was significantly different between males and females in the age group 25-44 years in the acute hospital population. In this age group HAI prevalence was higher in males.

Figure 6-6: *Acute Hospitals. Prevalence of HAI and 95% confidence intervals by age group and gender*

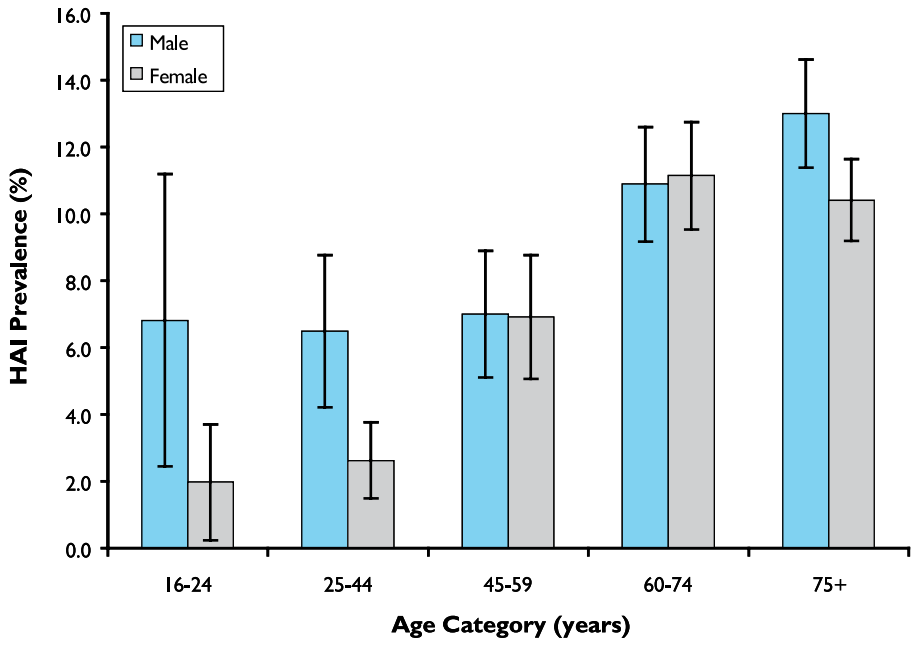
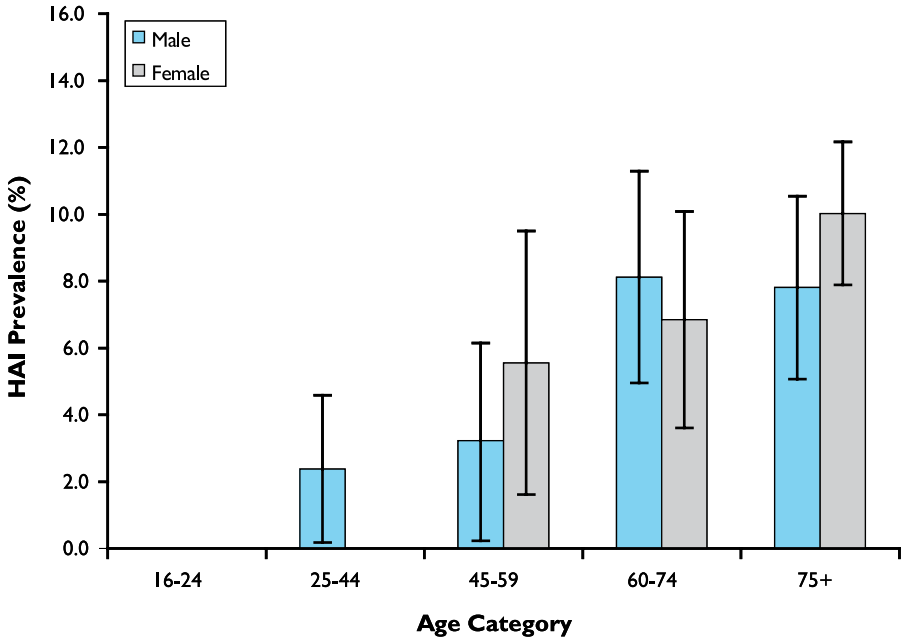


Figure 6-7: *Non-acute Hospitals. Prevalence of HAI and 95% confidence intervals by age group and gender*

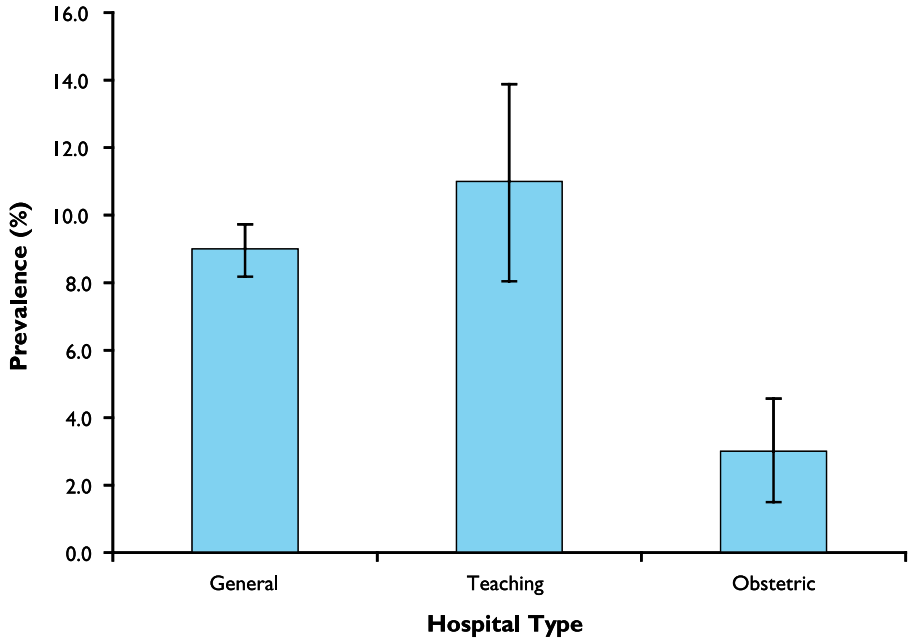


6.3.3 Prevalence of HAI by hospital type and size

There was no difference between prevalence of HAI between teaching hospitals and general hospitals but the prevalence of HAI was lower in obstetric hospitals (see Figure 6-8 and Appendix Table 5-18, page 204). This may be a reflection of specialty variation and case mix variation. HAI prevalence did not vary significantly between large, medium and small acute hospitals (Appendix Table 5-19 page 204).

There was no difference in prevalence of HAI by size of non-acute hospitals (see Appendix Table 5-20 page 204).

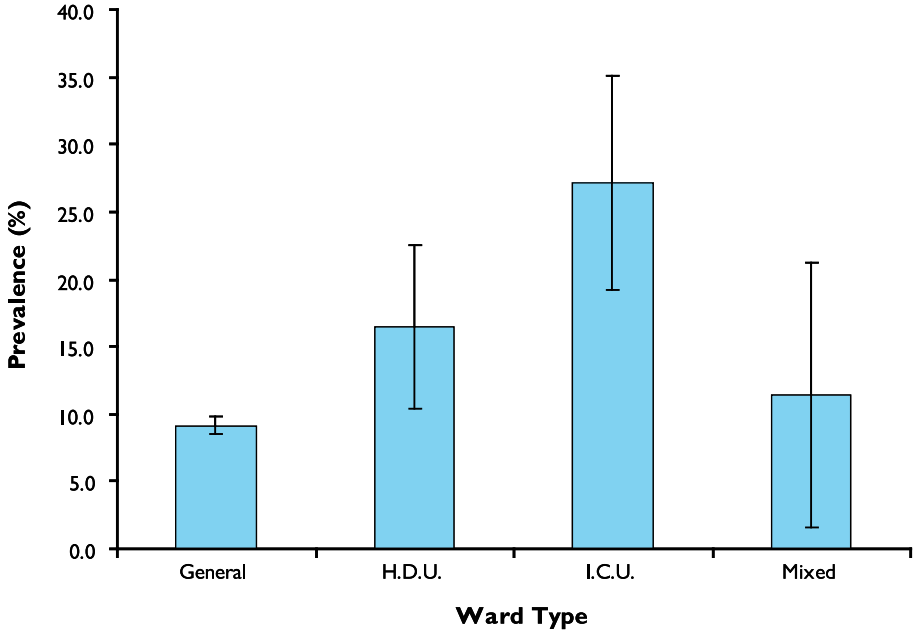
Figure 6-8: *Acute Hospitals. Prevalence of HAI in eligible inpatients and 95% confidence intervals by hospital type*



6.3.4 Prevalence of HAI by type of ward

There appeared to be a higher prevalence of HAI between Intensive Care Unit (ICU) and High Dependency Unit (HDU) ward types compared to general wards. This maybe due to the high levels of morbidity and acute illness of patients within the intensive care wards. (Figure 6-9 and Appendix Table 5-11, page 197). The prevalence found within ICU wards was highest at 27.1% (95% CI 19.2-35.1) and in HDU was 16.5% (95% CI 10.4-22.6) whereas in general wards the prevalence was 9.2% (95% CI 8.5-9.9).

Figure 6-9: *Acute Hospitals. Prevalence of HAI in eligible inpatients and 95% confidence intervals by ward type*



6.3.5 Prevalence of HAI by Boarder status

A comparison of HAI prevalence between patients who were specialty boarders and non-boarders indicated that boarders in acute hospitals were less likely to have a HAI, with prevalence of 5.9% (95% CI 3.7-8.2) compared with 9.6% (95% CI 8.9-10.4) for non-boarders (Appendix Table 5-12 page 198 and Appendix Table 5-13 page 198). There were too few boarders in non-acute hospitals to permit a comparison. Only the Medicine specialty had sufficient boarders in acute hospitals for a comparison of HAI at specialty level, but this showed little difference with non-boarders in the same specialty.

6.3.6 The proportions of acute inpatients with different types of HAI

Among acute hospital inpatients these data illustrate that all the HAI categories contribute to the total burden of HAI (Table 6-10). The main infection types in rank order were: Urinary Tract Infection (n=222); Surgical Site Infection (n=197); Gastrointestinal Infection (n=191); Eye, Ear, Nose, Throat and Mouth Infections[1] (n=155); Lower Respiratory Tract Infections other than Pneumonia (n=139); Skin and Soft Tissue Infections (n=137); Pneumonia (n=109). In Appendix Table 5-5 (page 191) the CDC categories are separated to show the types of infection contained within each broad grouping.

1 CDC groups Eye, Ear, Nose, Throat and Mouth Infections as a single major category of infection. They are grouped by anatomical location but in clinical practice the specialties are quite distinct. When the narrower infections are disaggregated the most common infection type is oral cavity (with 107 infections) and the other 48 are divided throughout the infection types. For this reason Eye, Ear, Nose, Throat and Mouth Infections will not be discussed as a single group.

Table 6-10: *Acute Hospitals. Number and percentage of HAI cases by HAI type*

HAI Type	Infections	
	N	%
Bone and Joint Infection	6	0.5
Blood Stream Infection	55	4.4
Central Nervous System Infection	2	0.2
Cardiovascular System Infection	11	0.9
Eye, Ear, Nose, Throat or Mouth Infection	155	12.5
Gastrointestinal Infection	191	15.4
Lower Respiratory Tract Infection other than Pneumonia	139	11.2
Pneumonia	109	8.8
Reproductive System Infection	17	1.4
Systemic Infection	2	0.2
Surgical Site Infection	197	15.9
Skin and Soft Tissue Infection	137	11.0
Urinary Tract Infection	222	17.9
Total	**1 243**	**100.0**

If all respiratory tract infections are combined (lower respiratory tract infection and pnemonia) then this group makes up 20% of the total HAI. These two infection types are defined separatly according to CDC grouping.

Table 6-11 presents the numbers and percentage of acute hospital inpatients with specific categories of HAI. Comparison of Table 6-10 and Table 6-11 illustrates the importance of several categories to the overall prevalence of HAI which can be obscured by the use of multiple infection categories at a patient level. The HAI types affecting the 126 inpatients with multiple HAIs are provided in Appendix Table 5-3 on page 189.

Table 6-11: *Acute Hospitals. Numbers and percentage of eligible inpatients with HAI by HAI type*

HAI Type	Inpatients with HAI	
	N	%
Bone and Joint Infection	1	0.1
Blood Stream Infection	37	3.4
Central Nervous System Infection	1	0.1
Cardiovascular System Infection	7	0.6
Eye, Ear, Nose, Throat or Mouth Infection	118	10.7
Gastrointestinal Infection	145	13.2
Lower Respiratory Tract Infection other than Pneumonia	112	10.2
Pneumonia	86	7.8
Reproductive System Infection	12	1.1
Systemic Infection	1	0.1
Surgical Site Infection	163	14.8
Skin and Soft Tissue Infection	113	10.2
Urinary Tract Infection	181	16.4
Multiple Infections[1]	126	11.4
Total	**1 103**	**100.0**

1 Inpatients may have more than one infection. In this instance, they have been reported under the 'Multiple Infections' category. See Appendix for details of multiple infections Appendix Table 5 3 page 225

6.3.7 Prevalence of HAI in acute hospital inpatients, by specialty

The highest prevalence of HAI in acute hospital inpatients were found in the specialties Care of the Elderly (11.9% (95% CI 10.0-13.7%)), Surgery (11.2% (95% CI 9.5-12.9%)), Medicine (9.6% (95% CI (8.5-10.7%)) and Orthopaedics (9.2% (95% CI 7.3-11.1)) (Table 6-12). Obstetrics had very little prevalent HAI (0.9%).

Table 6-12: *Acute Hospitals. Prevalence of HAI in eligible inpatients by specialty*

Specialty	Inpatients with HAI N	HAI Prevalence within specialty %	95% CI
Care of the Elderly	199	11.9	(10.0 - 13.7)
Dentistry	2	12.5	(4.1 - 20.9)
Gynaecology	10	4.8	(1.2 - 8.4)
Haematology	8	6.7	(2.0 - 11.3)
Medicine	491	9.6	(8.5 - 10.7)
Obstetrics	4	0.9	(0.0 - 1.9)
Oncology	12	8.8	(2.0 - 15.7)
Orthopaedics	105	9.2	(7.3 - 11.1)
Other	0	0.0	- -
Psychiatry	9	3.5	(0.3 - 6.7)
Surgery	247	11.2	(9.5 - 12.9)
Urology	16	6.3	(3.0 - 9.5)
Total	**1 103**	**9.5**	**(8.8 - 10.2)**

The distribution of different HAI types within specialties is given in Appendix Table 5-9 (page 196). These data illustrate that at individual specialty level, all the HAI categories contribute to the burden of HAI. For example, 71% of the 247 HAI in surgical inpatients, and 57% of the 105 HAI in Orthopaedic inpatients were in categories other than Surgical Site Infection Among Care of the Elderly inpatients, 68% had infections other than Urinary Tract Infection and Pneumonia. Dentistry specialty should be interpreted with caution as the numbers are very small (n=2).

Conversely, within the specialty of Surgery, 29% of the 247 HAI were Surgical Site Infection and the remainder were distributed in other CDC Major categories. In Orthopaedics 43% of HAI were Surgical Site Infection and in Care of the Elderly Urinary Tract Infections and Pneumonias accounted for 32% of HAI (see Appendix Table 5-9 page 196).

6.3.8 Acute hospital funnel plots for specialties within each hospital

Figure 6-10 to Figure 6-18 show, for each specialty, the adjusted (age, gender and season) HAI prevalence of individual hospitals plotted against hospital specialty size, and 95% and 99% confidence limits for a HAI prevalence estimate by increasing hospital size. Very few hospitals have adjusted HAI prevalence which is above the upper confidence limits. Variation may be attributed to differences in case mix factor not accounted for here, such as co-morbidity within the hospital inpatient population giving rise to increased risk of HAI among inpatients (see section 5.4.4 Funnel plots page 41).

Figure 6-10: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Care of the Elderly specialty*

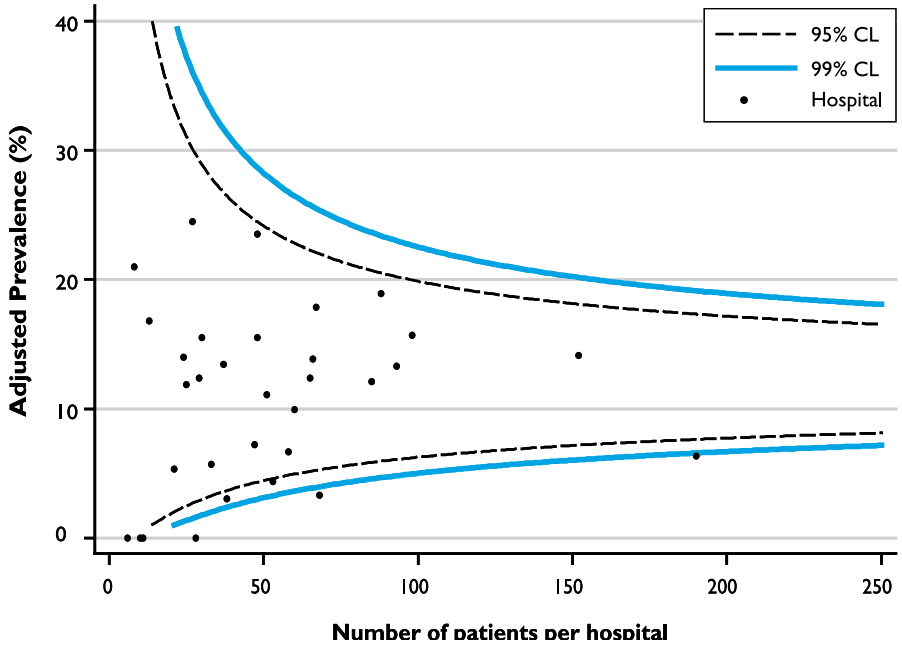


Figure 6-11: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Gynaecology specialty*

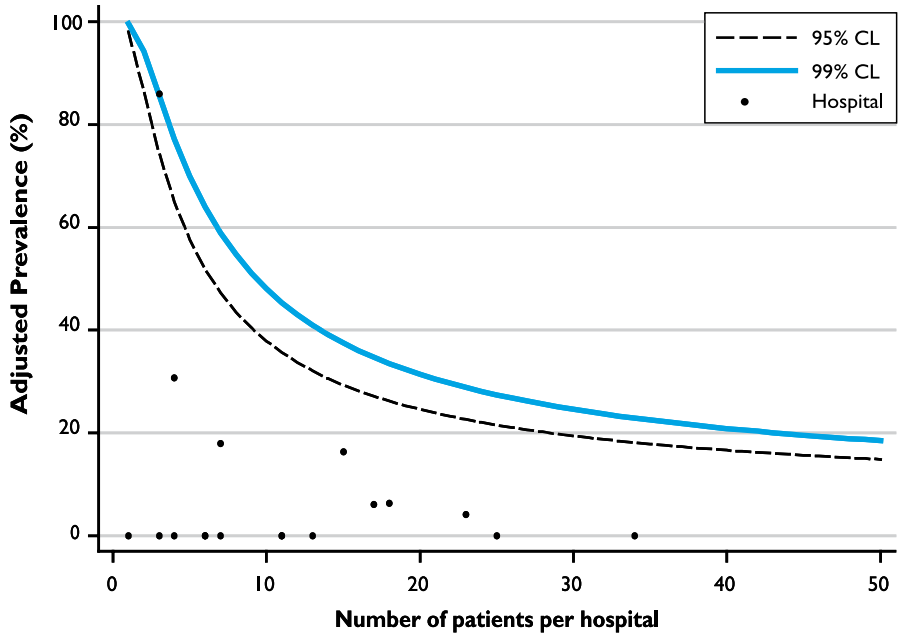


Figure 6-12: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Haematology specialty*

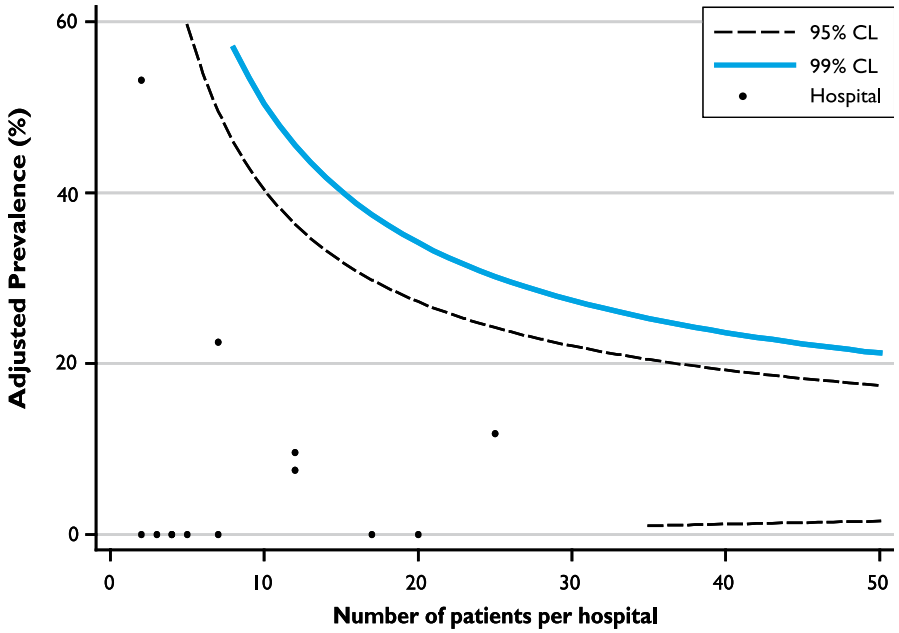


Figure 6-13: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Medical specialty*

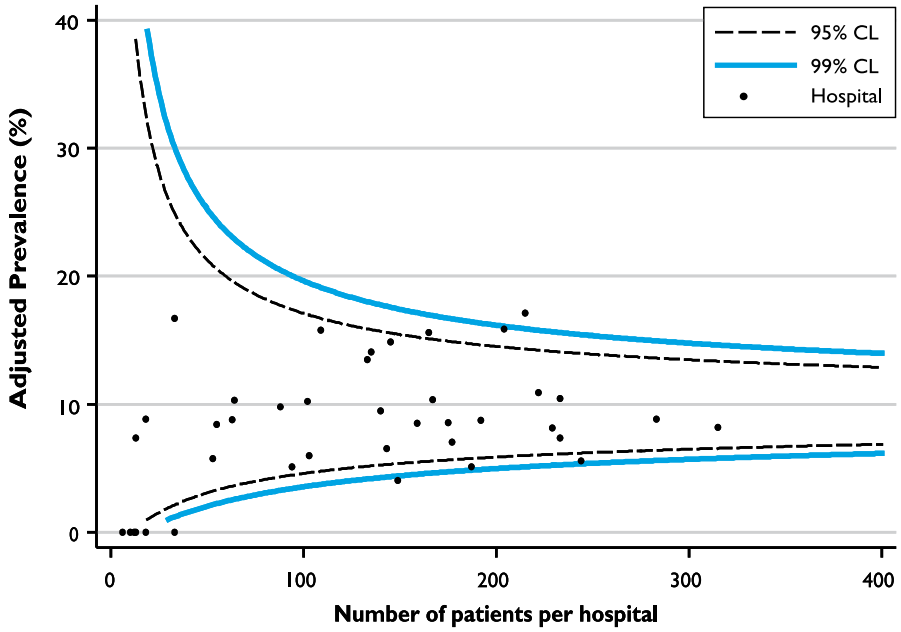


Figure 6-14: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Obstetrics specialty*

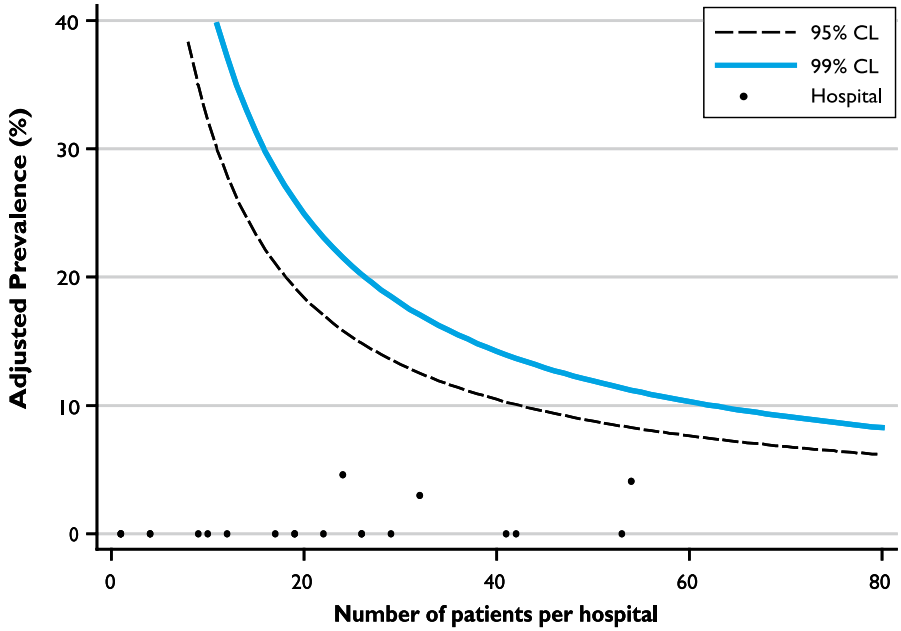


Figure 6-15: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Oncology specialty*

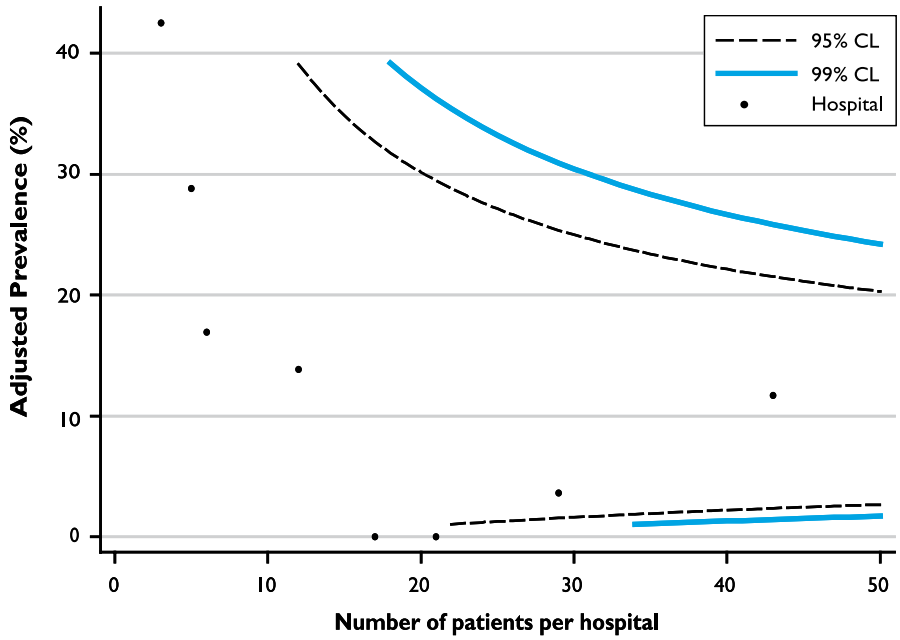


Figure 6-16: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Orthopaedic specialty*

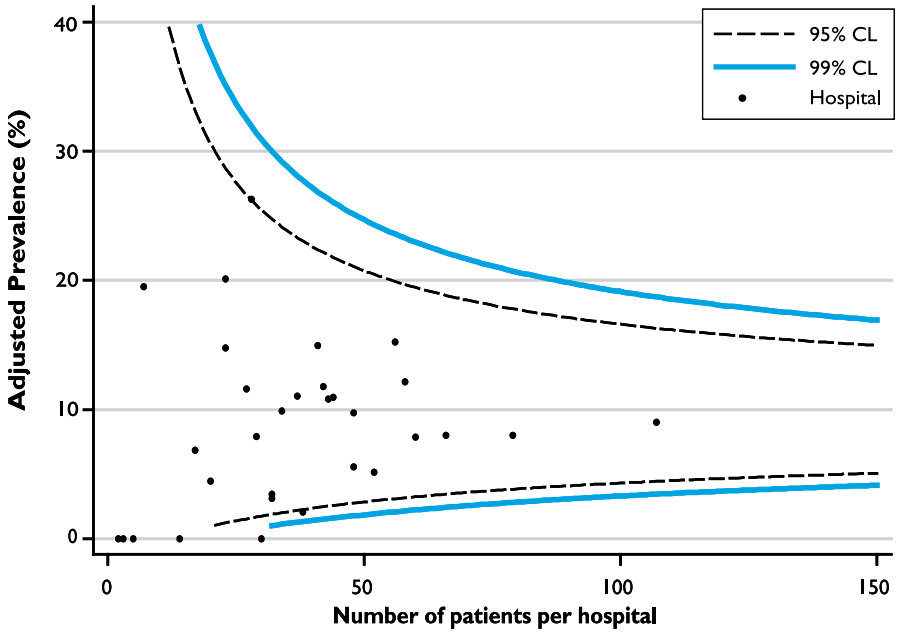


Figure 6-17: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Surgery specialty*

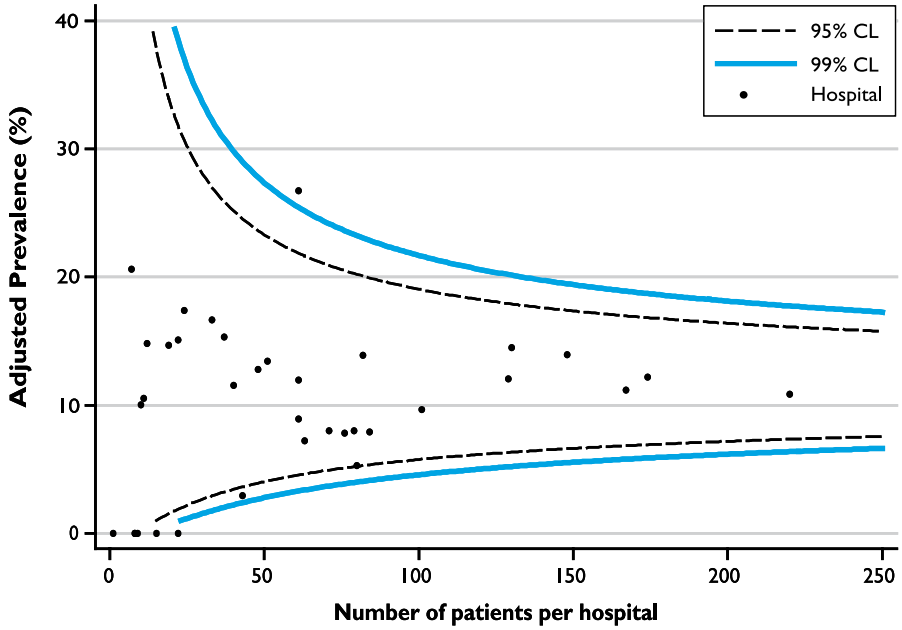
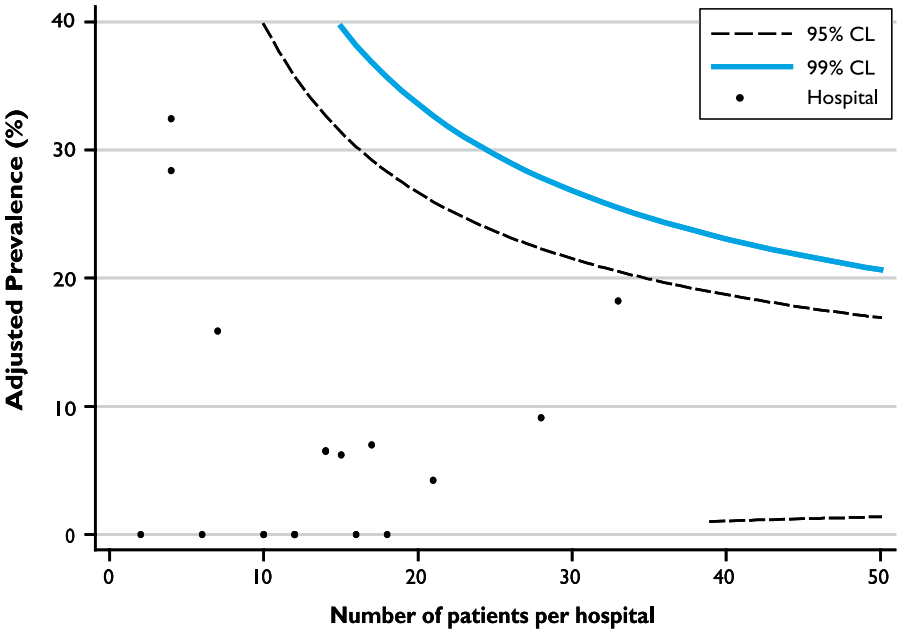


Figure 6-18: *Acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Urology specialty*



6.3.9 The proportions of non-acute inpatients with different types of HAI

The specialty distribution of non-acute hospital inpatients differs from that of acute hospital inpatients and therefore the pattern of HAI contributing to the burden of HAI is different (Table 6-13). Urinary Tract Infection (n=46), Skin and Soft Tissue Infection (n=44), Eye, Ear, Nose, Throat or Mouth Infection (n=22), Gastrointestinal Infection (n=20) and Lower Respiratory Tract Infection other than Pneumonia (n=19) made up 92% of infections. The only categories of HAI that were not found in non-acute hospital inpatients were Blood Stream Infections, Central Nervous System Infections and Systemic Infections. Although some more severe HAI, which particularly affect acute hospital inpatients e.g. Pneumonias and Surgical Site Infections are very much less common, they do occur in non-acute hospitals.

If all respiratory tract infections are combined (lower respiratory tract infection and pnemonia) then this group makes up a large proportion of the total HAI. These two infection types are defined separatly according to CDC grouping.

Table 6-13: *Non-acute Hospital. Number and percentage of HAI cases by HAI type*

HAI Type	Infections	
	N	%
Bone and Joint Infection	1	0.6
Cardiovascular System Infection	1	0.6
Eye, Ear, Nose, Throat or Mouth Infection	22	13.4
Gastrointestinal Infection	20	12.2
Lower Respiratory Tract Infection other than Pneumonia	19	11.6
Pneumonia	4	2.4
Reproductive System Infection	2	1.2
Surgical Site Infection	5	3.1
Skin and Soft Tissue Infection	44	26.8
Urinary Tract Infection	46	28.1
Total	**164**	**100.0**

Table 6-14: *Non-acute Hospitals. Numbers and percentage of eligible inpatients with HAI by HAI type*

HAI Type	Inpatients with HAI	
	N	%
Bone and Joint Infection	1	0.6
Cardiovascular System Infection	1	0.6
Eye, Ear, Nose, Throat or Mouth Infection	21	13.4
Gastrointestinal Infection	18	11.5
Lower Respiratory Tract Infection other than Pneumonia	16	10.2
Pneumonia	4	2.6
Reproductive System Infection	2	1.3
Surgical Site Infection	4	2.6
Skin and Soft Tissue Infection	40	25.5
Urinary Tract Infection	43	27.4
Multiple Infections[1]	7	4.5
Total	**157**	**100.0**

1 Inpatients may have more than one infection. In this instance, they have been reported under the 'Multiple Infections' category. A listing of all HAI affecting the seven inpatients with multiple HAI is provided in Appendix Table 5 3 page 225.

6.3.10 Prevalence of HAI for non-acute inpatients, by specialty

Overall in non-acute hospitals, one in ten inpatients in the two medical specialties, (Medicine and Care of the Elderly combined) were found to have a HAI and one in twenty inpatients in the specialty Psychiatry were found to have a HAI (Table 6-15) these comprised principally Skin and Soft Tissue and Urinary Tract Infection. The distribution of the HAI across the categories for the inpatients with HAI in all specialties is given in Appendix Table 5-10 page 197. The highest prevalence of HAI in non-acute hospital inpatients were found in the following specialties: Medicine (11.4% (95% CI 8.6-14.1%)), Care of the Elderly (7.8% (95% CI 4.7-10.9%)) and Psychiatry (5.0% (95% CI 3.5-6.4%)). The number of patients in surgery and orthopedics are small and therefore should be interpreted with caution.

Table 6-15: *Non-acute Hospitals. Prevalence of HAI in eligible inpatients by specialty*

Specialty	Inpatients with HAI N	HAI Prevalence within specialty %	95% CI
Care of the Elderly	34	7.8	(4.7 - 10.9)
Medicine	64	11.4	(8.6 - 14.1)
Orthopaedics	1	7.1	- -
Psychiatry	56	5.0	(3.5 - 6.4)
Surgery	2	40.0	- -
Urology	0	0.0	- -
Total	**157**	**7.3**	**(6.0 - 8.6)**

6.3.11 Non-acute hospital funnel plots for specialties within each hospital

Figure 6-19 to Figure 6-21 show, for each specialty, the adjusted HAI prevalence (age, gender, season) of individual hospitals plotted against hospital specialty size. 95% and 99% confidence limits for a HAI prevalence estimate are shown by increasing hospital size (see section 5.4.4 Funnel plots page 41).

No non-acute hospital specialty prevalence estimates were above the upper 95% confidence limit.

Figure 6-19: *Non-acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Care of the Elderly specialty*

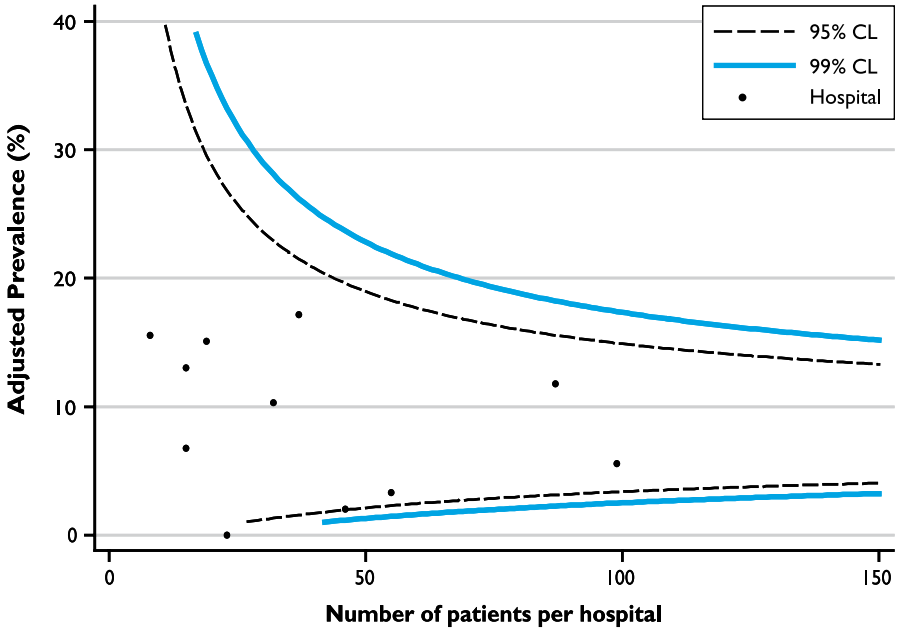


Figure 6-20: *Non-acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Medical specialty*

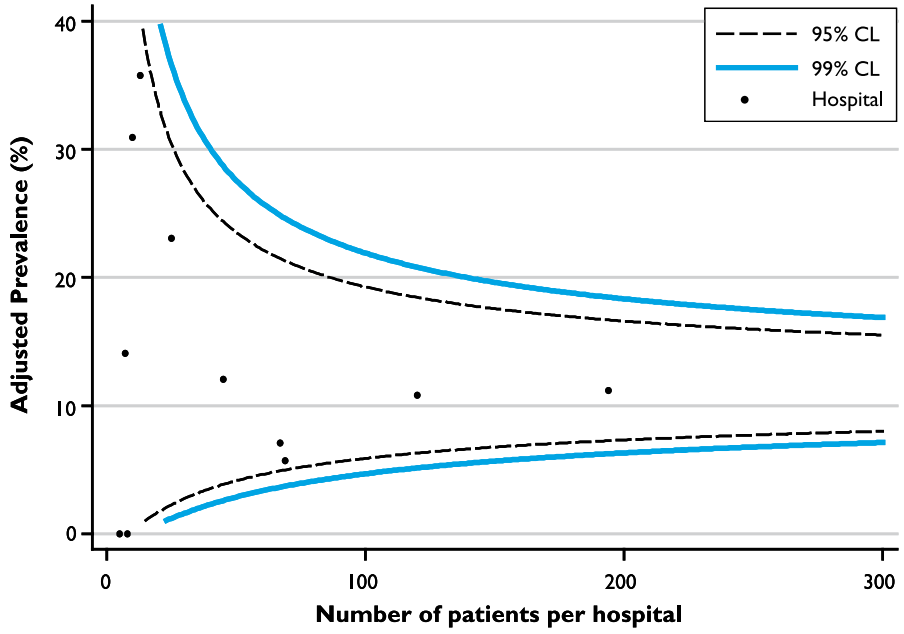
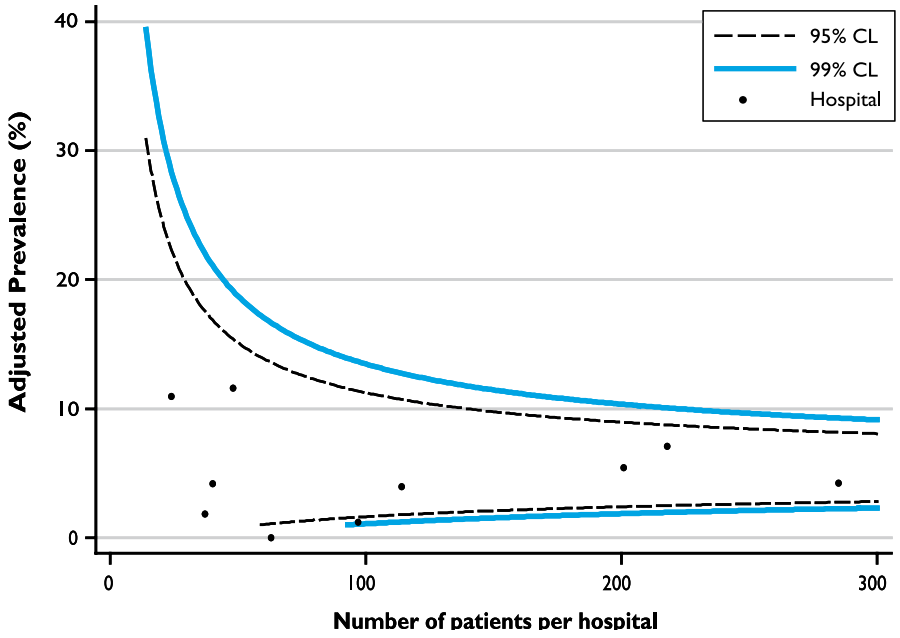


Figure 6-21: *Non-acute hospital funnel plot showing adjusted prevalence by inpatient numbers for Psychiatry specialty*



6.3.12 Prevalence by admission type

No difference in prevalence of HAI by admission type was found in acute or non-acute hospital inpatients (Table 6-16 and Table 6-17).

Table 6-16: *Acute Hospitals. Prevalence of HAI by admission type*

Admission Type	Inpatients with HAI		95% CI		
	N	%			
Planned	236	8.5	(7.2	-	9.8)
Unplanned	867	9.8	(9.0	-	10.6)
Total	**1 103**	**9.5**	**(8.8**	**-**	**10.2)**

Table 6-17: *Non-acute Hospitals. Prevalence of HAI by admission type*

Admission Type	Inpatients with HAI		95% CI		
	N	%			
Planned	85	9.0	(7.0	-	11.0)
Unplanned	72	6.0	(4.4	-	7.5)
Total	**157**	**7.3**	**(6.0**	**-**	**8.6)**

6.4 Microbiology

CDC definitions do not require microbiological confirmation for each infection type. In some instances microbiology reports were not available at the time of survey. Where microbiology reports were available the information was recorded. Where a test had been requested but the result was awaited was recorded as no microbiology report available. Microbiology reports are therefore incomplete. In acute hospitals 540 microbiology reports were recorded from 1243 infections. Microbiology results are biased towards screening practises within individual hospitals, i.e. screening for MRSA. The turnaround time for reporting varies for different organisms and between different laboratories. The most common organisms identified in inpatients with HAI were: *Staphylococcus aureus* (n=141 cases) (of which Meticillin resistant *Staphylococcus aureus* (MRSA) made up 93 cases and Meticillin sensitive *Staphylococcus aureus* (MSSA) 48 cases), *Clostridium difficile* (n=95) cases, followed by 46 cases of *Coliforms*. (Appendix Table 5-21 page 205).

In non-acute hospitals 54 isolates were reported from 164 infections. The most common organisms identified in inpatients with HAI were: *Staphylococcus aureus* (n=15) (of which Meticillin sensitive *Staphylococcus aureus* made up 9 cases and Meticillin resistant *Staphylococcus aureus* (MRSA) 6 cases); *Clostridium difficile* (n=13), and *Escherichia coli* (6 cases) (see Appendix Table 5-24 page 212). This is a similar pattern to that found in acute hospitals, however, the proportions of MRSA and MSSA are reversed in the non-acute hospitals. Appendix Table 5-25 page 213 shows a full listing of organisms found in each broad infection type.

Appendix Tables 5-27 (page 215) and 5-28 (page 216) show the number of microbiology reports recorded for each HAI type.

6.5 Antimicrobials

Data on antimicrobials were collected, this included antivirals and antifungals inclusive of topical preparations as well as systemic. The percentage of inpatients in the acute population who were prescribed one or more antimicrobials on the day of survey was 32.1%. Table 6-18 shows that 19.2% percent of patients were prescribed one antimicrobial; 9.8% of inpatients were prescribed two antimicrobials: 2.3% were prescribed 3 different antimicrobials and a further 0.8% of inpatients were prescribed 4 different antimicrobials.

Table 6-18: *Acute Hospitals. Number of antimicrobials prescribed per eligible inpatient at time of survey*

Number of Antimicrobials	Inpatients Surveyed	
	N	%
0	7 887	67.9
1	2 224	19.2
2	1 140	9.8
3	270	2.3
4	87	0.8
Total	**11 608**	**100.0**

The most common antimicrobial group prescribed in acute hospitals was the Penicillins; 7% of inpatients were prescribed an antimicrobial from this group (Table 6-19). Some of these patients could be prescribed penicillin along with another antimicrobial and therefore appear within the multiple category. Appendix Table 6-1 (page 217) presents results for all antimicrobials. A total 1497 (12.9%) of inpatients were prescribed multiple antimicrobials.

Table 6-19: *Acute Hospitals. Number of antimicrobials prescribed per eligible inpatient at time of survey*

Antimicrobial Group	Inpatients Surveyed	
	N	%
No Antimicrobials	7 887	67.9
Aminoglycosides	17	0.2
Antifungal	197	1.7
Antiviral	28	0.2
Carbapenams and Monobactams	14	0.1
Cephalosporins	221	1.9
Glycopeptide	84	0.7
Macrolides, Lincosamides, Streptogramin	138	1.2
Penicillins	807	7.0
Quinolones	301	2.6
Sulphonamides and Trimethoprim	159	1.4
Tetracyclines	16	0.1
Multiple1	1 497	12.9
Other	242	2.1
Total	**11 608**	**100.0**

1 Those inpatients on more than one antimicrobial were recorded in the 'Multiple' category.

Table 6-20 shows the proportions of prescriptions for different groups of antimicrobials. Penicillins made up 30.8% of all prescribed antimicrobials followed by the 'other' category at 16%, Cephalosporins were next in the rank order with 10.4% of all antimicrobials prescribed, then Quinolones with 9.9%. Antifungals made up 9.2% of all antimicrobials prescribed, Antivirals 2.2%. Appendix Table 3-3 on page 169 lists the specific antimicrobials included in each antimicrobial group. Appendix Table 6-1 on page 217 shows the numbers and percentages of specific antimicrobials being prescribed.

Table 6-20: *Acute Hospitals. Numbers and percentages of prescriptions of antimicrobials at time of survey by antimicrobial group*

Antimicrobial Group	Frequency of all Antimicrobial Prescription	
	N	%
Aminoglycosides	112	2.0
Antifungal	518	9.2
Antiviral	122	2.2
Carbapenems and Monobactams	76	1.3
Cephalosporins	591	10.4
Glycopeptide	241	4.3
Macrolides, Lincosamides, Streptogramin	489	8.6
Penicillins	1 745	30.8
Quinolones	558	9.9
Sulphonamides and Trimethoprim	250	4.4
Tetracyclines	52	0.9
Other	908	16.0
Total	**5 662**	**100.0**

The percentage of inpatients in the non-acute hospital population who were prescribed one or more antimicrobial was 15.6%. Twelve point six percent of inpatients were prescribed one antimicrobial. Table 6-21 shows that 2.5% of inpatients in non-acute hospitals were prescribed two antimicrobials and a further 0.5% of inpatients were prescribed 3 different antimicrobials and no inpatients were prescribed 4 antimicrobials.

Table 6-21: *Non-acute Hospitals. Number of antimicrobials prescribed per eligible inpatient at time of survey*

Number of Antimicrobials	Inpatients Surveyed	
	N	%
0	1 811	84.4
1	271	12.6
2	54	2.5
3	10	0.5
4	0	0.0
Total	**2 146**	**100.0**

In non-acute hospitals as in acute hospitals antimicrobials in the penicillins group were the most frequently prescribed.

Appendix Table 6-2 (page 220) shows the disaggregated results for all antimicrobials. Three percent of inpatients were on multiple antimicrobials (Table 6-21).

Table 6-22: *Non-acute Hospitals. Number and percentage of prescriptions at time of survey by antimicrobial group*

Antimicrobial Group	Inpatients Surveyed	
	N	%
No Antimicrobials	1 811	84.4
Aminoglycosides	0	0.0
Antifungal	54	2.5
Antiviral	4	0.2
Cephalosporins	11	0.5
Glycopeptide	8	0.4
Macrolides, Lincosamides, Streptogramin	8	0.4
Penicillins	67	3.1
Quinolones	21	1.0
Sulphonamides and Trimethoprim	35	1.6
Tetracyclines	18	0.8
Multiple[1]	64	3.0
Other	45	2.1
Total	**2 146**	**100.0**

Within non-acute hospitals 19.3% of antimicrobials prescribed were antifungals at the time of survey, 25.4% were Penicillins and 18.6% of antimicrobials prescribed were classified in the 'other' category (Appendix Table 6-2 page 220). The next ranked antimicrobial grouping was Sulphonamides which made up 9.8% of all prescriptions.

1 Those inpatients on more than one antimicrobial were recorded in the 'Multiple' category

Table 6-23: *Non-acute Hospitals. Numbers and percentages of prescriptions of antimicrobials at time of survey by antimicrobial group*

Antimicrobial Group	Antimicrobial Prescription Frequency	
	N	%
Aminoglycosides	1	0.2
Antifungal	79	19.3
Antiviral	6	1.5
Cephalosporins	18	4.4
Glycopeptide	10	2.4
Macrolides, Lincosamides, Streptogramin	16	3.9
Penicillins	104	25.4
Quinolones	30	7.3
Sulphonamides and Trimethoprim	40	9.8
Tetracyclines	29	7.1
Other	76	18.6
Total	**409**	**100.0**

6.6 Prevalence of HAI by season

Data collection in acute hospitals was conducted throughout the year of surveillance for the Prevalence survey (2005-2006). The year was divided into quarters and similar bed numbers of inpatients in each group of hospital size and type were randomly selected to be surveyed during each quarter. The results on Table 6-24 show some variation in the unadjusted HAI prevalence by season. The logistic regression analysis suggests that season of survey does have an effect on HAI prevalence (Table 6-29).

Table 6-24: *Acute Hospital prevalence of HAI by calendar quarter*

Quarter	Dates of Survey	Mean Bed Occupancy	Inpatients With HAI	Inpatients Without HAI	Prevalence of Inpatients with HAI	95% CI			Inpatients Surveyed per Season	
		%	N	N	%				N	%
1	Oct 05 Jan 06	80.1	292	2 271	11.4	(9.7	-	13.1)	2 563	22.1
2	Feb06 April06	82.3	338	3 024	10.1	(8.9	-	11.2)	3 362	29.0
3	May06 Jul 06	75.4	225	2 641	7.9	(6.4	-	9.3)	2 866	24.7
4	Aug06 Oct 06	77.5	248	2 569	8.8	(7.4	-	10.2)	2 817	24.3
Total		**78.8**	**1 103**	**10 505**	**9.5**	**(8.8**	**-**	**10.2)**	**11 608**	**100.0**

6.7 Invasive devices

It is important to note that data included in these analyses were only recorded for inpatients included within the burden study (n=3262 for acute hospitals and n=627 for non-acute hospitals) (see Figure 5-1 page 35).

In acute hospital inpatients the most common invasive devices were Peripheral Vascular Catheters (PVCs) with 30.3% of inpatients (56.8% of all devices) being treated with one or more PVCs. The majority of PVCs were found in medical patients. Twenty percent of inpatients were found to have a urinary catheter in situ. Urinary catheters were more widely distributed among the specialties, most commonly found (in descending order) in Medicine, Care of the Elderly, Surgery, and Orthopaedics. Devices for mechanical ventilation were found in medical and surgical patients in ICU so appears proportionally smaller. The majority of Central Vascular Catheters (CVCs) were found in surgical and medical patients. Further details of the prevalence of invasive devices by specialty are included in the Appendix Table 6-3 page 222.

Table 6-25: *Acute Hospitals. Number of eligible inpatients with invasive devices, and proportion of invasive devices*

Invasive Device[1]	Inpatients		Invasive Devices	
	N	%	N	%
No Device	1 868	57.3	-	-
Urinary Catheter	660	20.2	660	36.2
Peripheral Vascular Catheter (PVC)	987	30.3	1 034	56.8
Central Vascular Catheter (CVC)	104	3.2	112	6.1
Ventilators	16	0.5	16	0.9
Total	**3 262**		**1 822**	**100.0**

1 Note that the count of inpatients represents the total number with that device and that each inpatient may also be included in counts for other invasive devices. The 'Total' is therefore not a sum of the rows above but an accurate count of the inpatients involved in this analysis (acute, burden inpatients only).

In non-acute hospital inpatients the most common invasive devices were urinary catheters with 12.4% of inpatients (90.7% of all devices) within the burden study having a urinary catheter in situ. Only 1.1% of inpatients were found to have a PVC. Details of the prevalence of invasive devices by specialty are included in Appendix Table 6-4 (page 222).

Table 6-26: *Non-acute Hospitals. Number of eligible inpatients with invasive devices, and proportion of invasive devices*

Invasive Device[1]	Inpatients Surveyed		Invasive Devices	
	N	%	N	%
No Device	530	84.5	-	-
Urinary Catheter	78	12.4	78	90.7
Peripheral Vascular Catheter	7	1.1	7	8.1
Central Vascular Catheter	-	-	-	-
Invasive Mechanical Device	1	0.2	1	1.2
Total	**627**	**100.0**	**86**	**100.0**

1 Note that the count of inpatients represents the total number with that device and that each inpatient may also be included in counts for other invasive devices. The 'Total' is therefore not a sum of the rows above but an accurate count of the inpatients involved in this analysis (acute, burden inpatients only).

6.8 Surgery

6.8.1 Acute hospitals

Table 6-27 outlines the surgical procedures undergone in the year preceding the survey for the 59 inpatients with Surgical Site Infection. Surgical procedures undergone in the year preceding the survey were collected for burden study and HAI patients.

These inpatients were included in the burden study and were all surveyed whilst in an acute hospital. The data collection protocol permits 3 implant procedures and 3 non-implant procedures to be recorded per inpatient in one year preceding the date of survey.

Twenty-seven of the 59 (45.8%) inpatients were readmitted to hospital with SSI. Of the inpatients with SSI: 22 inpatients had Superficial SSI, 20 had Deep SSI and 17 had Organ Space SSI. Three catergories of surgery accounted for arround half of all SSI (Bones and Joint, Cardiovascular and Digestive Tract).

Table 6-27: *Acute Hospitals. Number and percentage of surgical procedures performed on inpatients diagnosed with a Surgical Site Infection*

Type of surgery	Procedures[1]	
	N	%
Arteries and Veins	6	6.6
Bones and Joints	22	24.2
Cardiovascular	10	11.0
Digestive tract	15	16.5
Female Genital	4	4.4
Head	1	1.1
Misc.	5	5.5
Other abdominal surgery	5	5.5
Respiratory	2	2.2
Skull and Spine	6	6.6
Soft Tissue	5	5.5
Thoracic	4	4.4
Urinary	6	6.6
Total	**91**	**100.0**

1 There were two burden acute inpatients that had an SSI (both superficial) but no surgical procedures recorded. They have been omitted from Table 6 27

6.9 Prevalence logistic regression analysis

6.9.1 Acute hospitals univariate analysis

Logistic regression analyses were performed in order to examine the relationship between specific variables and HAI. Univariate analyses were carried out to assess candidate variables for inclusion in the multivariate model. HAI prevalence was assessed by gender, age, admission type, calendar quarter, hospital size, hospital subtype and specialty (see analysis section on page 41).

Table 6-28 shows that HAI are more prevalent in men, among the elderly, during November to January and within the specialties of Care of the Elderly, Surgery and Medicine.

Table 6-28: *Acute hospital univariate logistic regression (n=11 552)*

Explanatory Variable	Classification System	Inpatients N	Prevalence %	Odds Ratio (standard error)	Univariate Logistic p-value
Gender	Female	6 750	8.8	1	0.011
	Male	4 858	10.4	1.198 (0.085)	
Age[1]	<=50	2 279	4.5	1	<0.0001
	51-70	3 243	9.9	2.345 (0.291)	
	71-80	2 918	10.8	2.592 (0.326)	
	81+	3 152	11.5	2.787 (0.352)	
Admission Type	Planned	2 776	8.5	1	0.086
	Unplanned	8 832	9.8	1.172 (0.108)	
Calendar Quarter	Nov 05 - Jan 06	2 563	11.4	1	0.01
	Feb 06 - Apr 06	3 362	10.1	0.869 (0.095)	
	May 06 - July 06	2 866	7.9	0.663 (0.089)	
	Aug 06 - Oct 06	2 817	8.8	0.751 (0.093)	
Hospital Size[2]	Large	7 467	9.9	1	0.094
	Medium	3435	9.2	0.926 (0.080)	
	Small	676	7.0	0.680 (0.124)	
Hospital Subtype	General	7 877	9.0	1	0.003
	Obstetrics	169	3.0	0.310 (0.161)	
	Teaching	3 562	11.0	1.262 (0.118)	
Specialty[3]	Medicine	5 132	9.6	1	<0.0001
	Care of the Elderly	1 677	11.9	1.273 (0.139)	
	Dentistry	16	12.5	1.350 (0.536)	
	Gynaecology	208	4.8	0.477 (0.192)	
	Haematology	120	6.7	0.675 (0.259)	
	Obstetrics	446	0.9	0.086 (0.050)	
	Oncology	136	8.8	0.915 (0.401)	
	Orthopaedics	1 145	9.2	0.954 (0.127)	
	Psychiatry	256	3.5	0.344 (0.168)	
	Surgery	2 207	11.2	1.191 (0.128)	
	Urology	255	6.3	0.633 (0.181)	

1 16 patients were excluded because no information was available on their age

2 30 patients were excluded because they were being treated in very small hospitals

3 10 patients were excluded because they were being treated in 'other' specialty

6.9.2 Acute hospital multivariate logistic regression analysis

Each of the variables from the univariate analyses were initially included in a multivariate logistic regression model (44). Admission type, hospital size and hospital subtype were subsequently excluded as they did not have a significant effect on prevalence of HAI in the multivariate model ($p>0.05$). Table 6-29 shows the results from the final multivariate model.

Table 6-29: *Acute hospital multivariate logistic regression (n=11 582)*

Explanatory variable	Classification system	Regression Coefficient (standard error)	Odds Ratio (standard error)	95% CI for odds ratio
Gender	Female	0	1.0	
	Male	0.156 (0.067)	1.169 (0.077)	(1.028 - 1.329)
Age[1]	<=50 (baseline)	0	1.0	
	51-70	0.637 (0.124)	1.891 (0.228)	(1.494 - 2.395)
	71-80	0.757 (0.129)	2.131 (0.261)	(1.676 - 2.711)
	81+	0.847 (0.128)	2.333 (0.292)	(1.825 - 2.982)
Specialty[2]	Medicine (baseline)	0	1.0	
	Care of the Elderly	0.131 (0.104)	1.140 (0.107)	(0.949 - 1.370)
	Dentistry	0.612 (0.453)	1.843 (1.411)	(0.411 - 8.271)
	Gynaecology	-0.417 (0.349)	0.659 (0.219)	(0.344 - 1.263)
	Haematology	-0.309 (0.312)	0.734 (0.273)	(0.354 - 1.520)
	Obstetrics	-1.722 (0.603)	0.179 (0.922)	(0.065 - 0.491)
	Oncology	-0.037 (0.366)	0.963 (0.296)	(0.527 - 1.761)
	Orthopaedics	-0.021 (0.142)	0.979 (0.111)	(0.784 - 1.223)
	Psychiatry	-0.793 (0.407)	0.453 (0.156)	(0.230 - 0.890)
	Surgery	0.268 (0.100)	1.308 (0.110)	(1.108 - 1.542)
	Urology	-0.490 (0.280)	0.613 (0.162)	(0.365 - 1.028)
Calendar Quarter	Nov 05-Jan 06 (baseline)	0	1.0	
	Feb 06 -April 06	-0.171 (0.104)	0.843 (0.072)	(0.713 - 0.996)
	May 06-July 06	-0.379 (0.119)	0.685 (0.064)	(0.570 - 0.823)
	August 06-October 06	-0.316 (0.113)	0.729 (0.067)	(0.609 - 0.873)
Constant term		**-2.771 (0.147)**		

1 16 patients were excluded because no information was available about their age

2 10 patients were excluded because they were being treated in the 'other' specialty

The final model included gender, age, specialty and calendar quarter and had a log likelihood of –3551 with 17 degrees of freedom giving an AIC of 7136.

The model can be used to estimate the prevalence of HAI in patient subgroups based on the values of the regression coefficients and Equation 3.

Equation 3: *Calculation for the estimated prevalence of HAI in a given population using regression coefficients*

$$P(HAI) = \exp(\alpha) / (1+\exp(\alpha)) \quad (44)$$

where α is the sum of the relevant regression coefficients

P(HAI) is the expected prevalence for a given population

Example 1

To estimate the prevalence of HAI in a population of female patients aged ≤50 years in an obstetrics specialty during the period May to July the relevant regression co-efficients must be identified from Table 6-29 and summed.

Hence α = -2.771+0+0-1.722-0.379

= -4.872

Prevalence of HAI = exp (-4.872)/[1+exp (-4.872)]

= 0.0076/1.0076

=0.0075

Thus the prevalence in this group is estimated to be 0.75%

Example 2

The prevalence of HAI in a population of male patients aged 81+ years in a care of the elderly specialty during November to January is derived as follows:

Hence α = -2.771+0.156+0.847+0.131+0

=-1.637

Prevalence of HAI = exp (-1.637)/[1+exp (-1.637)]

= 0.195/1.195

=0.163

The prevalence of HAI in this group is estimated to be 16.3%

6.9.3 Non-acute hospitals univariate analysis

Univariate analyses were carried out to assess candidate variables for inclusion in the multivariate model for non-acute hospitals. Gender, age, admission type, calendar quarter, hospital size and specialty were assessed (Table 6-30). Twenty patients being treated under orthopaedics (n=14), surgery (n=5) and urology (n=1) specialties were not included in the analysis because there were so few of them. There is low power to detect differences in calender quarters as most non-acute hospitals were sampled in one quarter.

Table 6-30: *Non-acute hospital univariate logistic regression (n=2 126)*

Explanatory variable	Classification system	Inpatients N	Prevalence	Odds Ratio (standard error)	Univariate Logistic P-value
Gender	Female	1 176	8.3	1	0.033
	Male	950	5.9	0.689 (0.120)	
Age[1]	<=50	392	1.8	1	0.0001
	51-70	383	5.7	3.352 (1.584)	
	71-80	522	8.4	5.063 (2.213)	
	81+	827	9.8	5.972 (2.565)	
Admission Type[2]	Planned	942	9.0	1	0.010
	Unplanned	1 183	5.8	0.624 (0.114)	
Calendar Quarter	Nov 05 - Jan 06	33	9.1	1	0.344
	Feb 06 - Apr 06	266	9.8	1.083 (0.648)	
	May 06 - July 06	1 579	6.9	0.741 (0.430)	
	Aug 06 - Oct 06	248	6.5	0.690 (0.450)	
Hospital Size	Large	704	5.5	1	0.013
	Medium	842	8.4	1.570 (0.367)	
	Small	452	6.2	1.126 (0.305)	
	Very small	128	12.5	2.436 (0.722)	
Specialty	Medicine	563	11.4	1	0.0001
	Care of the Elderly	436	7.8	0.659 (0.174)	
	Psychiatry	1 127	5.0	0.408 (0.084)	

1 Two patients were excluded because no information was available on their age

2 One patient was excluded because no information was available on their admission type

6.9.4 Non-acute hospitals multivariate analysis

Candidate variables from the univariate analyses were initially included in a multivariate regression model. Calendar quarter was excluded because the equally distributed seasonal data collection was not undertaken within the non-acute hospitals (see Table 6-30 'Inpatients' column). Gender, admission type, and hospital size were excluded after multivariate analysis as they did not significantly improve the multivariate model ($p>0.05$). The final model is shown in Table 6-31.

Table 6-31: *Non-acute hospital multivariate logistic regression (n=2 124)*

Explanatory variable	Classification system	Regression Coefficient (standard error)	Odds Ratio (standard error)	95% CI for odds ratio
Age[1]	<=50 (baseline)	0	1.0	
	51-70	1.113 (0.475)	3.044 (1.350)	(1.276 - 7.265)
	71-80	1.453 (0.458)	4.276 (1.822)	(1.855 - 9.858)
	81+	1.568 (0.453)	4.799 (2.036)	(2.090 - 11.022)
Specialty	Medicine (baseline)	0	1.0	
	Care of the Elderly	-0.455 (0.241)	0.634 (0.142)	(0.409 - 0.982)
	Psychiatry	-0.500 (0.196)	0.607 (0.126)	(0.404 - 0.910)
Constant term		**-3.522 (0.457)**		

The final model had a log likelihood of –531 with 5 degrees of freedom giving an AIC of 1072.

Example 1

Using Equation 3 where α = -3.522 + 1.113 + 0 = -2.409

The estimated prevalence of HAI in a population of patients aged 51-70 years in a General Medicine specialty is 8.2%.

1 Two patients were excluded because no information was available on their age

6.10 Length of stay analysis

6.10.1 Data collection and analysis

Data used to calculate the length of stay (LOS) was collected for all patients in acute hospitals in the burden study (n=3263) and for patients in the prevalence survey that had been diagnosed with a HAI (n=727). Details of the design of the study can be found in the section on Study design page 33.

Table 6-32: *Numbers of patients in LOS analysis*

Survey	Patients	
	N	% total
Burden study	3 263	81.8
Prevalence	727	18.2
Total	**3 990**	**100**

6.10.2 Burden study demographics

Figure 6-22 and Figure 6-23 allows a subjective comparison of age and gender distribution to be made of the patients sampled in the burden study compared to the rest of the patients in the prevalence survey.

Figure 6-22: *Acute Hospitals. Inpatients surveyed as part of the burden study by age group and gender (n=3 258)* [1]

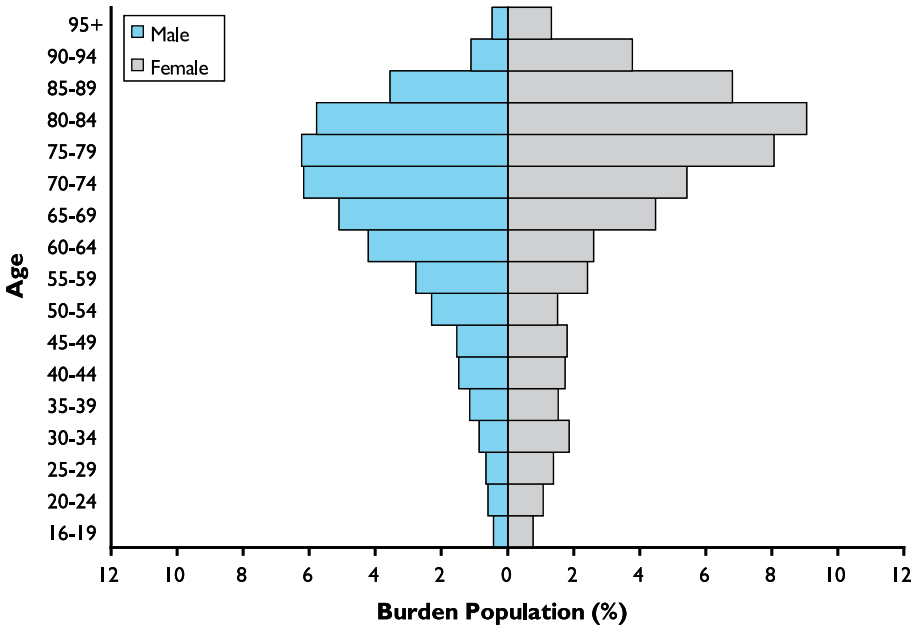
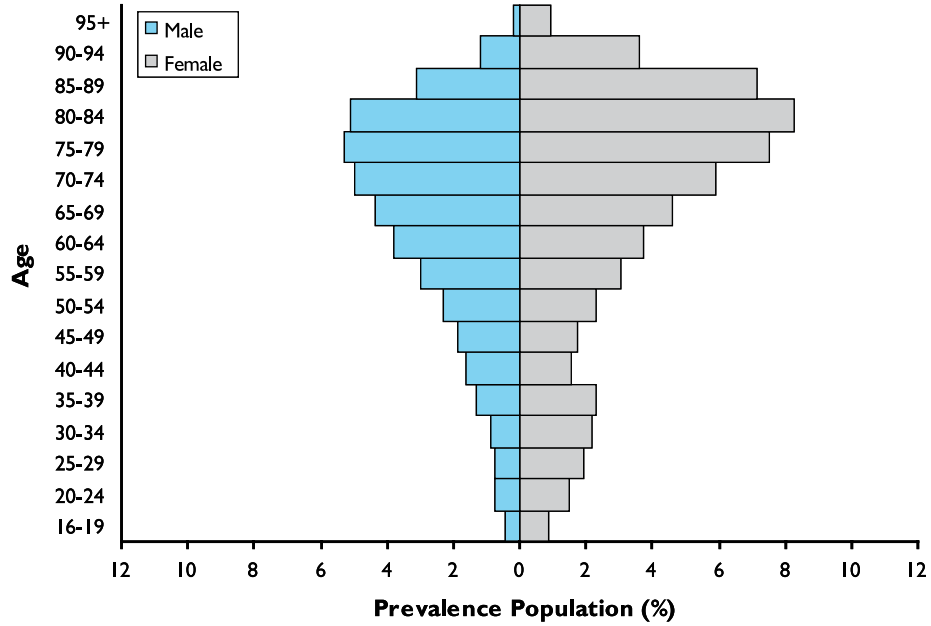


Figure 6-23: *Acute Hospitals. Inpatients surveyed by age group and gender as part of the prevalence study (n=8 334).*[2]



1 Five inpatients had missing age data so were not included.

2 Eleven patients had missing age data so were not included

Table 6-33 and Table 6-34 allows a subjective comparison of age and gender distribution to be made of the patients sampled in the burden study compared to the rest of the patients in the prevalence survey, and they are similar.

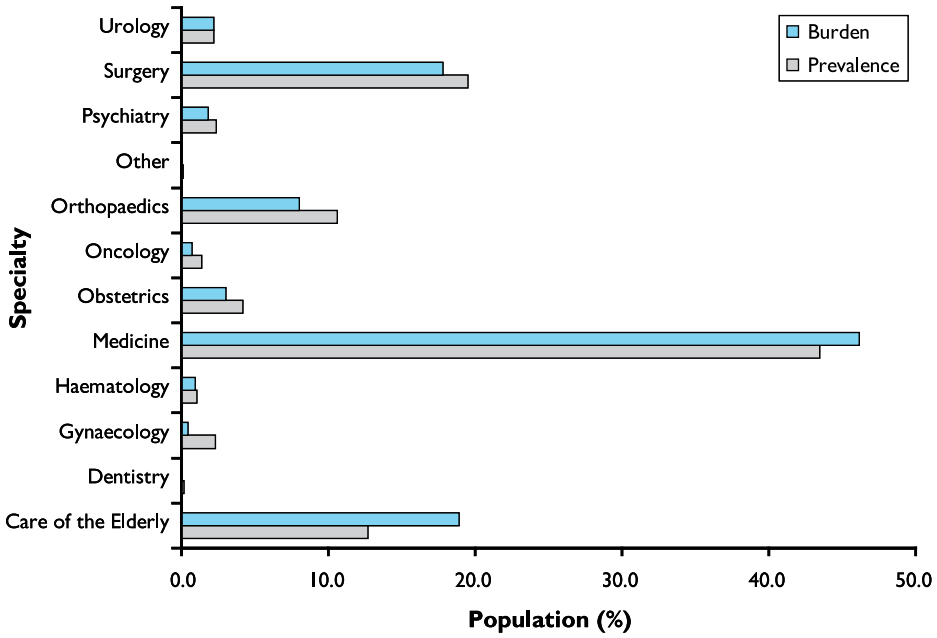
Table 6-33: *Acute Hospitals. Burden study inpatient number and percentage of inpatients by specialty and gender (n=3 263)*

Specialty	Female		Male		All Inpatients	
	N	%	N	%	N	%
Care of the Elderly	429	23.6	187	12.9	616	18.9
Gynaecology	15	0.8	0	0.0	15	0.5
Haematology	18	1.0	13	0.9	31	1.0
Medicine	702	38.7	804	55.6	1 506	46.2
Obstetrics	98	5.4	0	0.0	98	3.0
Oncology	19	1.0	4	0.3	23	0.7
Orthopaedics	155	8.5	107	7.4	262	8.0
Psychiatry	34	1.9	25	1.7	59	1.8
Surgery	316	17.4	265	18.3	581	17.8
Urology	30	1.7	42	2.9	72	2.2
Total	**1 816**	**100.0**	**1 447**	**100.0**	**3 263**	**100.0**

Table 6-34: *Acute Hospitals. Prevalence survey number and percentage of inpatients by specialty and gender (n=8 345)*

Specialty	Female		Male		All Inpatients	
	N	%	N	%	N	%
Care of the Elderly	667	13.5	394	11.6	1 061	12.7
Dentistry	3	0.1	13	0.4	16	0.2
Gynaecology	193	3.9	0	0.0	193	2.3
Haematology	39	0.8	50	1.5	89	1.1
Medicine	2 089	42.3	1 537	45.1	3 626	43.5
Obstetrics	348	7.1	0	0.0	348	4.2
Oncology	56	1.1	57	1.7	113	1.4
Orthopaedics	530	10.7	353	10.3	883	10.6
Other	7	0.1	3	0.1	10	0.1
Psychiatry	118	2.4	79	2.3	197	2.4
Surgery	849	17.2	777	22.8	1 626	19.5
Urology	35	0.7	148	4.3	183	2.2
Total	**4 934**	**100.0**	**3 411**	**100.0**	**8 345**	**100.0**

Figure 6-24: *Acute Hospitals. Comparison of inpatients specialties for burden and prevalence survey populations as a percentage of each sample population*



6.10.3 Censoring

For 12 patients it was not possible to allocate a LOS due to a missing admission date. Therefore there were 3 978 patients included in the LOS analysis of which 527 (13.2%) were censored (see section 5.4.6 page 43).

6.10.4 Discharge status

The destination of patients once they were discharged from hospital is shown in Table 6-35. This relationship between HAI status and discharge status is confounded by the underlying morbidity of the patient, therefore these data should be interpreted with caution e.g. the cause of death is not necessarily HAI.

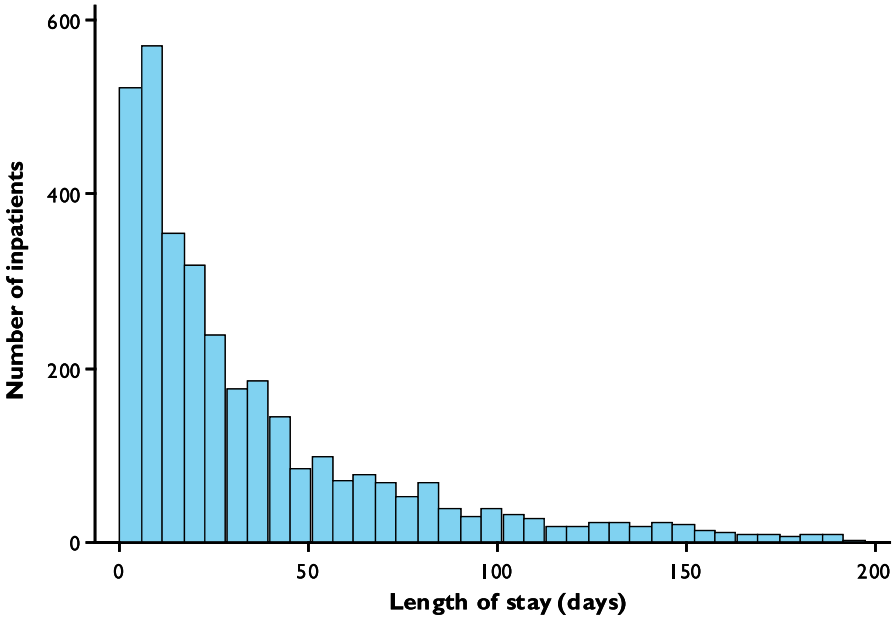
Table 6-35: *Acute Hospitals. Inpatient discharge status by HAI status (n=3 978)*

Discharge Status	Inpatients without HAI		Patients with HAI		Total	
	N	%	N	%	N	%
Another Hospital	299	10.4	172	15.7	471	11.8
Died	218	7.6	191	17.4	409	10.3
Home / Care home	1 999	69.4	572	52.0	2 571	64.6
Still in hospital	117	4.1	71	6.5	188	4.7
Not Known	246	8.5	93	8.5	339	8.5
Total	**2 879**	**100.0**	**1 099**	**100.0**	**3 978**	**100.0**

6.10.5 Acute hospital distribution of length of stay data

Preliminary examination of LOS data (n=3978) showed a skewed distribution with a median of 22 days and a mean of 46.9 days. Five percent of patients had been in hospital for more than 150 days, one percent been in hospital for more than one year and the longest LOS was over 10 years. The majority of patients LOS was under 200 days therefore Figure 6-25 demonstrates the distribution of LOS in a histogram.

Figure 6-25: *Acute Hospital histogram of LOS for those with LOS < 200 days (n=3 978)*



6.10.6 Inclusion and exclusion criteria

Table 6-36 outlines the inclusion and exclusion criteria used for the LOS analysis. After application of these criteria, 3 536 patients remained eligible for inclusion in the LOS analysis to develop the model.

Table 6-36: *Inclusion/Exclusion criteria for the LOS study analysis*

	Inclusion Criteria	Exclusion Criteria
Type of Care	Acute	Non-acute
LOS	All Patients in the burden study and patients in the extended prevalence study diagnosed with HAI except those who met the exclusion criteria	Patients who have been in hospital for one day or less (n=438)

6.10.7 LOS by discharge status

Table 6-37 shows the median LOS for patients by discharge status, it can be seen that patients who went home or to a care home have the lowest median LOS compared to the others.

Table 6-37: *Acute hospitals. Median length of stay and quartiles by discharge status (n=3 324)*

Discharge status	Inpatients N	Median LOS (days)	Lower Quartile (days)	Upper Quartile (days)
Another hospital	471	37	18	69
Died	409	43	24	80
Home/Care home	2 571	17	7	43
Still in Hospital	188	152.5	110	254.5
Not known	339	18	5	52

6.10.8 Length of stay by specialty

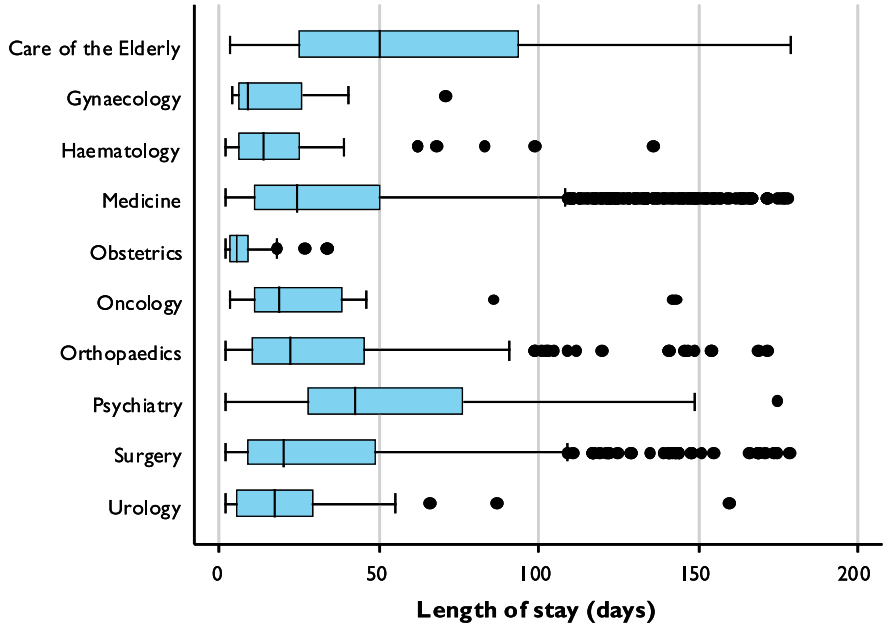
Table 6-38 shows the LOS for patients stratified by specialty. Median LOS varies considerably by specialty from 5 days in Obstetrics to 50 days in Care of the Elderly.

Table 6-38: *Acute Hospitals. Median and quartiles of length of stay by specialty (LOS <=180 days) (n=3 324)*

Specialty	Inpatients N	Median LOS (days)	Lower Quartile (days)	Upper Quartile (days)
Care of the Elderly	643	50	25	94
Gynaecology	15	9	6	26
Haematology	33	14	6	25
Medicine	1 538	24	11	50
Obstetrics	63	5	3	9
Oncology	27	19	11	38
Orthopaedics	276	22	10	46
Psychiatry	49	43	28	77
Surgery	620	20	9	49
Urology	60	18	5	29

In order to create useful boxplots lengths of stay greater than 180 days were excluded; there were 212 patients in the excluded group. (Figure 6-26).

Figure 6-26: *Acute Hospitals. box plot of length of stay by specialty (LOS <=180 days) (n=3 324)*



6.10.9 Length of stay by infection type for those with HAI

Figure 6-27 and Table 6-39 (n=867) show the LOS for patients stratified by HAI type. Median LOS varies from 31 days for patients with bloodstream infections to 49 days for those with urinary tract infections. This analysis excludes the 2321 inpatients with no HAI, 118 with 'multiple infections' and 18 'other'.

Figure 6-27: *Acute Hospitals. Box plot of length of stay by HAI type (LOS <=180 days) (n=867)*

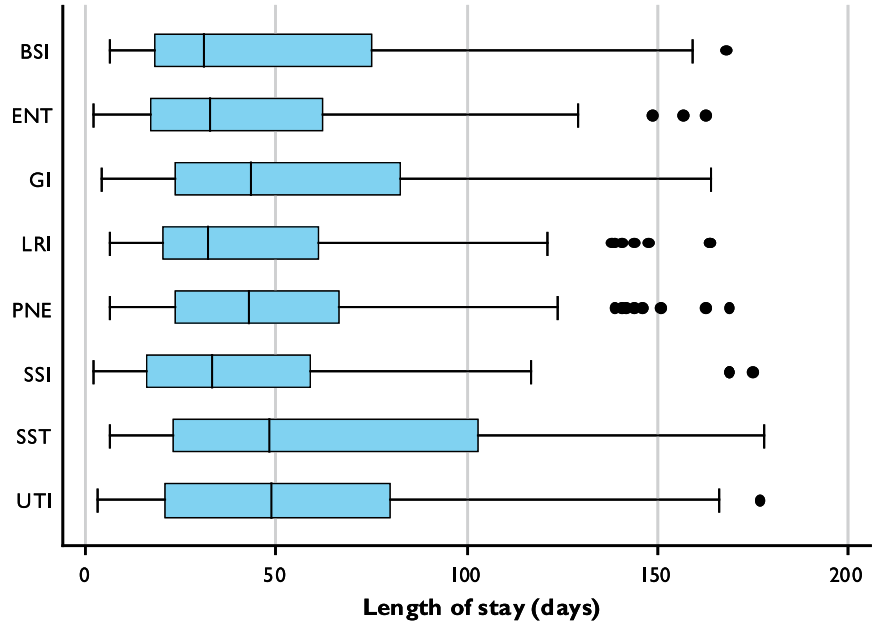


Figure 6-27 shows some variation in LOS for patients with different infection types.

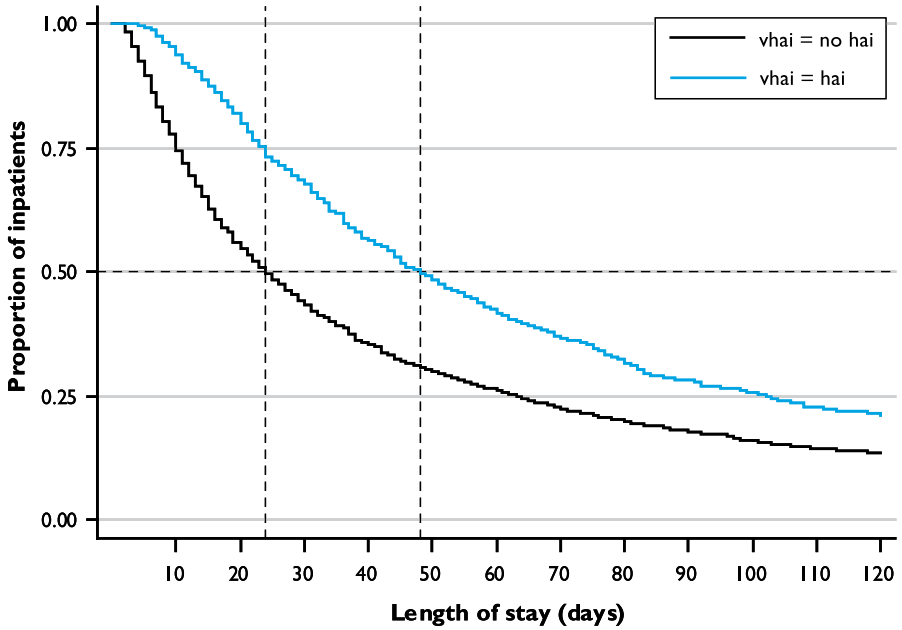
Table 6-39: *Acute Hospitals. Median and quartiles of length of stay by infection type (LOS <=180 days) (n=8 67)*

Infection Type[1]	Inpatients N	Median LOS (days)	Lower Quartile (days)	Upper Quartile (days)
Bloodstream Infection	35	31	18	75
Eye, Ear, Nose, Throat or Mouth	107	33	17	62
Gastrointestinal infection	132	44	24	83
Lower respiratory tract infection	105	32	20	61
Pneumonia	80	43	24	67
Surgical site infection	145	33	16	59
Skin and soft tissue infection	99	48	23	103
Urinary tract infection	164	49	21	80

6.10.10 Kaplan Meier analyses

The population used in this analysis (n=3 536) is as described in section 6.10.1 (page 90). Figure 6-28 shows the Kaplan Meier curves for LOS of patients with and without a HAI. These survival curves are statistically different ($p<0.05$). Patients with a HAI have a median LOS of 48 days, 95% CI (45-52) compared with a median LOS of 24 days, 95% CI (23-26) for patients without a HAI.

Figure 6-28: *Acute Hospitals. LOS sample Kaplan Meier curve by HAI*



1 Restricted to inpatients with only one infection

6.11 Length of stay models

These models were based on all patients within the burden study and patients within the prevalence survey with HAI (n=3536). Three models of increasing complexity were assessed and are discussed in detail: (see section 5.4.6 page 43)

- Model 1 included HAI status yes/no (n=3536)
- Model 2 included HAI status and specialty (n=3536)
- Model 3 included HAI status, specialty, age, gender, hospital size, admission type, and calendar quarter (n=3536)

6.11.1 LOS model 1 HAI status only

Table 6-40 describes the simplest model including only HAI status.

Table 6-40: *Acute Hospitals. LOS Model 1 showing variable, category, number of inpatients in each variable category, regression coefficient and standard error for HAI status*

Variable	Category	Inpatients N	Regression Coefficient (standard error)
HAI Status	No HAI	2446	0
	HAI	1090	0.684 (0.073)
Constant term			**3.286 (0.077)**

The model had a log likelihood of –5456 and an AIC of 10918.

Example 1

A patient with no HAI would have an expected median LOS of 26.7days

exp(3.286) = 26.7 days

Example 2

A patient with a HAI would have an expected median LOS of 53.0 days

exp (3.286+0.684) = exp(3.286) exp(0.684) = 1.98 exp(3.286) = 53.0 days

The estimates of median LOS for a patient with HAI and without HAI were 53 days and 26.7 respectively, giving an additional LOS associated with HAI of 26.3 days. Therefore the LOS in patients with a HAI is almost double that of patients without a HAI. The estimated lengths of stay for patients with and without HAI are shown in Table 6-41.

The estimates of LOS obtained from Model 1 (Table 6 41) are considerably longer than those reported by ISD in their Scottish Morbidity Report (SMR) on inpatients in Scottish hospitals 45. Information Services Division. Scottish morbidity record. In: ISD Scotland; 2006. This is because ISD data have been collected prospectively i.e. they are incidence data. Prevalence studies are biased towards inpatients with long LOS and exaggerate LOS (see limitations section 9.2 page 149).

Table 6-41: *Acute Hospitals. Estimates derived from LOS Model 1 of LOS for inpatients with and without HAI (Model 1 was produced using HAI status only)*

HAI status	Estimated median LOS (days)
No HAI	26.7
HAI	53.0

6.11.2 LOS model 2 HAI status and specialty

This model included HAI status and specialty and is described in Table 6-42.

Table 6-42: *Acute Hospitals. LOS Model 2 showing variable, category, number of inpatients, regression coefficient and standard error for HAI and specialty*

Variable	Category	Inpatients N	Regression Coefficient (standard error)
Specialty	Medicine (baseline)	1 627	0.000
	Care of the Elderly	719	0.855 (0.147)
	Gynaecology	17	-0.779 (0.355)
	Haematology	33	-0.666 (0.184)
	Obstetrics	63	-1.450 (0.138)
	Oncology	27	-0.458 (0.192)
	Orthopaedics	286	-0.190 (0.100)
	Psychiatry	63	1.607 (0.655)
	Surgery	638	-0.318 (0.092)
	Urology	63	-0.624 (0.203)
HAI status	HAI not identified (baseline)	2 446	0.000
	HAI identified	1 090	0.726 (0.061)
Constant term			**3.196 (0.073)**

The model had a log likelihood of –5155 with and AIC of 10334.

Example 1

A patient in Medicine without a HAI would have an expected median LOS of 24.4 days

=exp (3.196) = 24.4 days

Example 2

A patient in Care of the Elderly with a HAI would have an expected median LOS of 118.7days

=exp (3.196+0.855+0.726) = exp (4.777) = 118.7 days

Example 3

A patient in Care of the Elderly without a HAI would have an expected median LOS of 57.4

=exp (3.196+0.855) = exp(4.05) = 57.4 days

In this model, regardless of specialty, the estimated median LOS of a patient with a HAI is double the LOS of a patient without a HAI, since

=exp (0.726)= 2.1.

Table 6-43 gives the estimates for median LOS for patients with and without HAI and the additional LOS associated with HAI by specialty.

Table 6-43: *Acute Hospitals. Estimates derived from LOS Model 2 for LOS for inpatients with and without HAI (Model 2 was produced using HAI status and specialty data)*

Specialty	Estimated Median LOS (days)		Increase in stay due to HAI (days)
	No HAI	HAI	
Care of the Elderly	57.4	118.7	61.3
Gynaecology	11.2	23.2	12.0
Haematology	12.6	25.9	13.3
Medicine	24.4	50.5	26.1
Obstetrics	5.7	11.8	6.1
Oncology	15.5	31.9	16.4
Orthopaedics	20.2	41.7	21.5
Psychiatry	1 21.8	251.7	129.9
Surgery	17.8	36.7	18.9
Urology	13.1	27.0	13.9

6.11.3 LOS model 3 HAI, specialty, age and gender

Model 3 included HAI status, specialty, age, gender, hospital size, admission type and calendar quarter. Gender and admission type were not significant in the model and were removed ($p>0.05$). The final model is shown in Table 6-44.

Table 6-44: *Acute Hospitals. LOS Model 3 showing variable, category, number of inpatients, regression coefficient and standard error for age, hospital size, specialty, calendar quarter and HAI status*

Variable	Category	Inpatients N	Regression Coefficient (standard error)
Age	<=50 (baseline)	479	0
	51-70	942	0.039 (0.098)
	71-80	1 008	0.193 (0.106)
	81+	1 107	0.283 (0.114)
Hospital size	Large (baseline)	2 232	0
	Medium / Other	1 304	0.119 (0.109)
Specialty	Medicine (baseline)	1 627	0
	Care of the Elderly	719	0.752 (0.148)
	Gynaecology	17	-0.675 (0.399)
	Haematology	33	-0.537 (0.207)
	Obstetrics	63	-1.368 (0.192)
	Oncology	27	-0.384 (0.211)
	Orthopaedics	286	-0.189 (0.097)
	Psychiatry	63	1.643 (0.638)
	Surgery	638	-0.254 (0.089)
	Urology	63	-0.543 (0.209)
Calendar Quarter	Nov 05-Jan 06 (baseline)	844	0
	Feb 06-April 06	1 077	-0.129 (0.132)
	May 06-July 06	790	-0.105 (0.126)
	August 06-October 06	825	0.082 (0.139)
HAI status	HAI not identified (baseline)	2 446	0
	HAI identified	1 090	0.718 (0.059)
Constant term			**3.047 (0.133)**

The model had a log likelihood of –5126 and an AIC of 10290. Interactions with HAI were fitted but none were significant.

Example 1

A patient aged <=50, without a HAI, in an obstetrics ward within a large hospital on a date between November and January would have an expected median LOS of 5.4 days.

=exp (3.047+ (-1.368)) = exp (1.679) = 5.4

Example 2

A patient aged 81+, with a HAI, in care of the elderly ward within a medium sized hospital (250-499 beds) on a date between February and April would have an expected median LOS of 120.3 days

= exp (3.047+0.283+0.718+0.752+0.119+(-0.129) = exp(4.79)= 120.3

In this model, regardless of all other factors, estimated median LOS for patients with a HAI is double the LOS for patients without a HAI as exp(0.718)=2.05.

6.12 Length of stay estimate for economic analyses

The estimates of LOS obtained from Model 3 (Table 6-44) are considerably longer than those reported by ISD in their Scottish Morbidity Report (SMR) on inpatients in Scottish hospitals (45). This because ISD data have been collected prospectively i.e. they are incidence data. Prevalence studies are biased towards inpatients with long LOS and can therefore exaggerate LOS.

Freeman and McGowan (46) calculated the average duration of infection through an incidence study. This was 5 days for 93% of the population. For this analysis the assumption was made that the first 2 days of stay patients cannot have a HAI and for the period of 2 days to 7 days after admission it was unlikely that they have had an infection and recovered.

In order to best approximate an incidence study the prevalence data were reanalysed using only those patients who had been in hospital between two and seven days, at the time the survey was undertaken.

Inpatients of unknown age and the small number of inpatients who were admitted to the specialty of dentistry were also excluded.

Table 6-45: *Inclusion and exclusion criteria for inpatients in the LOS analyses used for the economic analysis*

	Inclusion Criteria	Exclusion Criteria
LOS	All patients in the burden study and patients in the prevalence survey diagnosed with HAI except who have been admitted to hospital >2 and <=7 days.	All patients who have been in hospital for <2 days or >7 days at time of survey.
Age	All patients in the burden study and patients in the prevalence survey diagnosed with HAI except those who met the exclusion criteria	Patients with age unknown (n=2)
Specialty	All patients in the burden study and patients in the prevalence survey diagnosed with HAI except those who met the exclusion criteria	Patients with the specialty dentistry (n=2) considered too small to analyse

6.12.1 LOS model 1 (HAI Only) with limited dataset n=1158

Table 6-46 describes the simplest model used to calculate LOS which includes HAI status only

Table 6-46: *Acute Hospitals. LOS model 1 showing variable, category, number of inpatients in each variable category and regression coefficient for HAI status only using limited dataset*

Explanatory variable	Classification system	Inpatients N	Regression Coefficient (standard error)
HAI Status	No HAI	1 016	0
	HAI	142	0.503 (0.093)
Constant term			**2.319 (0.045)**

The model had a log likelihood of –1 491 and an AIC of 2 987.

The estimated lengths of stay are shown in Table 6-47. The estimated LOS of a patient with a HAI is 16.8 days and without HAI 10.2 days giving an additional LOS associated with a HAI of 6.6 days.

The estimated LOS in patients with a HAI is 65% higher than that of a patient without a HAI as exp (0.503)=1.65.

Table 6-47: *Acute Hospitals. LOS Model 1 estimates for median LOS for inpatients with and without HAI (Model 1 was produced using HAI status only) using limited data set*

HAI status	Estimated Median Length of Stay (days)
No HAI	10.2
HAI	16.8

6.12.2 LOS model 2 (HAI status and specialty) with limited dataset n=1158

This model included HAI status and speciality and is described in Table 6-48.

Table 6-48: *Acute Hospitals. LOS model 2 showing variable, category, number of inpatients, regression coefficient and standard error for HAI and specialty using limited data set (n=1 158)*

Variable	Category	Inpatients N	Regression Coefficient (standard error)
Specialty	Medicine (baseline)	580	0.000
	Care of the Elderly	91	0.586 (0.133)
	Gynaecology	10	-0.366 (0.383)
	Haematology	16	-0.625 (0.142)
	Obstetrics	54	-0.875 (0.081)
	Oncology	10	-0.028 (0.114)
	Orthopaedics	109	0.054 (0.106)
	Psychiatry	9	0.994 (0.049)
	Surgery	252	-0.277 (0.083)
	Urology	27	-0.711 (0.223)
HAI status	No HAI (baseline)	1 016	0.000
	HAI	142	0.530 (0.088)
Constant term			**2.389 (0.050)**

The model had a log likelihood of –1421 with an AIC of 2866. The estimated LOS in patients with a HAI is 70% higher compared with patients without a HAI as exp (0.53) =1.7.

The model estimates and additional LOS due to HAI, by specialty are shown in Table 6-49. These data were most consistent with ISD inpatient incidence data and were therefore used to calculate the economic burden of HAI.

Table 6-49: *Acute Hospitals. Estimates for median LOS for inpatients with and without HAI and increased LOS due to HAI in days, from LOS model 2 (Model 2 was produced using HAI status and specialty data) using limited data set.*

Specialty	Estimated Median LOS (days)		Increase in LOS (days)
	No HAI	HAI	
Care of the Elderly	19.6	33.3	13.7
Gynaecology	7.6	12.8	5.2
Haematology[1]	5.8	9.9	4.1
Medicine	10.9	18.5	7.6
Obstetrics	4.5	7.7	3.2
Oncology[1]	10.6	18.0	7.4
Orthopaedics	11.5	19.5	8.0
Psychiatry[1]	29.5	50.1	20.6
Surgery	8.3	14.0	5.7
Urology	5.4	9.1	3.7

1 There were no patients with HAI in these specialties in the limited dataset, however estimates can still be made for the additional LOS

6.13 Hospital costs as a result of increased length of stay

For the estimate of the additional hospital cost due to HAI in acute hospitals regardless of specialty, the additional LOS was taken to be 6.6 days (see Table 6-47 page 105), (HAI=16.8 days, No HAI=10.2 days).

The cost per episode of care[1] for all acute patients in Scotland in 2005/06 was £2 548 with an average stay of 5.6 days. Therefore the implicit average cost per day is £455 (cost per case divided by average stay). However, this is likely to seriously overestimate the cost of additional days on a patient's stay. The following table presents an estimate of the additional cost of a day in hospital for an infection, assuming the main types of care are laboratory tests, prescribing and nursing care.

The first column is the average cost per episode of care for each of the types of hospital resource used. The second column of data shows the result of simply dividing each figure in the first column by 5.6 days, the average stay. The final column then hypothesises that the main costs of additional stay for an infection will be nursing, laboratories and pharmacy. In other words, the cost of an additional day includes all of the costs usually associated with a patient spending a day in hospital with the following exceptions: (no costs of doctors on the ward (but some microbiologist costs are allowed for), no costs for surgical operating time in theatre and no time for allied health professionals. All other hospital costs are included.

Table 6-50: *Estimates of additional cost of a day in acute Scottish hospitals 2005/2006*

	Per episode of care	Per day	Additional day
Medical	£356	£64	£0
Nursing	£716	£128	£128
Pharmacy	£220	£39	£39
Allied Health Professions	£131	£23	0
Other	£22	£4	0
Theatre	£258	£46	0
Laboratories	£114	£20	£20
Overheads	£731	£131	£131
		£455	**£319**

1 'Episode of care' is defined as one patient undergoing one period of hospitalisation.

In 2005/6 there were 961 024 episodes of care in acute hospitals in Scotland. However, this figure includes paediatrics (who were not covered by this study) and excludes general psychiatry beds in acute hospitals. Excluding these two specialties gives a total of 917 385 cases. Psychiatry inpatients in acute hospitals were omitted from the economic analysis due to the differences in cost of patient care episode.

A HAI prevalence of 9.5% (obtained in this study) results in a total of 87 152 HAI per year. If the increased LOS is 6.6 days per HAI that would be equivalent to 575 200 bed-days. At the suggested cost for additional HAI-related stay of £319 (Table 6-50), the total cost is £183 million. (The full average cost of £455 per day had been used the total would be £262 million but this is likely to be an overestimate).

6.13.1 Analysis of cost by specialty

This analysis was based on specialty specific increased LOS due to HAI in the limited sample (Table 6-49).

The specialties haematology, oncology and psychiatry were excluded from the analysis since no patients with HAI were reported in the limited sample (Table 6-45). This was due to the smaller numbers of patients in these specialties. There is no reason to believe that HAI would not have an impact on their LOS.

For the specialty specific analysis estimate of the costs of an additional day were calculated on a similar basis as in Table 6-50 (Table 6-51).

Table 6-51: *Acute Hospitals. Estimate of additional cost of a day in hospital by specialty*

	Cost per patient care episode	Median LOS (days)	Implicit cost per day £	Cost per additional day £
Care of elderly	£5 496	23.4	£235	£187
Gynaecology	£1 979	2.7	£733	£418
General medicine	£1 613	4.8	£336	£267
Obstetrics	£1 506	2.0	£753	£596
Orthopaedics	£3 668	6.4	£573	£304
General surgery	£2 296	4.4	£522	£308
Urology	£1 777	3.4	£523	£304

6.13.2 Additional length of stay as a result of infection

On this basis the added LOS was as shown in Table 6-49. Table 6-52 shows the specialty specific increased LOS due to HAI estimated from the limited data set (Table 6-45) and the specialty specific cost of an additional inpatient day (Table 6-51).

Table 6-52: *Acute Hospitals. Additional length of stay associated with HAI by specialty and cost per added day*

Specialty	Increase LOS (days)	Cost per added day £
Care of the elderly	13.7	£187
Gynaecology	5.2	£418
Medicine	7.6	£267
Obstetrics	3.2	£596
Orthopaedics	8.0	£304
Surgery	5.7	£308
Urology	3.7	£304

Even allowing the cost per day to be lower for additional days may overestimate these data. For example, the costs of an additional day are very high for obstetrics and gynaecology. It is unlikely clinically, that a woman acquiring a HAI in one of those specialties will be so much more expensive to care for than one in any of the other specialties. Fortunately, the influence of these specialties on the total proves to be relatively small so the bias is not serious. Table 6-53 shows data (33) on the number of cases by specialty in Scottish acute hospitals in 2005/06 and the prevalence specialty specific HAI prevalence reported in this survey.

Table 6-53: *Acute Hospitals. Number of discharges after a patient care episode by specialty in Scottish acute hospitals in 2005/06 and the prevalence of infection from the current survey*

Specialty	Discharges N	Prevalence of HAI (%)
Care of the elderly	47 704	11.9
Gynaecology	29 985	4.8
Medicine	249 354	9.6
Obstetrics	95 014	0.9
Orthopaedics	71 349	9.2
Surgery	132 713	11.2
Urology	31 234	6.3

From these data it is possible to estimate the annual number of cases of HAI if the prevalence data from this study is applied nationally. This is shown as the first column of data in Table 6-54. Multiplying by the added stay for each specialty gives the total days stay attributable to HAI in the following column. The other two columns show the total cost of this care when multiplying by the variable costs and full average cost method (although it should be noted that the latter is almost certainly an overestimate).

Table 6-54: *Acute Hospitals. Estimated number of infections from current study applied to national annual data for each specialty showing annual estimate of HAI, increase LOS in days, an estimate of variable cost and full cost*

	Annual HAI Estimate N patients	Additional occupied bed days due to HAI	At variable cost £ million	At full cost £ million
Care of the elderly	5 677	77 772	15	18
Gynaecology	1 439	7 484	3	5
Medicine	23 938	181 929	49	61
Obstetrics	855	2 736	2	2
Orthopaedics	6 564	52 513	16	30
Surgery	14 864	84 724	26	44
Urology	1 968	7 281	2	4
Total for 7 specialties	**55 305**	**414 439**	**112**	**165**

Table 6-54 shows that when valued at an approximation to the additional cost per day for an infection, the total cost for these seven specialties was £112 million. The main costs were incurred in general medicine, followed by general surgery, orthopaedics and care of the elderly. (Note that when valued at the full average cost per day the total rose to over £165 million but this is likely to be an overestimate[1]).

The four surgical specialties listed in Table 6-55 can be further analysed in terms of what the additional bed-days occupied as a result of an infection could be used for.

1 An example of why the full average cost per day would overestimate the true cost of added days of stay for infection comes from medical oncology. With an average stay of 3.2 days the average pharmacy cost per day is £362 reflecting the fact that many patients are admitted to receive expensive cancer chemotherapy. If the full average cost were used to value additional stay due to infection it would involve assuming patients received £362 of medicines per day until they went home. While they will certainly be prescribed medicines to treat the infection it would be unlikely to cost this much and hence using the full average cost would be an overestimate. Similarly in orthopaedics using the full average cost would assume patients used £167 of operating theatre time per day even when they might only have a chest infection, for example.

Table 6-55: *Acute Hospitals. Estimated additional bed days made available by reducing HAI, by 25% or 100%.*

Specialty	Additional occupied bed-days due to HAI (N)	Average stay per patient care episode (days)	Potential number of additional patients that could be treated (N)	
			If 25% of HAIs avoided	If 100% of HAIs avoided
Surgery	84 724	4.4	4 814	19 255
Orthopaedics	52 513	6.4	2 051	8 205
Gynaecology	7 484	2.7	693	2 772
Urology	7 281	3.4	535	2 141

6.13.3 Sensitivity analysis

A sensitivity analysis involves assessing the robustness of the results. The results in Table 6-54 already include a sensitivity analysis in that the variable cost and the full average cost were used to show the different impact on the results. Another analysis that can be performed is to vary the prevalence of infections in the whole sample and in each specialty to the low and high values for the 95% confidence interval (Table 6-56).

Table 6-56: *Sensitivity analysis of economic analysis*

Specialty	Baseline (£ million)	Low prevalence (£ million)	High prevalence (£ million)
Overall sample	183	170	197
Top 4 Specialties			
Medicine	49	43	54
Surgery	26	22	30
Orthopaedics	16	13	19
Care of the elderly	15	12	17

6.14 Use of prescription of antimicrobials as a proxy indicator of HAI

Table 6-57 examines the use of prescription of antimicrobials as an indicator of HAI. Group 1 represents the group of inpatients who were prescribed an antimicrobial 48 hours or more after admission to hospital and Group 2 represents all other patients. Thus Group 2 includes both those who never had an antimicrobial and those who have had all their antimicrobials prescribed within 48 hours of admission.

Table 6-57: *Acute hospitals. Comparison of HAI prevalence between group 1 and group 2*

Group	Inpatients (N)	%	Inpatients with HAI (n)	Prevalence of HAI	95% CI	χ^2 test
Group 1	1 899	16.4	891	46.9	(44.6 - 49.2)	p<0.0001
Group 2	9 709	83.6	212	2.2	(1.9 - 2.5)	

Within the acute hospital sample there was a statistically significant difference in the prevalence of HAI in patients between groups 1 and 2. This suggested that further investigation was warranted.

Table 6-58: *Non-acute hospitals. Comparison of HAI prevalence between group 1 and group 2*

Group	Inpatients (N)	%	Inpatients with HAI (n)	Prevalence of HAI	95% CI	χ^2 test
Group 1	264	12.3	146	55.3	(49.1 - 61.4)	p<0.0001
Group 2	1 882	87.7	11	0.6	(0.3 - 1.0)	

Within the non-acute hospital sample there was also a statistically significant difference in the prevalence of HAI in patients (Table 6-58).

Using a χ^2 test for the null hypothesis (described on page 44) generates a result TS=4 600 with 1 degree of freedom and P<0.0001 in both acute and non-acute hospitals. Therefore it is possible to reject the null hypothesis. It is possible to conclude that prevalence rates for groups 1 and 2 are different in both acute and non-acute hospitals.

This suggested that further investigation was warranted. The sensitivity and specificity of prescription of antimicrobials 48 hours or more after admission to hospital as an indicator of HAI was tested (Table 6-59 and Table 6-60).

To further investigate the use of prescription of antimicrobials ≥48 hours after admission as an indicator of HAI three measures of the validity of an indicator test were considered: sensitivity, specificity and positive predictive value (PPV). (See Appendix section Use of antimicrobials as an indicator of HAI page 226 for details).

For acute hospital inpatients, the test of prescription of antimicrobials 48 hours or more after admission to hospital had a sensitivity of 80.8% and specificity of 90.4%. However the positive predictive value was only 46.9% (Table 6-59).

Table 6-59: *Acute Hospitals. Sensitivity, specificity and positive predictive value for the prescription of antimicrobials 48 hours or more after admission to hospital as an indicator of HAI*

	Estimate %	95% CI		
Sensitivity	80.8	(78.3	-	83.1)
Specificity	90.4	(89.8	-	91.0)
PPV	46.9	(44.7	-	49.2)

For non-acute hospital inpatients, the test of prescription of antimicrobials 48 hours or more after admission to hospital had a sensitivity of 93.0% and specificity of 94.1%. The positive predictive value was 55.3% (Table 6-60).

Table 6-60: *Non-acute Hospitals. Sensitivity, specificity and positive predictive value for the prescription of antimicrobials 48 hours or more after admission to hospital as an indicator of HAI*

	Estimate %	95% CI		
Sensitivity	93.0	(87.8	-	96.5)
Specificity	94.1	(92.9	-	95.1)
PPV	55.3	(49.1	-	61.4)

6.15 Prevalence compared with incidence measured during the survey

Appendix Table 7-1 (page 224) compares the estimated incidence over the period 1/10/2005 and 31/9/2006 with the incidence rate collected by the SSHAIP Surgical Site Infection (SSI) Surveillance programme. Incidence estimates were obtained from prevalence data using Equation 2 (page 45). These data demonstrate the difference in HAI cases between prevalence surveillance and incidence surveillance. On the day of a prevalence survey there are only a very few inpatients who have undergone each procedure but throughout the year of an incidence survey the total number of inpatients undergoing a particular procedure will be very large in comparison.

7 RESULTS ON THE PROJECT MANAGEMENT ASPECTS OF THE SCOTTISH NATIONAL HAI PREVALENCE SURVEY

7.1 Acceptability, feasibility and cost results

Each objective set in the project initiation document and approved by the Project Steering Board and the HAITF has been met. Throughout the survey the budget remained within the tolerances (timescales and budget) set by the project team (See Appendix Table 10-2 page 232). Progress against the plan outlined in the pilot study report (4) also remained within the defined tolerances. Table 7-1 shows the costs calculated from the estimates of time spent on the Scottish National HAI Prevalence Survey. The project plans and the protocol enclosed in this document (Volume 2) were feasible and the aims and objectives outlined at the initiation phase of the project were achieved.

Table 7-1: *Costs calculated from the estimates of time spent on the Scottish national HAI prevalence survey in acute and non-acute hospital surveillance by the project team based at HPS*

Resource	Total Hours	Cost per hour	Total
Total material costs. Includes IT equipment for team, production of posters and handouts, travel for team	-	-	£114 500
Total project staff costs for: Project Manager Project Administrator Information Analyst Surveillance Nurse/Epidemiologist x7 (not all concurrent) Consultant Epidemiologist Consultant Statistician Consultant Health Economist	610 weeks	Variable	£418 385
Set up costs provided by NSS	-	-	£45 000
Total costs for HPS project team and materials	**22 875**		**£577 885**
Total costs including cost to service (from Table 7-2)	**23 603**		**£594 672**

The estimated cost to the service is shown on table Table 7-2. This shows the total cost for Scotland.

Table 7-2: *Estimated time and financial cost of the Scottish national HAI prevalence survey to the local health services*

Resource	Total Hours	Cost per hour	Total
Nominated link infection control nurse	420	£21.80	£9 156
Introduction to ward manager	140	£30.40	£4 256
Local ward Staff	138	£21.80	£2 997
Psychiatric hospital escorts	30	£12.60	£378
Total cost to service	**728**		**£16 787**

The costs cover work during the period 01 January 2005 till 31 March 2007. Details of how these calculations were made are included in Appendix 10 on page 231. These cost estimates have been based on the Unit costs of Health and Social Care 2006 published by the Personal Social Services Research Unit (PSSRU) at the University of Kent (47).

7.2 What is a suitable methodology for repeated prevalence surveys, which give comparable information?

The methodology used in this survey is recommended for future prevalence surveillance.

The methodology developed for the prevalence survey was refined during the pilot survey and is included in Volume 2. The protocol remained unchanged throughout the main survey and issues raised by the data collectors were recorded on an issues log for the project. Issues and the solutions found to those issues were raised and recorded by all members of the project team. The data collectors shared any issues with the rest of the team at regular meetings and with the help of the consultant epidemiologist came to a solution for these issues.

The key features of the methodology required of any future prevalence surveillance in Scotland to ensure that results can be compared with those reported here are:

1. Use of the protocol prepared for this survey
2. Intensive training of data collectors on the application of the CDC criteria
3. Use of the electronic data collection tool which ensures collection of a complete data set and enables validation of input data
4. Validation of data collection as part of the survey

8 DISCUSSION

8.1 Objective 1 - What is the overall prevalence of HAI and the specific types of HAI in adult inpatients in acute and non-acute hospitals in Scotland?

This first national survey of the prevalence of HAI of 13 754 adult inpatients in acute and non-acute hospitals in Scotland was undertaken by a team of investigators based within the SSHAIP team at HPS who were fully trained in the survey methodology, including HAI definitions. Data collection tools developed for the survey, monitoring and validation of data collection aimed to ensure the robustness and consistency of the data. All 45 acute hospitals and a representative sample of 22 non-acute hospitals in Scotland were included in the survey.

This survey examined the burden and prevalence of HAI and is the first of its kind to do so at a national level, including all hospitals in the acute sector and 25% of patients in the non-acute setting.

8.1.1 Acute hospitals overall prevalence

The prevalence of HAI in patients in acute hospitals was found to be 9.5% (95% CI 8.8-10.2). The differences in populations sampled and in survey methodology which make comparisons of the results of HAI prevalence surveys inappropriate have been fully enumerated by Gastmeier (48) and are summarised in the literature review (Appendix Table 1-1 page 160). These include differences in the populations studied (hospital type and practice, year of study, type and case-mix of patients) and methodological issues, including HAI case definitions and their application in case ascertainment. It is coincidental, therefore, that this 9.5% prevalence estimate in acute hospitals is similar to that reported in UK surveys in 1980 (5) and in 1993-4 (49). The population studied in this Scottish survey was however, older than those studied in these two UK studies. More recently a HAI prevalence survey of acute hospitals has been undertaken in England, Wales, Northern Ireland and the Republic of Ireland (25-28) (the HIS survey in 2006), over a four month (February to May) period during the year the Scottish survey was undertaken, which used the same HAI definitions (18). In this survey of volunteer hospitals a prevalence of 7.6% (combined England, Wales, Northern Ireland and the Republic of Ireland) was reported in a survey of 75,765 patients in 273 acute hospitals. However, even in this survey there are differences in patient case mix and aspects of the methodology which mean that a comparison of the unadjusted, overall HAI prevalence with that reported here should be undertaken with caution.

Most prevalence surveys (22, 25-28) concentrate on a subset of HAI types these often include four infections: pneumonias, urinary tract infections, surgical site infections and blood stream infections. This survey found an overall prevalence in these infection types of 5%. However this survey found that these types of HAI were not the most common and accounted for only about half of all the HAI identified.

Inpatient populations can, however, be summarized in terms of the proportion of survey population greater than 64 years. It is important to note that the inclusion criteria within each of the 3 prevalence surveys undertaken in the UK were slightly different. Using this approach, 64.8% (63.6% for Acute, 70.9% for non-acute) of Scottish inpatients were 65 or older, a considerably older population than that reported by Meers (5) (42.7%) and Emmerson et al (6) (55.7%). The recent HIS Survey indicated that England, Wales and Northern Ireland had similar proportions of patients over 64 years, the Republic of Ireland showed a slightly younger inpatient population (28). The population in a prevalence survey is differnet from that of an incidence survey. ISD incidence data show that 49.1% of the hospital population are over 64 years old.

The logistic regression models created may be used to calculate the expected prevalence rate in a population for comparison with the observed prevalence rate. This comparison would take into account the distribution of the variables in the population that were found to affect the prevalence rate in the models.

8.1.2 Acute hospitals prevalence by hospital type, specialty and ward type

Prevalence varies according to the patient population in a hospital, specialty and ward and the interventions patients undergo within that setting (see Figure 6-6 page 57 and Figure 6-9 page 59). Each of these will be discussed in turn.

Other studies (5, 6, 19) have indicated that hospital type has an effect on prevalence of HAI. In this study, there appeared to be a difference in prevalence of HAI between Obstetric hospitals and other types of hospital (see Figure 6-8 page 59 and Appendix Table 5-18 page 204). However, HAI prevalence did not vary significantly between large, medium and small acute hospitals (see Appendix Table 5-19 page 204). This may be a reflection of case mix variation and specialty variation. Specialty HAI prevalence was therefore also examined.

Various studies (5, 6, 19-21, 50) have reported variation in HAI prevalence by specialty. This survey found the highest prevalence of HAI in acute hospital inpatients was found in the specialties Care of the Elderly (11.9%), Surgery (11.2%), Medicine (9.6%) and Orthopaedics (9.2%), (Table 6-12). One implication of this observation is the importance of emphasising hospital wide infection control policies and practice, such as standard precautions, which can reduce the prevalence of a wide range of HAIs.

As expected, the highest prevalence of HAI was found in ICU and HDU wards due to the immunocompromised nature of the patient population and the invasive nature of the multiple interventions performed in these settings. The prevalence found within ICU wards was 27.1% (95% CI 19.2-35.1) and in HDU was 16.5% (95% CI 10.4-22.6). Within general wards prevalence was 9.2% (95% CI 8.5-9.9).

8.1.3 Acute hospitals HAI type

In this survey the most commonly recorded HAI among acute hospital patients were, in order of proportions of all HAI found: Urinary Tract Infections (17.9%); Surgical Site Infections (15.9%); Gastrointestinal Infections (15.4%) and Respiratory Tract Infections (11.2%). Skin and Soft Tissue (11.0%) were also prominent.

Many HAI prevalence surveys have focused on the historic 'main types' of HAI including the most recent HIS survey (18). The data collectors in the Scottish survey were trained to be precise and accurate in collecting information about all types of HAI. Moreover they were provided with a data collection tool that included all the criteria for the CDC definitions of all types of HAI and these were accessible at the time the data were being collected.

This study indicates that the pattern of proportions of HAI appears to be different to previously published studies. Fifty two percent of Gastrointensinal Infections had organisim data recorded, of those 95% were *Clostridium difficile*. This is likely to be explained by recent initiatives throughout the UK on standardising microbiology testing and mandatory surveillance, which focus on *Clostridium difficile* in hospital patients (29). Eighty percent of *Clostridium difficile* infections recorded occurred in patients in the General Medicine and Care of the Elderly specialties (Appendix Table 5-9 page 196). However microbiology reports were unavailable for 44% of inpatients diagnosed with gastrointestinal tract infections at the time of survey. Due to the fact that CDC definitions of HAI do not require positive microbiology to make a positive diagnosis, it is likely that many of the 44.0% of all gastrointestinal infections were due to norovirus (NV).

The surgical site infection data are also of interest in terms of microbiology. A third of all *Staphylococcus aureus* microbiology data recorded was for SSI. Of all the microbiology data collected for SSI, 52% was *Staphylococcus aureus* and 70% of these were MRSA. The majority of *Staphylococcus aureus* infections (70%) occurred in patients in General Medicine and Surgery specialties (Appendix Table 5-9 page 196).

Comparisons of the types and proportion of HAI reported in other studies (3, 5, 17, 19-23) are confounded not only by the differences in population case-mix and methodology noted above but also by an emphasis customarily placed in HAI incidence and prevalence studies on recording only certain 'major' HAIs viz: Urinary Tract infections, Surgical Site Infections, Pneumonias and Blood Stream Infections. In the Scottish National HAI prevalence survey these made up only 47% of all infection types. In this study, Pneumonias accounted for 8.8% of HAI and Blood stream Infections for 4.4%. The impact of different types of HAI in terms of increased LOS and cost is discussed later. What is noteworthy in the results of this survey is that the spectrum of HAI occurring in acute hospital patients is wide. This is also the case at the level of individual specialties. Most, if not all types of HAI occur in patients in every specialty. However, as would be expected, patients in some specialties have a higher prevalence of HAI than others. It may be that frequent patient movement between wards as part of bed management may result in the more widespread occurrence of HAI.

It is also worthy of note that multiple infections were found in 1.1% of all inpatients (or 11.4% of acute hospital inpatients with HAI). These findings reinforce the differences between inpatient populations in each healthcare environment and, for similar reasons, emphasise that prevalence of patients with multiple infections reported in previous surveys should only be compared

with caution. Meers et al (5) found that 5.6% of HAI inpatients had more than one HAI, but surveys in Germany (19), Italy (20), Switzerland (23) and Slovenia (17) suggest that this statistic can range from 4.1% to 21.2%. This broad range is probably indicative of differences in survey methodology and diagnostic rigour, as much as differences in the surveyed populations.

8.1.4 Non-acute hospitals overall prevalence

The prevalence of HAI in patients in non-acute hospitals was found to be 7.3% (95% CI 6.0-8.6), i.e. lower than that in acute hospitals. Differences in the specialty distributions and case-mix in the acute and non-acute hospital populations may account for this difference.

8.1.5 Non-acute hospitals prevalence by hospital, specialty and ward type

There are few surgical patients in the non-acute hospital population while psychiatric patients, a group with a relatively low prevalence of HAI (5%), make up just over 50% of the population. In other reports (51, 52) where HAI prevalence has been found to be similar or higher than that in acute hospitals it is very probable that differences in the population sampled e.g. age and case-mix, and in methodology, account for the differing result (Table 6-14 page 70).

8.1.6 Non-acute hospitals infection types

HAI infection type contributing to the burden of HAI in non-acute hospitals was different to that in acute care (Appendix Table 5-10 page 197). Among non-acute hospital patients Urinary Tract Infections were frequent, but as frequent were what could be considered a minor, but no less distressing type of HAI - Skin and Soft Tissue (SST) Infection. Taken together these affected about four percent of the inpatients and almost two thirds of psychiatry HAIs were SST or UTI. The most common organism recorded in these cases of HAI was *Staphylococcus aureus*, of which approximately a third were MRSA. Another frequent infection was GI. It is worthy of note that all of the GI infections with a positive microbiology report (65%) recorded in non-acute hospitals were attributable to *Clostridium difficile*. Almost all of the *Clostridium difficile* (92%) infections were found in patients in the Care of the Elderly and General Medicine specialties (Appendix Table 5-10 page 197). It is also worthy of note that 35% of those diagnosed with gastrointestinal tract infections in non-acute hospitals had no microbiology reported at the time of survey. Again, a large proportion of these 35% could be norovirus but no microbiological reports were available at the time of survey. Multiple HAI infections were found in 1.0% of non-acute inpatients (i.e. 4.5% of non-acute hospital inpatients with HAI had more than one infection).

8.1.7 Multivariate logistic regression analysis

Several factors independently affect HAI prevalence in both acute and non-acute hospitals (Table 8-1). Although seasonality is important in acute hospitals, it is important to note that the seasonality investigation was not possible for non-acute hospitals. It is quite possible that the lack of seasonal effect found in non-acute hospitals shown on Table 8-2 is due to the fact that the majority of non-acute hospitals were surveyed within a single quarter. (see discussion on Feasibility page 144).

Table 8-1: *Acute Hospitals. Variables affecting HAI prevalence*

Variable	Acute Hospitals
Specialty	Y
Age	Y
Gender	Y
Quarter	Y
Hospital Size	N
Admission Type	N

Table 8-2: *Non-acute Hospitals. Variables affecting HAI prevalence*

Variable	Non-acute Hospitals
Specialty	Y
Age	Y
Gender	N
Quarter	-
Hospital Size	N
Admission Type	N

8.1.8 Objective 1 recommendations

Further analyses need to be undertaken on the burden study component of the study (at specialty level) to examine the impact of co-morbidities that may affect prevalence of HAI. Co-morbidities can be analysed in future by collecting ISD discharge codes for patients included in the survey. It is recommended that this should be considered in future work, and that analysis is undertaken on data from inpatients included in the burden study to examine the impact of morbidity, as reflected in discharge diagnosis, on the prevalence of HAI.

Key Summary Points

Acute Hospitals

- Prevalence of HAI in patients in acute hospitals was 9.5% (95% CI 8.8-10.2)
- The highest prevalence of HAI in acute hospital inpatients were found in the specialties Care of the Elderly (11.9%), Surgery (11.2%), Medicine (9.6%) and Orthopaedics (9.2%)
- In acute hospitals the highest prevalence was found in ICU and HDU wards
- The most common HAI in acute hospital inpatients were Urinary Tract Infections (17.9%), Surgical Site Infections (15.9%), Gastrointestinal Infections (15.4%), Lower Respiratory Infections (11.2%) and Skin and Soft Tissue Infections(11.0%)
- The most common organisms identified in inpatients with HAI, where these data were available were *Staphylococcus aureus* (105 cases) [71 cases of Meticillin resistant *Staphylococcus aureus* (MRSA) and 34 cases of Meticillin sensitive *Staphylococcus aureus* (MSSA)] *Clostridium difficile* (88 cases), followed by *Coliforms* (34 cases)

Non-acute Hospitals

- The prevalence of HAI in patients in non-acute hospitals was 7.3% (95% CI 6.0-8.6)
- In non-acute hospitals, one in ten inpatients in the two specialties, Medicine and Care of the Elderly (combined) was found to have an HAI and one in twenty inpatients in the specialty Psychiatry was found to have an HAI
- In non-acute hospital patients Urinary Tract Infections were frequent, but as frequent were Skin and Soft Tissue Infection. These affected about four percent of the inpatients
- The most common organism recorded in these cases of HAI, where these data were available was *Staphylococcus aureus*, of which approximately a third were MRSA. Almost all of the *Clostridium difficile* (92%) infections were found in patients in the Care of the Elderly and General Medicine specialties

8.2 Objective 2 - What is the impact of HAI in terms of length of stay on NHS activity?

8.2.1 Calculating LOS

Calculating LOS is a complex task and the methodology employed to calculate additional stay has a great effect on the additional LOS calculated (53). Freeman and McGowan (46) found that, measured in the same way in prevalence and incidence series, 'the consequences of nosocomial infection in prolonging hospital stay will appear to be almost twice as severe in a prevalence series' compared with patients who had their discharge data collected from monthly summaries of discharges.

Freeman and McGowan also point out that the hospital population is very different from the whole population of the country. While hospital based studies are of scientific interest, it must be remembered that the patients found in hospital are not directly comparable to similar demographic groups. For example, in men over 60 years the hospital population are more likely to have certain underlying diseases in addition to their reason for admission (53).

In their incidence survey of HAI in one acute hospital in England, Plowman et al (3) reported that the LOS of patients with HAI was 21.7 days compared with 7.6 days for patients without HAI (That is a LOS 2.8 times greater for patients with HAI compared to those without). Freeman and McGowan (46) found that the average prolongation of hospital stay recorded for the same group of patients in an incidence study was 7.3 days compared with 13.3 days when estimated in a prevalence survey. Patients who have longer LOS have an increased risk of HAI, not only due to a longer period in hospital, but also because of an increased vulnerability to HAI due to underlying infection (54). In prevalence surveys the overrepresentation of patients with longer hospital stays contributes to the higher estimates of additional LOS.

Several factors including age, gender and number and severity of underlying disease affect the LOS of patients. It is argued by some (55) that the additional LOS due to HAI which is reported in the literature can be attributed to the underlying disease and a resulting vulnerability not only to HAI but to other complications. Indeed, estimates of LOS derived from physicians' direct costing of the additional LOS result in estimates which are even lower than those obtained from incidence studies. Haley (56) also found confounding effects on LOS estimates of five secondary diseases, viz. obesity, pulmonary embolism, renal failure, diabetes and chronic lung disease. Glynn et al (57) argue that it is events in hospital such as interventions which have the greater effect on additional LOS. Suffice to say that the impact of underlying disease is still debated. In their paper, Freeman and McGowan state that 'the duration of the extra hospital stay caused by nosocomial infection after it occurs is slightly, if at all, related to underlying disease even though such diseases have been identified as strong predictors of the risk of infection.

From ISD published bed days for all inpatients, it is apparent that the findings of this study are quite different from their published mean LOS for each specialty (Table 6-51 page 108). This is supported by other studies calculating LOS using prevalence surveys (46, 56, 58). French and Cheng (58) in a study conducted in Hong Kong using prevalence to estimate the cost of HAI found that the LOS for patients without HAI was 23 days and with HAI was 46 days which is the same as found in the current study (double increase in LOS for patient with HAI).

8.2.2 Adjusted best estimate of increased LOS due to HAI comparable with the inpatients data from ISD

Table 6-49 (page 106) shows that LOS varies by specialty. The increase in LOS for each specialty is 70% using the best estimate for increased LOS. In Urology and Obstetrics, three and four additional days respectively are shown compared with Care of the Elderly with 14 additional days. Based on ISD bed days data for each specialty (59) this estimate appears to be reasonable.

It is clear that there is a wide variation between specialty for increased LOS with Care of the Elderly being the longest with 13.7 additional days and obstetrics being the shortest with 3.2 days additional stay. These LOS estimates are confounded by the co-morbidity status of the patients within these specialties.

For the economic analyses, only patients who had been in hospital for between greater or equal to two days and seven days or less were included in estimating additional LOS due to HAI. This was an attempt to get as close an estimate for LOS as the incidence data suggest. This minimised the bias resulting in prevalence estimates for all patients being adjusted from 27 days to 6.6 days.

8.2.3 Objective 2 recommendations

Further work is required to analyse the prevalence data collected within this survey with the Information and Statistics Division (ISD) International Classification of Disease 10 (ICD-10) data (from the Scottish Morbidity Register 1 (SMR1) when it is collated (45)) which would provide information on co-morbidities and allow a more detailed logistic regression analysis to be undertaken.

The results of this prevalence survey are valuable in estimating costs. However, consideration should be given to incorporating LOS analyses into ongoing incidence surveys.

Key Summary Points

- Calculating LOS is a complex task, the methodology employed to calculate additional stay has a great effect on the additional LOS calculated
- The best estimate of increase in LOS is obtained by using a reduced sample of patients who had been admitted between 2 and 7 days
- This results in a 70% increase in LOS for patients with HAI
- The increase length of stay due to HAI ranged from 3.2 days in Obstetrics to 13.7 days in Care of the Elderly
- Morbidity data which are currently unavailable will be included in further analyses of factors affecting HAI prevalence and increase LOS

8.3 Objective 3 - What are the hospital costs associated with HAI in Scotland and how much cost saving would be anticipated as a result of HAI control?

8.3.1 Context

There are two main undesirable consequences of a patient acquiring a HAI while in hospital:

(i) the impact on the health of the patient (reduced quality of life and possibly reduced survival)

(ii) increased treatment costs and prolonged hospital stay

In terms of the cost, one of the main UK studies to date was the Plowman report (3) commissioned by the UK National Audit Office who used an incidence study to estimate the hospital cost to be in the region of £1 000 million per year in England. A recognised weakness of this work was that it was based on a study of a single hospital in England in the early 1990s; while extrapolation of the results may suggest broad orders of magnitude, these become less relevant when applied to other settings and when practice changes.

8.3.2 Length of stay analysis discussion

The present study was not specifically designed to estimate the cost in the same way as the Plowman report, but it was acknowledged from the outset that an estimate relevant to Scotland based on current practice would assist in policy formulation. With this in mind, length-of-stay was selected as the statistic that could most readily and accurately be collected at an individual patient level without requiring significant additional resources for data collection.

The additional LOS is unlikely to be perfectly correlated with the true additional costs of acquiring a HAI while in hospital – for example, the additional costs are likely to involve additional pathology tests, medicines and other treatments, and increased staff time (notably nursing care). A specifically designed study could set about collecting data on all of these factors but this was beyond the scope of a prevalence study. The results suggest areas in which further research might be considered (see Objective 3 recommendations page 127).

However, the selection of additional length-of-stay as a proxy for all resource use associated with a HAI poses additional problems. The first set of problems relates to the censoring of data and these have been discussed in the statistical section of the report. The second set of problems relate to making allowance for all of the other factors that can influence LOS.

Many (possibly most) of the variables that affect LOS could only be measured in a specially designed incidence study (surveying all ward types and recording all HAI types), which would be very expensive to carry out. For example, the specialty of the ward indicates something about the type of illness the patient was suffering from, but it is not a simple relationship. The number of co-morbidities is likely to increase with the age of the patient but the correlation is

not perfect. Older patients are less likely to have suitable supportive discharge arrangements, and so on. Many of these factors are extremely hard to quantify (e.g. patient's ability to cope and whether they have a suitable place to be discharged to). Co-morbidity can be investigated using ICD10 codes which are collected by ISD. However during this study the time delay in hospital records departments coding discharged patients meant that the current study was unable to address these co-morbidities at time of writing (see Feasibility section page 144).

In the 2004 Scottish Executive policy statement 'Building a Better Scotland', the 'efficient government' initiative was launched. (http://www.scotland.gov.uk/Publications/2004/11/20318/47372). This proposed savings be divided into those that were cash-releasing (cash-releasing efficiency savings, or CRES) and those that freed resources for other purposes but did not release cash (time-releasing efficiency savings, or TRES). The savings from tackling infections acquired in hospital are most likely to be TRES, since hospital costs are fixed in the short-term to medium-term when workload changes. The time that is released by reducing HAI could be used to improve patient care either by for example, reducing waiting times and making more effective use of skilled professional staff.

8.3.3 Economic analysis approach

The prevalence approach used the whole dataset but the approach to sampling created problems by over-representing the people with a long LOS. The approach using model 2 and a reduced sample of patients to calculate LOS used above (see section 6.12 Length of stay estimate for economic analyses page 103) corrects for this to some extent but at the cost of excluding everyone with a LOS of less than two days. Given that the average stay in some specialties is only 3-4 days, this can be a sizeable minority of patients and it tends to increase the average stay for those without a HAI.

8.3.4 How does this figure compare to earlier estimates?

Table 8-3 compares some recent estimates of the added cost of HAI and compares them to the current study:

Table 8-3: *Comparison of economic estimates of cost of HAI estimated by previous studies*

	HAI %	Added stay days	Added cost £	Total cost £ million
Scottish Office 1999 (60)	9	2	314	22
Plowman 1994 (3) (Incidence)	7.8	11	2 917	101
Walker 2001 (13)	9.2	11	2 244	186
This study 2007	9.5	6.6	2 105	183
This study 2007 using the full average cost per stay	9.5	6.6	3 003	262

Adjusting the Plowman and Walker figures to 2005/6 figures using the Hospital and Community Services Pay and Prices Index gives totals of £146m and £196m respectively. This study estimates that the most plausible figure for overall cost of HAI per year to the NHS to be £183 million (Table 6-56). Estimates based on 95% CI of prevalence as estimated in this survey gave a range from £170 million to £197 million.

It is notable that estimates of the proportion of patients who acquire HAI is fairly consistent across the studies. However, the estimates of increased LOS show considerable variation, as discussed elsewhere in this report but the added cost per HAI is also relatively consistent.

8.3.5 Objective 3 recommendations

In order to generate the most accurate estimates of the cost of additional stay two things would be desirable:

1. A cohort study of people admitted to hospital that allows incidence to be estimated – if the costs in different specialties are of interest (e.g. haematology, oncology) this should be taken into account in designing the sampling framework
2. A more accurate estimate of the cost of added days of stay related to a HAI

However these would require costly and time-consuming studies. It is recommended that the prevalence survey should proceed to re-analyse the prevalence data using ISD discharge data including information on the patients' disease classification (ICD-10), which would allow a more specific comparison of patients with and without HAI. This data was not available at the time of writing.

It is recommended that the ICD-10 data when available is incorporated into the analysis.

Key Summary Points

- Costs of HAI in Scotland are estimated to be £183 million per year for all the specialties
- The cost of HAI in individual specialties ranges from £2 million per year (Obstetrics and Urology) to £49 million (Medicine)
- A more detailed analysis could be undertaken using ISD data, which was not available at the time of writing
    - It is recommended that the prevalence survey data are re-analysed using ISD ICD-10 discharge data
- If a reduction of HAI by 25% could be made within the surgical specialty an estimated 4 814 additional cases per year could be treated

8.4 Objective 4 - Prescription of antimicrobials 48 hours after admission to hospital as a proxy indicator of HAI

Thirty two percent of all acute hospital inpatients were prescribed antimicrobials at the time of the prevalence survey (Table 6-18). In non-acute hospitals, 15.6% of inpatients were prescribed one or more antimicrobials (Table 6-21).

The numbers of HAI in patients who had been prescribed any antimicrobial 48 hours or more after admission to hospital (Group 1) was significantly greater ($P<0.0001$) than the number of HAI in those who had not been prescribed any antimicrobial at the time of survey or who had been prescribed antimicrobials less than 48 hours after admission (Group 2) (Table 6-57 (page 113) and Table 6-58 (page 113)). Sensitivity of over 80% was found in acute hospitals and over 90% specificity in both acute and non-acute hospitals. However the positive predictive value was found to be around 50% in both acute and non-acute hospitals. It is clear that there is potential merit in using this as a test for HAI and it could provide a useful tool for hospital epidemiology.

Hospital Pharmacy departments could potentially provide regular reports on the number of inpatients who have been prescribed antimicrobials 48 hours or more after admission, which could be shared with the infection control teams at relatively little cost and time compared to prevalence surveillance (See Table 7-2).

8.4.1 Objective 4 recommendations

Undertaking a more detailed incidence study of all hospital inpatients over a given time which records the number of new cases of HAI during a given period, would give a more detailed picture. To undertake a similar analysis to the one included here, all the antimicrobials prescribed to an inpatient during their hospital stay would need to be recorded. Incidence studies are expensive in terms of time and cost and are generally undertaken in specialised units or on groups of inpatients who have undergone a specific procedure.

Key Summary Points

- There was a statistically significant difference in the prevalence of HAI between patients who were given an antimicrobial 48 hours after admission compared with those who did not
- Using antimicrobials as a proxy indicator of HAI provides a test with both sensitivity and specificity >80%; but positive predictive value of approximately 50%
- These results are encouraging and a more detailed study is recommended to investigate the use of antimicrobial prescribing as a diagnostic test for hospital wide epidemiologic surveillance

8.5 Objective 5: How do the incidence estimates obtained from prevalence measured in this survey compare with the results of targeted incidence surveys?

Prevalence data are a cost effective and timely way of gathering information of HAI. Incidence studies are more expensive and take longer to complete. On this basis, using prevalence data to generate the same information as incidence surveillance would be a cost effective approach.

There is some literature which suggests that prevalence data can be converted to incidence data. Two key papers (43) and (61) discuss the mathematical relationship between prevalence and incidence. These models describe incidence as 'prevalence divided by the duration of a HAI or an estimate of duration of infection'. However, these models are only valid if LOS is exponential and in the current study it is log normal. Graves et al (62) have applied the model and present results which they believe to be acceptable. Gastemeier (63) and Rossello-Urguell (64) advise against the use of the model.

Several authors (62-65) have used these formulae and applied them to the data resulting from HAI prevalence studies. Their conclusions on the applicability of the model in practice are conflicting, and the evidence base for the use of these formulae is inconclusive. Nonetheless the relationship appears to be statistically sound in special circumstances and biologically reasonable and, if an appropriate setting could be found, would be a useful additional approach to surveillance analysis.

As can be seen from Appendix Table 7-1 (page 224), the information available from SSHAIP SSI incidence data were of limited value for a number of reasons. Not all of the categories of surgery included in the incidence programme were found in the prevalence survey (i.e. insufficient numbers), and when these procedures were mapped there were only three categories of surgery that had sufficient data for comparison. For these three categories of surgery, calculated incidence was compared with measured incidence. These results were found to be variable: only one category of surgery appeared to have a rate which was comparable, and the others were not comparable.

The final results from the formula may be biased towards higher risk inpatients from medium to large acute teaching hospitals, as only complicated major surgical procedures were compared.

8.5.1 Objective 5 recommendations

From the data available no conclusions can be drawn about the validity of this approach for modelling national incidence surveillance data and further work is recommended to examine this relationship in more detail.

Key Summary Point

- Incidence data from hospitals participating in the SSHAIP incidence surveillance programme were used to compare measured incidence with incidence calculated using the current survey prevalence data
- The comparison was found to be of limited value
- There were only three categories of surgery that had sufficient data for comparison
- For these three categories of surgery, calculated incidence was compared with measured incidence and only one category of surgery (major vascular surgery) appeared to have a value, which was comparable
- Further work is recommended to examine this relationship in more detail

8.6 Objective 6 - What are the priority areas for targeted incidence surveillance?

8.6.1 Implications of the prevalence study for the SSHAIP programme

The current SSHAIP programme of national HAI surveillance was described in Table 2-2 (page 30). This study provides information for the further development of the SSHAIP programme. Priorities for HAI surveillance should be decided on the basis of high volume (total numbers of HAI nationally), high cost (the costs of the HAI nationally) and high risk (the consequences of the HAI to the patient).

8.6.2 Volume

Volume can be represented by numbers of HAIs. The numbers of organisms causing HAI, devices used and specialties in which large number of HAI occur are also important considerations when discussing the volume of HAI. Each of these will be discussed in turn.

The prevalence survey results indicate that the highest proportion of HAI in acute hospitals was: Urinary Tract Infection (17.9% of all HAI); Surgical Site Infection (15.9%); Gastrointestinal Infection (15.4%) (Table 6-10 page 61) (95% of which were caused by *Clostridium difficile*). Respiratory Infection comprising lower Respiratory tract infection (11.2%) and Pneumonia (8.8%) comprise 20% of all HAI. In non-acute hospitals these were: urinary tract infection (28.1% of all HAI); Skin and Soft Tissue Infection (26.8%); Gastrointestinal Infection (12.2%) (Table 6-13 page 69).

Where microbiology reports were available the most common types of organism associated with HAI found in acute hospitals were (in descending order): *Staphylococcus aureus* (MRSA and MSSA); *Clostridium difficile* and *Coliforms*. Thirty one percent of all blood stream infections found were due to *Staphylococcus aureus* (Appendix Table 5-22). In non-acute hospitals the same organisms were most common although proportionally more MSSA than MRSA were reported (Appendix Table 5-24).

The devices which were most the most frequently in situ were peripheral vascular catheters (PVCs), urinary catheters and central vascular catheters (CVCs). These were found in greater volume in particular specialties (PVCs in medicine, CVCs in medicine and surgery, mechanical ventilation in ICU and urinary catheters in medicine, care of the elderly, surgery and orthopaedics). In non-acute hospitals the most common device was urinary catheters.

The large specialties in acute hospitals with the highest volume of HAI were in descending order: Care of the Elderly, Surgical, Medicine (including Renal), Urology and Orthopaedics (Table 6-12) in acute care. In non-acute hospitals these were Medicine, Psychiatry and Care of the Elderly (Table 6-15). Most blood stream infections occurred within inpatients being cared for under Haematology, Oncology, Surgery and Medical specialties (Appendix Table 5-9).

Almost one third of the hospital population were on an antimicrobial (Table 6-18 page 74). Almost 13% of all inpatients in acute hospitals were on multiple antimicrobials at the time of the survey. This represents a high volume of use.

On the basis of volume of cases the priorities for targeted incidence surveillance, would be:

- Catheter associated UTI
- SSI
- *Clostridium difficile* GI infections
- Vascular catheter associated infections (including *Staphylococcus aureus* bacteraemia)

There is also a need to consider specialty level surveillance in medicine and care of the elderly. It might be that vascular catheter surveillance would be particularly useful in these specialties as PVCs were most commonly found in these specialties.

8.6.3 Cost

Costs of HAI have been expressed in terms of specialty specific additional LOS (Table 6-52 page 109). Specialty additional costs per year ranged from £49 million in Medicine and £26 million in Surgery (ranked in the top 2) to £2 million a year in both Obstetrics and Urology (ranked joint lowest).

On this basis targeted incidence surveillance should focus on Medical and Surgical Specialties.

No analysis was undertaken to assess the cost of additional LOS at organism level. The study only collected date on the prevalence of devices and no association can be made between devices and additional LOS due to HAI.

8.6.4 Risk

Risk can be expressed in terms of the impact of the HAI on the patient. There is a large body of medical literature on the topic of HAI and its effect on individual patient morbidity. The Scottish National HAI Prevalence survey reports results on the volume and cost of HAI, however the third and final factor, which must be considered when discussing priority areas for surveillance, is the effect on morbidity and mortality, which is not addressed in the current study. Prevalence surveys are not able to assess the effect on the patients' morbidity and mortality due to the 'snap-shot' nature of the surveillance. In order to make recommendations on where priority should be given for future incidence surveillance; reference must be made to the medical literature in combination with the volume and cost findings from the prevalence survey.

The current prevalence survey only assessed the impact of the HAI on the patient in terms of additional LOS. A proxy indicator for the effect of HAI on morbidity is the additional LOS. The consequences of HAI in terms of additional LOS for the patients include: anger, pain, suffering and ill health, but also serious social consequences such as: a delay in return to work, potential loss of earnings, additional child care costs and cancellation of holidays. HAI increased the LOS in all specialties by 70%. The largest additional LOS was attributable to the specialty care of the elderly with an additional 14 days for those patients on average.

8.6.5 Effect on mortality

This survey has addressed the cost in terms of increased LOS due to HAI occurring in inpatients. There are however other adverse events associated with HAI.

Data from studies in the U S suggested that 10% of inpatients who acquired a HAI subsequently died as a direct result of the infection (66). The studies also suggested that the infection was a major contributory factor in the death of a further 30% of these inpatients. When the figures were extrapolated to the whole of the US population presenting with a HAI over the course of a single year, it was estimated that in 1982, some 20 000 deaths were directly attributable to HAI and that a further 60 000 were indirectly attributable to HAI. This means that, in the US, HAI was the eleventh leading cause of death. When deaths which were both directly and indirectly attributable to HAI were taken into consideration, HAI was considered the fourth leading cause of death.

It is often quoted that in the UK there are an estimated 5 000 deaths per year as a direct result of HAI and that HAI may be a significant contributing factor in a further 15 000 deaths per year (67). A study by Plowman et al (3) found 13% of inpatients with HAI died compared with 2% of those without. Adjusted for age, gender, co-morbidity and other factors, the mortality rate was 7 times higher for inpatients with HAI. These data are the best available approximation of mortality. However they are now quite out of date (in terms of population demographics and LOS) and were extrapolated from a single English hospital which did not include all the specialties seen in Scotland and, as such, there is a need for more robust data in Scotland in this regard. The SSHAIP programme should include special studies in this regard so that risk can be more adequately examined. On the basis of risk, as defined by additional LOS, priority areas for targeted surveillance should be in care of the elderly, medicine, surgery and orthopaedics. This may mean there is needed for targeted prevalence as the risk is not specific to one type of HAI.

8.6.6 Prioritising areas for targeted surveillance

The SSHAIP programme of work includes surveillance of *Staphylococcus aureus* bacteraemia (amongst other programmes of work) as a key indicator of HAI (see page 29 for outline of SSHAIP Programme). *Staphylococcus aureus* blood stream infections have a very serious effect on morbidity and mortality for patients and are considered to be largely preventable and therefore are a clear priority for targeted surveillance on the grounds of risk to the patient. It can be seen in Figure 8-1 that *Staphylococcus aureus* blood stream infections represent almost half of all bloodstream infections and a small proportion (1.4 %) of all HAI found

in Scottish acute hospitals, but because of the risk to the individual patient are included in the incidence surveillance programmes. Table 14-4 summarises the priorities for surveillance based on volume, cost and risk of each of the key potential priority areas.

Figure 8-1: *Pyramid representation of HAI types. Showing infection types, 55 blood stream infections in total, 17 of which are have Staphylococcus aureus as the causative organism.*

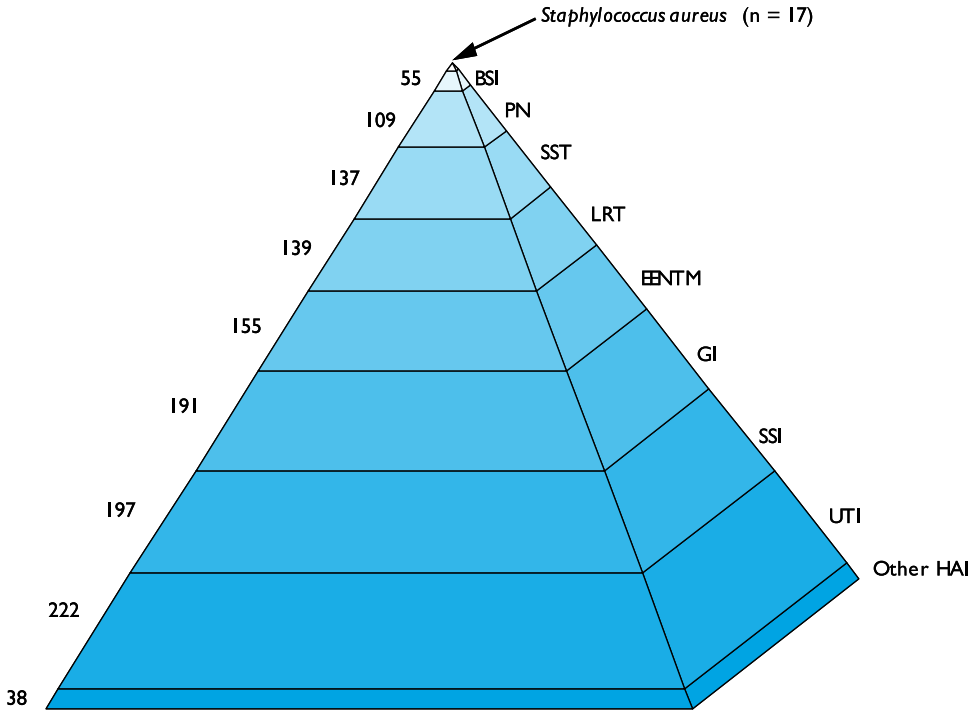


Table 8-4: *Priority areas for surveillance of HAI*

Potential Priority Areas	Volume of HAI (National)	Cost of HAI (National)	Risk (To individual patients)	Prioritise for surveillance (Combined volume cost and risk)
HAI Type				
Surgical Site	✓	✓	✓	✓
Urinary Tract	✓	✓	✓	✓
Pneumonia			✓	✓
Lower Respiratory Tract	✓	✓		
Gastrointestinal	✓	✓	✓	✓
Skin & Soft Tissue	✓			✓
Blood Stream			✓	✓
Specialty				
Medicine	✓	✓	✓	✓
Surgical	✓	✓	✓	
Care of the Elderly	✓	✓	✓	✓
Orthopaedic	✓	✓	✓	
Organism				
C. difficile	✓	✓	✓	✓
S. aureus	✓	✓	✓	✓
Devices				
PVCs	✓			✓
Urinary Catheters	✓	✓		✓
CVCs	✓	✓	✓	✓
Mechanical Ventilators		✓	✓	✓

Ideally, national data should be a by-product of local surveillance systems, and, national and local surveillance systems should be integrated so that no more data are sought nationally than are needed locally. While the overall aims of surveillance at local and national levels may be similar, the emphases vary: at national level there is likely to be more emphasis on the identification and prediction of national trends, and the evaluation of national interventions and control programmes. At the local level, local trends, outbreaks and individual cases of severe illness are likely to be more important, as are the evaluation of local interventions and initiatives, and the examination of local practises in patient care.

As a rule, active comprehensive, individual data systems are the most expensive, but provide the best quality data. In addition, valuable information can be gleaned from special studies (including outbreak investigations) and prevalence surveys. These, strictly, do not constitute surveillance, as they are not ongoing. Regularly repeated prevalence surveys may however be deemed to be surveillance.

8.6.7 Objective 6 recommendations

Targeted incidence surveillance for:

1. Surgical site infection
2. *Clostridium difficile*
3. CAUTI (Catheter Associated Urinary Tract Infection) in medicine, care of the elderly, surgery and orthopaedics and non-acute hospitals
4. Vascular catheter infections
    a. PVC in medicine
    b. CVC in surgery and medicine
5. *Staphylococcus aureus* bacteraemia

Antimicrobial prescribing should also be monitored

Repeated prevalence surveys for:

- specific specialties (elderly care, medicine)
- hospitals with small bed numbers where targeted incidence surveillance is of limited value
- as a cost effective means of measuring the impact of interventions over time (utilising at least 3 surveys pre and post intervention) (21, 68, 69).

Key Summary Points

- National and local surveillance systems should be integrated where possible and evaluated to ensure maximum public health benefit is achieved
- On the basis of high risk, volume or cost; priority areas for incidence surveillance are: Catheter Associated Urinary Tract Infection (CAUTI), Surgical Site Infection (SSI), Gastro Intestinal Infection (GI) specifically (*C.difficile*), Skin Soft Tissue Infection (SST) (related to Peripheral Vascular Catheters (PVC), Central Vascular Catheters (CVSs), and Blood Stream Infections (relating to CVCs)
- Specialty specific surveillance should be considered with regard to the above noted targeted areas in Medicine and Care of the Elderly with potentially targeted prevalence of all HAI
- Special studies on HAI attributable mortality should be undertaken in Scotland

8.7 Objective 7 - Priority areas for intervention

8.7.1 Preventability of HAI

The prevention and control of HAI now has a very high priority within the NHS in Scotland. It is necessary to ensure that this momentum is maintained and that further development is rational and builds on work already undertaken. It is not possible, at least at this time, to undertake comprehensive surveillance of every type of HAI on a continuous basis. As well as identifying the priority areas for surveillance, consideration needs to be given to where the greatest improvements in patient care are likely to come. At the same time issues of resources (staff, IT etc.), suitable methodologies and feasibility need to be taken into account.

Consideration in deciding priority areas for intervention are based on:

a The effectiveness of the prevention in terms of:
   i. The volume and severity of HAI types
   ii. The patient groups affected
   iii. Where most achievement is possible
   iv. Where methods of prevention are known to be effective

b. The cost of prevention

The proportion of HAI, which is potentially preventable, is not known. In the late 1960s epidemiologists in the USA noticed that feedback of information about Staphylococcal epidemics in hospitals could change the behaviour of the physicians, nurses and other personnel in such a way as to reduce HAI (70). A large multi-centre (SENIC) study by Haley et al (1985) (9) suggested that four components were required to reduce HAI: surveillance, control, an Infection Control Nurse to collect data and a physician actively involved. For surgical wound infection specifically, the suggested requirements were intensive surveillance, intensive control and a programme of regular feedback to surgeons. Hospitals which had all of these elements could reduce surgical wound infection rates by 20% over 5 years. Furthermore, hospitals with all of these elements *and* an interested physician could reduce surgical wound infection by 38% in the same time period (9). These findings are commonly referred to in the literature as the basis for surveillance of HAI. These data are now around 30 years old, (the study was conducted between 1971 and 1976) and their applicability are limited by the fact that the study was based on an American healthcare setting. The study has never been replicated out with the USA, however several other smaller studies have been published since by various authors.

In 1995 in the UK, the Hospital Infection Working Group of the Department of Health (DoH) in England (71) suggested that it might be possible to achieve a 30% reduction in HAI. In England in 2000 the National Audit Office (NAO) published a review of the management and control of HAI (67) and indicated through a census of infection control teams that 39% considered a 30% reduction to be achievable, 49% felt it was too high and 12% did not know. The most common estimate of possible reduction was between 5 and 10% of all HAI. The bed weighted average across all NHS trusts in England who participated, was a reduction potential of 15% of HAI.

Recently Harbarth and colleagues (1) have carried out a systematic review of the literature in this field for intervention studies published from 1990-2002. The review focused upon 25 relevant studies conducted in various patient populations and healthcare settings and found the a potential to reduce HAI ranged from 10% to 70%, depending on the setting, study design, baseline rates and type of HAI. Table 8-5 summarises the estimated reduction effect suggested by Harbarth et al. (1).

Table 8-5: *Potential reduction in HAI by type and setting indicated by Harbarth et al (2003)*

HAI type	Reduction potential (range)	Setting details
CVC associated bloodstream infection	14-71%	70% neonates 56% adult critical care
VAP	38-70%	ICUs
Catheter associated UTI	46-60%	All specialties
SSI	24-34%	Surgical specialties

The most common interventions leading to reduction of HAI were surveillance, hand hygiene, education and audit. The review concluded that approximately 20% of all HAI were preventable, but that there was a need for more research to be conducted on multi-modal interventions with careful design consideration including control groups.

Current literature on HAI prevention and control has focussed significantly on the effectiveness of 'care bundles' (72) in terms of interventions to control HAI. In their systematic review of the literature in 2007 Aboelela et al found that bundles of 2-5 interventions were employed in the 33 studies included in the review. The behavioural interventions included in the 'care bundle' approach evaluated in this review were education, formation of a quality team, compliance monitoring, staff performance and feedback and staff development skills and testing. The multi-modal approach does not allow the impact of a single intervention to be examined, however considering the multifaceted nature of HAI, this approach is beginning to be recommended (73) and is worth consideration in those areas of high volume, risk and cost identified in section 8.5 of this report.

The key implications from the literature and the present study, outlined in section 8.6, are that surveillance priorities should be in those areas of high risk, high volume and high cost. In addition, priorities for HAI interventions should also focus on the potential for prevention.

The current work on HAI surveillance in Scotland is being developed into a programme approach to the reduction of HAI in Scotland and as such must include the priority areas with most potential for prevention as identified in Table 8-5.

8.7.1 Priority areas for intervention

> 'Infection-a thing of which people are generally so afraid that they frequently follow the very practice in regard to it which they ought to avoid.'
>
> *Nightingale (1859)*

Healthcare associated infection is in some cases related to inappropriate patient care practices. The impact of these practices on outcome is greater in a healthcare setting than the general population as the patient population may be particularly susceptible to such infections, due to age or co-morbidities. In addition, immunocompromised patients such as infants or patients undergoing chemotherapy are likely to develop more serious disease, and the infection may result in death.

The common types of HAI found in the prevalence study such as urinary tract infections, surgical site infections and skin and soft tissue infections are often associated with healthcare interventions, for example use of catheters and surgery. Interventions vary, based on the needs of the patient population within and between hospitals. Accordingly, there will be a heterogeneity in the causes of HAI within any given hospital, which will necessitate a selection of intervention programmes aimed directly at these common infection types. The priority areas for intervention should be developed to reduce HAI and should be adaptable to individual settings with the overarching principles of directing the infection control resources to where the greatest improvement can be achieved first.

Since HAI can be an unintended consequence of healthcare interventions such as urinary catheterisation, vascular catheterisation or surgical procedures (74), there is a necessity for individual units and hospitals and NHS Boards to provide evidence of optimisation of practices related to these invasive healthcare interventions – any devised intervention programme should assist in this process.

National surveillance data have demonstrated that MRSA bacteraemia remains a problem in Scottish hospitals and, despite enormous efforts at improving infection control managerially and organisationally through the SEHD HAI Task Force programme, there is as yet no significant indication of a reducing incidence. The prevalence survey has demonstrated a continuing burden of HAI in NHS Scotland and it is clear that a specific focus on areas of high risk, volume and cost is required in order to improve quality of care and reduce the incidence of these HAIs.

The focus of these interventions should therefore be aimed at reducing urinary tract infection, surgical site infection, lower respiratory tract infection, gastrointestinal infection and skin and soft tissue infection. The healthcare practices which should be focussed upon in terms of priority should be those such as care and maintenance of devices such as urinary catheters, vascular catheters (peripheral and central) and mechanical ventilation. A focus should also be given to those practices that prevent surgical site infection (pre, peri and post op care), prevent transmission of infection (such as hand hygiene) and prevent and control antimicrobial resistance (such as prudent prescribing of antimicrobials). By targeting interventions in these areas where there is the most potential for prevention, the impact on outcome will be maximised.

8.7.2 Cost implications of targeting priority areas for prevention

The theoretical minimum risk of acquiring a HAI is unknown and requires further investigation. However, based on the evidence currently available, priority areas for surveillance should be those where there is the greatest potential for reduction in HAI rates.

The cost effectiveness of surveillance and other activities aimed at reduction of HAI also requires further investigation but, on the evidence currently available, it would appear that significant cost savings could be made by focussing on priority areas. Harbarth et al (1) indicate that 20% of all HAI in all specialties is probably preventable. This would mean that on the basis of the results from the survey that at any time 9.5% of all inpatients have an HAI, 1.8% (20% of 9.5%) would be preventable.

As an example, in a general surgical ward where the additional cost per patient per day is £308 (see Table 6-51 page 108) and the average additional LOS is 5.7 days, the average additional cost per case of surgical site infection is £1755.60. (This estimate only includes cost while the patient is in hospital and no account is made for additional healthcare costs once discharged). Table 14-6 shows the potential cost savings from various levels of HAI reduction.

Table 8-6: *Possible cost savings for various levels of % HAI reduction from prevention of all HAI, based on a total cost of £183 million.*

% Reduction of HAI	Cost Saving £ millions
10	28.3
20	36.6
30	54.9
40	73.2

If these data are then applied to those derived from the economic component of the prevalence survey, this indicates minimal potential cost savings of (1) £36.6 million (20% of £183 million) and indeed further potential savings might be possible by focussing on the aforementioned priority areas.

In recognition of the burden of HAI, both in terms of morbidity and mortality and its subsequent cost, it can be seen as a performance indicator. Encouraged by the move towards clinically (and cost) effective care provision, the development of performance indicators has progressed rapidly. This has resulted in strategic directives for mandatory participation in surveillance. As such, the resulting data from national HAI surveillance programmes in the UK are utilised within the Health, Efficiency, Access and Treatment (HEAT) target in Scotland and as part of the Health Commission's star rating assessment for hospitals in England.

Staphylococcus aureus bacteraemia (SAB) is an unambiguous marker of invasive infection. At present in the UK, SAB is usually hospital acquired (75). There is an assumption that high rates of SAB are an indicator of Infection Prevention and Control (IPC) performance. SAB also causes significant morbidity and mortality. As such the HAI target in Scotland is a reduction of SAB by 30% by 2010. On the basis that SAB is an indicator of all HAI, if the HEAT target were met, a potential £55 million cost saving could be made in NHS Scotland.

The use of these data in this way within the NHS has resulted in much interest from the media. The use of surveillance data as performance measures has resulted in a high public profile for HAI. HAI rates from surveillance studies are often compared between hospitals, countries and over time, but comparisons of crude infection rates should be made with due caution. Rates may be affected by factors such as differences in numerator or denominator definitions, surveillance methods with different sensitivities and specificities for case detection and different intensities of surveillance activities.

Table 8-7 summarises the priority areas for prevention, cost saving and thereafter those which should be prioritised for surveillance intervention.

Table 8-7: *Priority areas for intervention*

Potential Priority Areas	Potential for Prevention Based on Harbarth 2003 (1)	Potential for Cost savings Based on current survey and Plowman (3)	Prioritise for intervention
HAI Type			
Surgical Site	✓	✓	✓
Urinary Tract	✓	✓	✓
Pneumonia	✓	✓	✓
Lower Respiratory Tract			
Gastrointestinal			✓
Skin & Soft Tissue			✓
Blood Stream	✓	✓	✓
Specialty			
Medicine		✓	
Surgical		✓	
Care of the Elderly			✓
Orthopaedic			✓
Organism			
C. diff			✓
S. aureus	✓	✓	✓
Devices			
PVCs	✓	✓	✓
Urinary Catheters	✓	✓	✓
CVCs	✓	✓	✓
Mechanical Ventilators	✓	✓	✓

8.7.3 Objective 7 recommendations

- The SSHAIP programme should focus with NHS boards on targeting interventions where there is the most potential for prevention of HAI. The results from this study indicate these should be care and maintenance of devices such as urinary catheters, vascular catheters (peripheral and central) and mechanical ventilation. A focus should also be given to those practices which prevent surgical site infection (pre, peri and post operative care), those practices which prevent transmission of infection such as hand hygiene and practices which prevent and control antimicrobial resistance such as prudent prescribing of antimicrobials. By targeting interventions in these areas where there is the most potential for prevention, the impact on outcome will be maximised.
- Surveillance in settings outside hospitals should be considered in order to establish the burden and focus on required interventions for the prevention of HAI in these settings.
- The evidence base for interventions that will impact on HAI infection rates also requires development. There are gaps in the published literature on the effectiveness of single interventions, and well-conducted research studies are required. This should be the focus of the newly established Scottish Infection Research Network (SIRN).
- Further work is needed on the impact of HAI outbreaks in order to collect data on the numbers and types of outbreaks of HAI, the aetiology (where known) and the outcomes of control interventions. Such information would provide a knowledge base of outbreaks of HAI, the organisms responsible, methods of transmission, factors that contribute to outbreaks, and effective control interventions. Where similar problems appear in different locations the experience gained in an earlier outbreak along with new information may reveal answers to hitherto unanswered questions and/or assist in the implementation of effective control measures. This is particularly important as infection control teams in the hospital setting are burdened with the impact these infections have on their time and the subsequent costs associated with the management of these (76).

Key Summary Points

- The study has been a useful approach for identifying future targeting activities for surveillance and areas for intervention
- The priority area for focussing interventions in order to reduce HAI are care and maintenance of devices, (urinary catheters, vascular catheters (peripheral and central) and mechanical ventilation), surgical site infection prevention and prudent prescribing of antimicrobials
- The move towards targeted 'care bundles' for an intervention is worth considering in the priority areas identified in this study
- The importance of standard precautions and transmission based precautions should also be emphasised
- Priority areas for HAI prevention and control will continue to be identified through reviewing the evidence from published studies. There are gaps in the published literature on the effectiveness of single interventions, this should be a focus for SIRN
- Further work is needed on the impact of HAI outbreaks in order to collect data on the numbers and types of outbreaks of HAI, the aetiology where known and the outcomes of control interventions

8.8 Objective 8 - What are the acceptability, feasibility and cost of undertaking prevalence surveys in Scottish hospitals?

8.8.1 Acceptability

Acceptability was defined as: 'the adequacy of the survey to satisfy the, objectives and requirements set in the project initiation document' (77). This report contains the findings of the Scottish National Prevalence Survey. Each objective set by the project initiation document and approved by the Project Steering Board and the HAITF has been met. Throughout the survey the budget remained within the tolerances set by the project team. Progress against the plan outlined in the Project Initiation Document (77) did not exceed the defined time and cost tolerances shown on Appendix Table 10-2 page 232.

The first exception to these plans was highlighted in the pilot report (4). The collection of International Classification of Disease (ICD-10) codes during the collection of LOS data proved not to be feasible. Many hospitals have a long backlog in coding patient notes according to the ICD-10 system. These delays were up to 6 months for some large teaching hospitals and due to the timescales of the project and the variable nature of the data available within the timescale of the project it was approved by the steering group that ICD-10 codes would not be collected for the survey.

The second exception was the investigation of the seasonal effect within the non-acute hospitals. Throughout the survey the seasonal distribution of the hospitals according to size and type was maintained. Within the non-acute hospitals this was not possible. This was communicated to the Steering Group and due to the limited variation in specialty within the non-acute hospitals it was agreed to maintain the plans within the acute hospitals at the expense of the non-acute hospitals seasonal planning. The recruitment of additional data collectors allowed the team to survey all the hospitals planned; however, the majority of non-acute hospitals were surveyed during the period May 2006 to July 2006. This may have affected the non-acute hospital univariate logistic regression analysis. Further work is required to investigate a possible seasonal effect on HAI prevalence in this setting.

8.8.2 Feasibility

Feasibility is defined as 'Whether something is able to be made, done or achieved'. The project has been completed within budget and on time according to the original Project Initiation Document presented to the HAITF. The project plans and the methodology enclosed in this document (Appendix 1 Protocol) were feasible and the aims and objectives outlined at the initiation phase of the project were achieved.

8.8.3 Cost

The funding received by HPS from the SEHD for the Scottish National Prevalence Survey was £577 885 (Table 7-1). This funding covered the development of the methodology, pilot survey, main survey, and production of the final report. The specific tasks undertaken were:

- Extensive review of HAI surveillance literature
- Development of data collection protocol
- Development of a data collection tool
- Production of publication materials
  - Posters
  - Staff Information leaflets
  - Patient Information leaflets
- Full pilot survey to test protocol, communications and data collection tool
- Communication with Hospitals and Stakeholder Groups before during and after the project
- Project Management of the Prevalence Survey
  - Monitoring cost and time
  - Monitoring Issues and Risks
  - Maintaining issues log and resolving issues relating to data collection
- Extensive training of data collectors in CDC Definitions and data collection tool
- One years travel and subsistence for each data collector when required
- Surveillance costs (salaries for staff)
- Multiple Validation studies throughout the survey
- Detailed analysis and production of final report
- Detailed analysis of individual hospital data and reporting to individual hospitals
- Communication with local staff throughout the project
- Consultancy costs for epidemiology, statistics and economics

The cost to the service has been estimated as £16 787 (Table 7-2). This covers the time spent by infection control and clinical staff in supporting the survey by undertaking the following tasks:

- Informing local clinical staff of the prevalence survey
- Arranging security clearance for the data collectors
- Providing the data collectors with orientation to the hospital
- Distributing posters and leaflets throughout the hospital
- Arranging presentations from the Project Manager when required
- Collecting and reporting LOS data for local medical records systems and returning them to HPS
- Introducing clinical staff to data collectors
- Providing brief orientation of ward set-up to data collectors
- Clinical staff answered any enquiries from data collectors
- Occasional chaperone in closed psychiatric wards

The original protocol (developed in early 2005) included a cost estimate for both the pilot and main survey of £564 896 (78). This cost comprised £61 948 for the pilot study and a further £502 948 for the main survey (Table 7-1). The pilot study undertaken in three acute hospitals allowed the team to accurately estimate the cost and time to survey a variety wards within the pilot hospitals. Some additional funds were required in order to allow the surveillance of a sample of non-acute hospitals.

By the conclusion of the project the total costs for the HPS project team were £577 885 with £532 885 being provided directly to the project by the Scottish Executive from the 'Clean Hospitals' budget awarded by the HAI Task Force. An additional £45 000 was provided during the development of the pilot protocol from NSS, which took the form of salaries for HPS staff involved in developing the initial protocol before the main survey team were recruited. Ninety seven percent of the costs and time effort were borne by the HPS team.

The hospitals varied in size but overall cost of staff time can be approximated using these data. The cost to the service has been calculated as £16 787. This corresponds to an average cost to local hospitals of £20 per ward surveyed. Each hospital will be provided with a detailed report on the Prevalence of HAI within their hospital and the project team believe this cost to have been acceptable. This is supported by the fact that the survey was undertaken and completed according to the initial plans.

Key Summary Point

- The methodology described in this report is both feasible and acceptable for prevalence surveillance in Scotland
- All nine objectives described at the initiation of the project have been addressed
- The central cost controlled by HPS were £577 885
- The cost the service was estimated to be £16 787
- The total cost of the prevalence Survey was £594 672

8.9 Objective 9 - What is a suitable methodology for repeated prevalence surveys, which give comparable information?

This survey has developed a standardised prevalence surveillance method allowing the collection of robust data for this survey. This can be used in the future for HAI surveillance at national and local levels. There are two key aspects to future prevalence surveillance. The first is surveillance of HAI at a national level. The second is to use prevalence surveillance to undertake smaller local investigations more frequently as part of local hospitals infection control programmes of work.

The Scottish national prevalence survey was a considerable undertaking for both HPS and the local NHS boards. It is unlikely that a survey on this scale would be undertaken on a frequent basis. The Prevalence Survey has been reviewed as part of the HPS evaluation of surveillance systems. This was undertaken by an expert panel of senior public health professionals and included input from a wide range of stakeholder representatives.

This review made two recommendations for the National HAI Prevalence Survey:

- A 10 year interval between repeat surveys is appropriate
- If repeated then a sample of hospitals is sufficient

The methodology and key principles for future prevalence surveillance should be considered applicable in 10 years time. It is probable that developments in electronic patient records systems may well make the undertaking of such a survey considerably simpler in future.

Using the results of this survey it may be possible to select a representative sample of hospitals which would provide an estimate of the prevalence of HAI in Scottish hospitals.

Whilst it is recommended that a national survey of HAI prevalence should not be undertaken more frequently than every 10 years, there is a possibility that repeated local prevalence surveillance could be used at a hospital or board level more frequently to investigate the effectiveness of interventions on the prevention of HAI. A proposal for future work that would allow local ICTs to undertake prevalence surveillance of their hospital or particular specialty as part of their regular programme of work with the support of HPS has been developed. This approach would have a number of advantages.

- There would be a number of personnel within the service developing the skills to undertake prevalence surveillance.
- Prevalence is a relatively cheap and rapid way of estimating all HAI in a hospital. A number of surveys would need to undertaken afterwards to ensure the estimate of the survey was statistically sound.
- There are a number of hospitals within Scotland that do not qualify to be included with-in the incidence programmes undertaken as part of the SSHAIP surveillance, either because they do not undertake sufficient numbers of procedures to qualify or they do not undertake the specific procedures. Prevalence surveillance at a local level would allow such hospitals to monitor their HAI trends at a relatively low cost.

- Specialties with high numbers of HAI which comprise a range of specific infection types (medicine and care of the elderly) might usefully employ this approach to monitor trends and measure the impact of interventions over time.

Recommendations for future local prevalence surveillance:

1. The timing of the survey should be considered, with regards to the season effect.
2. Results of future local surveys should be interpreted with due care in terms of comparing individual hospital prevalence of HAI due to the variation of case mix, underlying health of the population and the season during which the hospital was surveyed.

8.9.1 Objective 9 recommendations

- Continued Prevalence will be supported by HPS and individual infection control teams should undertake surveillance as part of their planned programme of work. HPS input will be in training teams and maintaining the main data set and equipment for the survey, and in epidemiological and statistical support.
- The current data collection tool will be adapted to allow the individual infection control teams to perform simple statistical analysis themselves, using the same analyses that the national survey has used. (Although this would involve transferring the burden of surveillance to the ICTs the costs of undertaking this type of surveillance would be considerably cheaper than the national survey since no additional travel time or costs will be included in the costs and the ICTs will be able to undertake the prevalence surveys at times convenient to them as part of their normal working week.)

Key Summary Point

- A 10 year interval between large scale repeat national prevalence surveys is recommended by the HPS Surveillance Evaluation Review
- When repeated at a national level then a sample of hospitals is sufficient
- Local targeted prevalence surveys could be used more frequently as a cost effective method to investigate the effect of interventions between national prevalence surveys
- Repeated local targeted prevalence surveillance would allow monitoring of areas of particular concern between national surveys
- Repeated local targeted prevalence surveillance would allow monitoring of the effectiveness of prevention measures

9 LIMITATIONS OF THE SURVEY

9.1 Prevalence estimates

In prevalence surveys a cross sectional approach is adopted which is biased towards identifying HAI of longer duration. From a methodological aspect the main limitation in measuring prevalence lies in the application of specified definitions, including HAI case definitions in identifying patients with HAI. Data collectors were trained in the identification of patients with HAI and had easy access to CDC case definitions. Their validity of case reporting was monitored. They were limited to a certain extent however by the availability of information recorded in the many patient records including case notes, nursing records, prescribing records. The extent of microbiological investigation as well as the availability of reports of these and other investigations to data collectors at the time of the survey will also have affected the completeness and accuracy of the HAI diagnosis. An element of subjectivity does enter into the diagnosis of HAI, which had been present for days before the date of the survey. However the well documented protocol, the extensive training of data collectors, ongoing monitoring of performance and validation of data collection will have minimised the potential for bias.

It was not intended to undertake an analysis of intrinsic risk factors for HAI in this survey and these data were not collected. Data will become available from ISD on discharge diagnoses in the future, which will be used in further analyses. Data on extrinsic risk factors such as the presence or absence at the time of the survey of interventions such as peripheral and central venous catheters, urinary catheters and mechanical ventilation were collected and may be utilised in further analyses. However the absence of a specified intervention on the day of the survey may not accurately represent the facts, as catheters and other invasive devices could have been removed prior to the date of the survey. Data on the duration of exposure to specified interventions, which give a more accurate measure of risk, were not collected- this would require an incidence study.

9.2 LOS estimates

Estimates of additional LOS due to HAI are biased by the fact that longer stay patients are overrepresented in the sample and HAI of longer duration are more likely to be counted within a prevalence survey. Prevalence surveys therefore overestimate the LOS of all patients but this overestimation is greater for those patients with HAI.

The prevalence approach used the whole dataset but the approach to sampling created problems by over-representing the patients with a long length of stay. This can be illustrated by thinking about a 10-bedded ward: eight beds are occupied by patients who stay for one whole year, while, the other two beds have a different patient every day. At any given point, there will be 8 patients each with an average stay of 365 days and 2 patients with an average stay of 1 day, so the overall average would be 292 days (8x365 plus 2x1, all divided by 10). However, the calculation of national statistics would look across the whole year so there would be 730 patients with a stay of 1 day plus 8 patients with a stay of 365 days the average stay would be 4.9 days. This illustrates the problem with 'snapshot' approach in that it 'over-represents' patients who stay in hospital for a long time.

A specific limitation of this survey was that due to its size (numbers of acute hospitals and patients) only limited data were collected to adjust crude measures of LOS for factors other than HAI. Other smaller studies, or studies where patient data sets are available for study retrospectively have collected information on a range of indicator variables of risk of long inpatient stay such as: severity of illness, number of diagnoses, conditions arising in hospital, interventions etc. Information was available only on age group and specialty of admission as indicators of underlying illnesses, which might lead to increased LOS independently of HAI and also increase the risk of HAI due to prolonged inpatient stay. Data are awaited on discharge diagnosis/diagnoses which, when available, will be used in further analyses.

9.3 Outbreaks

Average costs have been used and it may be that actual costs of certain HAI exceed the average .e.g. the costs of outbreak have not been included and need to be considered.

One major MRSA outbreak in England was estimated to cost in excess of £400 000 in direct costs alone, excluding those costs associated with increased LOS, additional prescribing, and those arising from staff absence due to infection, or litigation (79).

Further additional costs associated with an outbreak may be those of adverse publicity resulting in loss of confidence in the hospital by the public and significant use of staff time in terms of managing this.

9.4 Economic analyses

The major limitation of the economic analysis is that there is no way to relate the prevalence found in this survey to the incidence of HAI throughout a calendar year.

Since the data required to use the formulae described in the literature (46) to convert prevalence to incidence a rough conversion approach has been to multiply the prevalent patients by the total number of patients who are treated in Scotland within a year. It is acknowledged that this is likely to be an over estimate of the true number of incident cases.

The biases mentioned as limitations of prevalence surveys and of LOS estimates particularly the fact that prevalence surveys overestimate LOS and the limitations of data collection will also affect the economic analyses of the cost of additional bed days. The gold standard reference for calculating costs of additional days due to HAI is the incidence study by Plowman (3) in which the costs were derived directly case by case is a very detailed and therefore costly methodological approach.

For the current survey an indirect method was used and assumptions had to be made to obtain the costs, based on Scottish Health Care Costs 2006, which were applied in the calculations. Calculations of the costs of additional bed days due to HAI, overall and by specialty, have been based on an assumption that the relevant costs are those for laboratory tests, pharmacy and nursing care only. Even with this assumption costs may be overestimated, as later days in a hospital stay are usually cheaper than earlier ones. The use of estimates of additional bed days based on a LOS analysis of patients with and without HAI with only very short hospital stays may compensate to some extent for the above two noted limitations.

9.5 Limitations to using antimicrobial prescribing as a test for HAI

Prevalence surveys only record the status of inpatients at the time of survey. Inpatients will not necessarily have the same status throughout their hospital stay.

It is important to note that during this survey the units of time recorded were days. Information was not included on time of admission and time of administration of first antimicrobial. It is important to note that 48 hours is 2 days and therefore could be anywhere between 36 and 50 hours after admission.

A number of inpatients may have been started on an antimicrobial on or before admission and then subsequent microbiological reports could suggest that a more appropriate therapy should be used and therefore changed prescription. These inpatients may appear to have been prescribed antimicrobials 48 hours or more after admission, but would not all necessarily have a HAI.

Prevalence surveys do not record all the antimicrobial therapies inpatients have been prescribed during their stay in hospital; only the antimicrobials the inpatients were prescribed at the time of the survey.

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11 RECOMMENDATIONS FOR FUTURE WORK

11.1 Objective 1

- Further analyses needs to be undertaken on the burden study component of the study (at specialty level) to look at other factors that may affect prevalence of HAI.

11.2 Objective 2

- Further work is required to analyse the prevalence data with the ISD ICD10 data which would provide information on co-morbidities and allow a more detailed logistic regression analysis to be undertaken.

11.3 Objective 3

- In order to generate the most accurate estimate of the cost of additional stay two things would be desirable:
  - A cohort study of people admitted to hospital that allows incidence to be estimated – if the costs in different specialties are of interest (e.g. haematology, oncology) this should be taken into account in designing the sampling framework
  - A more accurate estimate of the cost of added days of stay related to an infection
- However these would require costly and time consuming studies. It is recommended that the prevalence survey data are re-analysed using ISD discharge data including information on the patients' disease classification (ICD-10) when available which would allow a more specific comparison of patients with and without HAI.

11.4 Objective 4

- An incidence study of HAI and antimicrobial prescription as a proxy indicator should be carried out.

11.5 Objective 5

- Further work is needed in another study to examine the relationship between prevalence and incidence in more detail.

11.6 Objective 6

- Targeted incidence surveillance should be carried out on: Surgical site infection; *Clostridium difficile;* CAUTI (Catheter Associated Urinary Tract Infection), Vascular catheter infections, *Staphylococcus aureus* bacteraemia
- Antimicrobial prescribing should be monitored in Scotland
- Repeated prevalence surveys should be considered for specific specialties (elderly care, medicine), hospitals with small bed numbers where targeted incidence surveillance if of limited value, as a cost effective means of measuring the impact of interventions over time (utilising at least 3 surveys pre and post intervention (69))

11.7 Objective 7

- HPS should focus with NHS boards on targeting interventions where there is the most potential for prevention of HAI. These would be: care and maintenance of devices such as urinary catheters, vascular catheters (peripheral and central) and mechanical ventilation, surgical site infection (pre, peri and post op care), those practices which prevent transmission of infection such as hand hygiene and those practices which prevent and control antimicrobial resistance such as prudent prescribing of antimicrobials.
- Surveillance in settings outside hospitals should be considered in order to establish the burden and focus on required interventions for the prevention of HAI in these settings.

11.8 Objective 8

- Future national prevalence surveys in Scotland should use the methodology described in this study.

11.9 Objective 9

- Continued targeted local prevalence should be supported by HPS.

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APPENDIX 1 - LITERATURE REVIEW

A comprehensive literature review was undertaken for the HAI prevalence survey. The following table summarises multi-hospital (≥4) surveys undertaken from 1990 onwards in Europe. Only the most recent survey reported from an individual country has been included in the table, except in the case of the three surveys undertaken in the UK. The table reports country, year, population surveyed, HAI definitions and prevalence.

Appendix Table 1-1: *Literature review of prevalence*

Reference & publication date	Country	Year of survey	Inpatient population sampled:	Definition of 'a prevalent HCAI'[1]	Case definition	% inpatients with HCAI	Notes
(Smyth et al., 2006) (18)	UK and Eire	2006	Adults 273 acute hospitals, 75,763 patients	c1, c2, c3 met	CDC	UK: 7.6 England: 8.2 Wales: 6.3 N. Ireland: 5.5 Rep of Ireland: 4.9	Volunteer hospitals Local data collectors trained Selected wards within some hospitals
(Eriksen et al., 2005) (22)	Norway	Four surveys in 2002 and 2003	Adults & children 76 non-psychiatric acute hospitals, 11 – 12,000 patients per survey	c1, c2 met	Modified CDC	Range: 5.1 to 5.4 in four surveys	All hospitals involved Local data collectors Only 4 main HAI included
(Zotti et al., 2004) (20)	Regional, Italy	2000	Adults & children > 1year old 60 hospitals, 9467 patients	c1 inpatients ≥24hrs. c2 met	CDC	7.8	All hospitals included Local data collectors trained
(Klavs et al., 2003) (17)	Slovenia	2001 (October)	Adults & children 19 acute care hospitals, 6696 patients	C2 met otherwise not stated	CDC	4.6	All acute hospitals Data collection lead by hospital coordinators
(Gikas et al., 2002) (24)	Greece	1999	Adults & children 5 university, 9 regional hospitals, 3925 patients	c1, c2 met	CDC	8.6	Volunteer hospitals Local data collectors
(Pittet et al., 1999) (23)	Switzerland	1996	Adults & children 4 university acute hospitals, 1349 patients	c1, c2 met	CDC	11.6	4 hospitals involved Trained data collectors and observers Validation of data collection Excludes asymptomatic bacteruria

Reference & publication date	Country	Year of survey	Inpatient population sampled:	Definition of 'a prevalent HCAI'[1]	Case definition	% inpatients with HCAI	Notes
(Vaque et al., 1999)(21)	Spain	Annually 1990 -1997	Adults & children 123-214 acute hospitals, 34,489 - 51,674 patients	C2 met otherwise not stated	CDC excluding asymptomatic bacteruria	1990: 8.5 1997: 6.9	Volunteer hospitals, a large (74) core group participating every year Local data collectors
(Gastmeier et al., 1998) (19)	Germany	1998	Adults 72 acute hospitals, 14,966 patients	c1, c2, c3 met	CDC	3.5	Random selection of hospitals and patients Fully trained external data collectors Data collection validated
(Emmerson et al., 1996) (6)	Second UK Survey	1993-94	Adults & children 157 hospitals, 37,111 patients	c2 met, otherwise not stated	UK	9.0	Volunteer hospitals Local data collectors trained 'Possible',' probable' and 'definite' infections
(Meers, 1981) (5)	First UK Survey – England and Wales	1980	Adults & children 43 hospitals, 18163 patients	c2 met, otherwise not stated	UK	9.2	Volunteer hospitals Local data collectors Excludes geriatric and psychiatric patients. 'Possible',' probable' and 'definite' infections

1 Criteria for definition of 'a prevalent HAI' in HPS (Scotland 2006) survey: c1 arises ≥48 after admission; c2 fully meets survey case definition; c3 partially meets case definition and on antimicrobial treatment

APPENDIX 2 - DATA ITEMS COLLECTED DURING THE SURVEY

Appendix Table 2-1: *Data items collected for each component of the survey*

Data Item	Prevalence (No HAI present)	Prevalence (HAI present)	Burden
WARD SELECTION FORM			
Ward name	✓	✓	✓
Hospital name	✓	✓	✓
Official (administrative) specialty of ward 1,2,3,4	✓	✓	✓
WARD CENSUS			
Hospital	✓	✓	✓
Specialty[1]	✓	✓	✓
Survey Type (Burden or Prevalence)	✓	✓	✓
Date of census	✓	✓	✓
Time of census	✓	✓	✓
Beds occupied by inpatients at time of survey	✓	✓	✓
Beds occupied by patients staying for <24 hrs	✓	✓	✓
Unoccupied beds at time of census	✓	✓	✓
Total available beds at time of census	✓	✓	✓
Number of trained NHS nursing staff on duty	✓	✓	✓
Number of untrained NHS nursing staff on duty	✓	✓	✓
Number of trained agency nursing staff on duty	✓	✓	✓
Number of untrained agency nursing staff on duty	✓	✓	✓
Number of student nursing staff	✓	✓	✓
Comments on data collection	✓	✓	✓
Form completed by	✓	✓	✓
PATIENT DETAILS			
Patient hospital number	✓	✓	✓
Patient date of birth	✓	✓	✓
Gender	✓	✓	✓

Data Item	Prevalence (No HAI present)	Prevalence (HAI present)	Burden
Patients Bed Number	✓	✓	✓
Hospital Specialty responsible for patient care	✓	✓	✓
Date patient was admitted to this hospital	✓	✓	✓
Admission type	✓	✓	✓
Boarder	✓	✓	✓
Patient was transferred from another hospital	✓	✓	✓
Patient was transferred from another hospital ward	✓	✓	✓
Patient was transferred from another hospital ICU	✓	✓	✓
Transferred to ward from own ICU	✓	✓	✓
Patient was transferred from Care home	✓	✓	✓
Comments on data collection	✓	✓	✓
Date of Survey	✓	✓	✓
INFECTION			
HAI	✓	✓	✓
HAI type[2]		✓	✓
MICROBIOLOGY (subject to positive or awaited microbiology report)			
Microbiology specimen(s) status		✓	✓
Organisms identified/isolated/cultured 1, 2, 3, 4		✓	✓
Other organism		✓	✓
SURGERY			
Surgery within the last year		✓	✓
Readmitted with an SSI		✓	✓
Surgery without implant in year preceding survey		✓	✓
Date(s) of surgery (no implant) 1, 2, 3		✓	✓
OPCS Code(s) (no implant)[3]7 1, 2, 3		✓	✓
Other OPCS Code(s) (no implant)		✓	✓
Surgery with implant in last year		✓	✓
Date(s) of surgery (implant) 1, 2, 3		✓	✓

Data Item	Prevalence (No HAI present)	Prevalence (HAI present)	Burden
OPCS Code(s) (implant) [4] 1, 2, 3		✓	✓
Other OPCS Code(s) (implant)		✓	✓
ANTIMICROBIALS			
Patient is Currently receiving Antimicrobial Therapy	✓	✓	✓
Antimicrobial(s) [5] 1, 2, 3, 4	✓	✓	✓
Method of administration 1, 2, 3, 4	✓	✓	✓
Date Started 1, 2, 3, 4	✓	✓	✓
Prescription Type 1, 2, 3, 4	✓	✓	✓
INVASIVE DEVICES			
Invasive Device in situ		✓	✓
Urinary catheter in situ		✓	✓
Peripheral vascular catheter in situ		✓	✓
Number of peripheral vascular catheters in situ		✓	✓
Central vascular catheter in situ		✓	✓
Number of central vascular catheters in situ		✓	✓
Invasive mechanical ventilation in situ		✓	✓
Other invasive device in situ		✓	✓
DISCHARGE DETAILS			
Discharge date		✓	✓
Discharge status		✓	✓

1 Appendix Table 3-1 Mapping of specialty name to high level specialty groups
2 Appendix Table 3-4 Mapping of specific infection sites to high level HAI types
3 Appendix Table 3-2 Mapping of surgical procedures to high level surgery
4 Appendix Table 3-2 Mapping of surgical procedures to high level surgery
5 Appendix Table 3-3 Mapping of antimicrobials to high level antimicrobial groups

APPENDIX 3 - CONTROLLED LISTS

3.1 Specialties

Appendix Table 3-1: *Mapping of specialty name to high level specialty groups*

Specialty Group	Specialty Name
Care of the Elderly	Care of the Elderly - Care of the Elderly
	Care of the Elderly - GP Other than Obstetrics
	Care of the Elderly - Medicine
Dentistry	Dentistry - Oral Surgery
	Dentistry - Oral Medicine
	Dentistry - Orthodontics
	Dentistry - Restorative Dentistry
Gynaecology	Gynaecology - Gynaecology
Haematology	Haematology - Haematology
Medicine	Medicine - General Medicine
	Medicine - Cardiology
	Medicine - Clinical Genetics
	Medicine - Infectious Diseases
	Medicine - Dermatology
	Medicine - Endocrinology
	Medicine - Gastroenterology
	Medicine - Genito-Urinary Medicine
	Medicine - Medical Oncology
	Medicine - Renal Medicine
	Medicine - Neurology
	Medicine - Palliative Medicine
	Medicine - Rehabilitation Medicine
	Medicine - Respiratory Medicine
	Medicine - Rheumatology

Specialty Group	Specialty Name
Obstetrics	Obstetrics - GP Obstetrics
	Obstetrics - Obstetrics
	Obstetrics - Midwifery
Oncology	Oncology - Clinical Radiology
	Oncology - Clinical Oncology
Orthopaedics	Orthopaedics - Trauma & Orthopaedic Surgery
Other	Other
Pathology	Pathology - Chemical Pathology
Podiatry	Podiatry - Surgical Podiatry
Psychiatry	Psychiatry - General Psychiatry
	Psychiatry - Adolescent Psychiatry
	Psychiatry - Forensic Psychiatry
	Psychiatry - Psychiatry of Old Age
Surgery	Surgery - General Surgery
	Surgery - Vascular Surgery
	Surgery - Accident & Emergency
	Surgery - Anaesthetics
	Surgery - Cardiothoracic Surgery
	Surgery - Cardiac Surgery
	Surgery - Thoracic Surgery
	Surgery - Ear, Nose & Throat
	Surgery - Neurosurgery
	Surgery - Ophthalmology
	Surgery - Plastic Surgery
Urology	Urology - Urology

3.2 Surgery

Appendix Table 3-2: *Mapping of surgical procedures to high level surgery type*

Surgery Type	Surgical Procedures
Arteries and Veins	Arteries and Veins - Varicose vein surgery
	Arteries and Veins - Vascular surgery
Bones and Joints	Bones and Joints - Open reduction of fracture
	Bones and Joints - Hip prosthesis
	Bones and Joints - Knee prosthesis
	Bones and Joints - Other musculo-skeletal surgery
Cardiovascular	Cardiovascular - CABG chest and leg/radial (donor incision)
	Cardiovascular - CABG – chest only (donor incision e.g. mammary artery)
	Cardiovascular - Cardiac Surgery
	Cardiovascular - Heart valve replacement or repair of congenital defect
	Cardiovascular - Other cardiovascular surgery
Digestive tract	Digestive tract - Stomach surgery
	Digestive tract - Small intestine surgery
	Digestive tract - Large intestine surgery
	Digestive tract - Cholecystectomy
	Digestive tract - Appendectomy
	Digestive tract - Other surgery of the digestive tract
Endocrine and Breast	Endocrine and Breast - Mastectomy
	Endocrine and Breast - Thyroidectomy
	Endocrine and Breast - Other surgery of the endocrine system
Eye	Eye - Cataract surgery
	Eye - Other eye surgery
Female Genital	Female Genital - Vaginal hysterectomy
	Female Genital - Abdominal hysterectomy
	Female Genital - Other obstetric problem
Head	Head - Surgery of the head and neck

Surgery Type	Surgical Procedures
Head	Head - Surgery of the ear, nose or throat
Misc	Misc - Limb amputation
	Misc - Other prosthetic surgery
	Misc - Any other surgical procedure/intervention
Other	Other
Other abdominal surgery	Other abdominal surgery - Liver or pancreas surgery
	Other abdominal surgery - Laparotomy
	Other abdominal surgery - Repair of haemorrhoids
	Other abdominal surgery - Herniorrhaphy
	Other abdominal surgery - Splenectomy
	Other abdominal surgery - Other surgery haem/lymph system
	Other abdominal surgery - Organ transplant
Pregnancy	Pregnancy - Caesarean section
Respiratory	Respiratory - Other respiratory system surgery
Skin	Skin - Skin graft
Skull and Spine	Skull and Spine - Craniotomy
	Skull and Spine - Ventricular shunt
	Skull and Spine - Other surgery of the CNS
	Skull and Spine - Spinal fusion
	Skull and Spine - Laminectomy
Soft Tissue	Soft Tissue - Other surgery of the integumentary system
Thoracic	Thoracic - Thoracic surgery
Urinary	Urinary - Nephrectomy
	Urinary - Prostatectomy
	Urinary - Other surgery genitourinary system (except hysterectomy and CS)

3.3 Antimicrobials

Appendix Table 3-3 *Mapping of antimicrobials to high level antimicrobial groups*

Antimicrobial Group	Antimicrobial Name
Aminoglycosides	Amikacin
	Framycentin sulphate
	Gentamicin
	Neomycin
	Netilmicin
	Capreomycin
	Streptomycin
	Tobramycin
Antifungal	Amorolfine
	Benzoic Acid
	Clotrimazole
	Econazole Nitrate
	Sulconazole Nitrate
	Tioconazole
	Undecenoates
	Amphotericin
	Caspofungin
	Fluconazole
	Flucytosine
	Griseofulvin
	Itraconazole
	Ketoconazole
	Miconazole
	Nystatin
	Terbinafine
	Voriconazole

Antimicrobial Group	Antimicrobial Name
Antiviral	Cidofovir
	Didanosine
	Efavirenz
	Emtricitabine
	Enfuvirtide
	Famciclovir
	Fosamprenavir
	Foscarnet Sodium
	Ganciclovir
	Indinavir
	Inosine Pranobex
	Interferon beta
	Interferon beta-1a
	Lamivudine
	Lopinavir With Ritonavir
	Nelfinavir
	Nevirapine
	Oseltamivir
	Palivizumab
	Ribavirin
	Ritonavir
	Saquinavir
	Stavudine
	Tenofovir disoproxil
	Valaciclovir
	Valganciclovir
	Zalcitabine
	Zanamivir
	Zidovudine

Antimicrobial Group	Antimicrobial Name
Antiviral	Abacavir
	Aciclovir
	Adefovir Dipivoxil
	Amantadine Hydrochloride
	Amprenavir
	Atazanavir
	Penciclovir
Carbapenems and Monobactams	Ertapenem
	Imipenem With Cilastatin
	Meropenem
	Aztreonam
Cephalosporins	Cefalexin
	Cefixime
	Cefotaxime
	Cefoxitin
	Cefpirome
	Cefpodoxime
	Cefprozil
	Cefradine
	Ceftazidime
	Ceftriaxone
	Cefuroxime
	Cefradine
	Cefaclor
	Cefadroxil
Glycopeptide	Teicoplanin
	Vancomycin
Macrolides, Lincosamides, Streptogramin	Clarithromycin
	Clindamycin

Antimicrobial Group	Antimicrobial Name
Macrolides, Lincosamides, Streptogramin	Erythromycin
	Azithromycin
	Quinupristin with Dalfopristin
	Telithromycin
Other	Other Drugs
	Salicylates
	Salicylic Acid
	Chloramphenicol
	Clioquinol
	Clofazimine
	Colistin
	Cycloserine
	Dapsone
	Ethambutol Hydrochloride
	Fusidic Acid
	Isoniazid
	Linezolid
	Methenamine hippurate
	Metronidazole
	Mupirocin
	Nitrofurantoin
	Polymyxin B Sulphate
	Propamidine Isetionate
	Pyrazinamide
	Rifabutin
	Rifampicin
	Tindazole
	Not Known
Penicillins	Amoxycillin

Antimicrobial Group	Antimicrobial Name
Penicillins	Co-Amoxiclav
	Co-Fluampicil
	Ampicillin
	Flucloxacillin
	Benzylpenicillin
	Penicillin
	Phenoxymethylpenicillin
	Piperacillin
	Pivmecillinam Hydrochloride
	Tazocin
	Ticarcillin
Quinolones	Ciprofloxacin
	Levofloxacin
	Moxifloxacin
	Nalidixic
	Norfloxacin
	Ofloxacin
Sulphonamides and Trimethoprim	Silver sulphadiazine
	Sultrin Cream
	Co-Trimoxazole
	Sulphadiazine
	Trimethoprim
Tetracyclines	Demeclocycline
	Doxycycline
	Lymecycline
	Minocycline
	Oxytetracycline
	Tetracycline

3.4 HAI types

Appendix Table 3-4: *Mapping of specific infection sites to high level HAI types*

HAI Type	Specific Site of Infection
Urinary Tract Infection	Asymptomatic Urinary Tract Infection
	Other Infections of the Urinary Tract
	Symptomatic Urinary Tract Infection
Systemic Infection	Disseminated Infection
Skin & Soft Tissue Infection	Skin Infection
	Soft Tissue Infection
	Infected Burn
	Decubitus Ulcer
	Breast Abscess or Mastitis
Surgical Site Infection	Superfical Incisional Surgical Site Infection
	Deep Incisional Surgical Site Infection
	Organ\Space Surgical Site Infection
Reproductive System Infection	Endometritis
	Episiotomy Site Infection
	Vaginal Cuff infections
	Other Infections of the Male and Female Reproductive Tract
Pneumonia	Pneumonia
Lower Respiratory Tract Infection other than Pneumonia	Tracheobronchial
	Other Lower
Gastrointestinal Infection	Gastroenteritis
	Gastro Intestinal Tract Infection
	Intra Abdominal Infection
	Viral Hepatitis

HAI Type	Specific Site of Infection
Eye, Ear, Nose, Throat & Mouth Infection	Otitis Media
	Otitis Interna
	Mastoiditis
	Upper Respiratory Tract
	Conjunctivitis
	Eye Infection other than conjunctivitis
	Oral cavity
	Sinustis
	Otitis Externa
Cardiovascular System Infection	Arterial, Venous Infection
	Mediastinitis
	Endocarditis
	Myocarditis or Pericarditis
Central Nervous System Infection	Meningitis or Ventriculitis
	Spinal Abscess without Meningitis
	Intracranial Infection
Bloodstream Infection	Laboratory Confirmed Bloodstream
	Clinical Sepsis
Bone & Joint Infection	Osteomyelitis
	Joint or Bursa
	Disc Space Infection

APPENDIX 4 - DEMOGRAPHIC TABLES

4.1 Age and gender

Appendix Table 4-1: *Acute Hospitals. Number and percentage of inpatients surveyed by age group and gender*

Age	Female		Male		All Inpatients	
	N	%	N	%	N	%
16-19	95	1.4	50	1.0	145	1.3
20-24	158	2.3	82	1.7	240	2.1
25-29	204	3.0	84	1.7	288	2.5
30-34	243	3.6	99	2.0	342	3.0
35-39	242	3.6	145	3.0	387	3.3
40-44	187	2.8	181	3.7	368	3.2
45-49	205	3.0	208	4.3	413	3.6
50-54	241	3.6	266	5.5	507	4.4
55-59	335	5.0	341	7.0	676	5.8
60-64	396	5.9	452	9.3	848	7.3
65-69	531	7.9	531	10.9	1 062	9.2
70-74	671	9.9	615	12.7	1 286	11.1
75-79	889	13.2	645	13.3	1 534	13.2
80-84	985	14.6	611	12.6	1 596	13.8
85-89	817	12.1	373	7.7	1 190	10.3
90-94	423	6.3	133	2.7	556	4.8
95+	123	1.8	31	0.6	154	1.3
Missing	5	0.1	11	0.2	16	0.1
Total	**6 750**	**100.0**	**4 858**	**100.0**	**11 608**	**100.0**

Appendix Table 4-2: *Non-acute Hospitals. Number and percentage of inpatients surveyed by age group and gender*

Age	Female		Male		All Inpatients	
	N	%	N	%	N	%
16-19	3	0.3	8	0.8	11	0.5
20-24	14	1.2	25	2.6	39	1.8
25-29	16	1.4	43	4.5	59	2.8
30-34	15	1.3	41	4.3	56	2.6
35-39	21	1.8	38	4.0	59	2.8
40-44	31	2.6	46	4.8	77	3.6
45-49	36	3.0	45	4.7	81	3.8
50-54	23	1.9	36	3.8	59	2.8
55-59	31	2.6	43	4.5	74	3.5
60-64	40	3.4	68	7.1	108	5.0
65-69	52	4.4	73	7.6	125	5.8
70-74	98	8.3	93	9.7	191	8.9
75-79	154	13.0	128	13.4	282	13.1
80-84	241	20.3	137	14.3	378	17.6
85-89	231	19.4	84	8.8	315	14.7
90-94	130	10.9	38	4.0	168	7.8
95+	52	4.4	10	1.0	62	2.9
Missing	0	0.0	2	0.2	2	0.1
Total	**1 188**	**100.0**	**958**	**100.0**	**2146**	**100.0**

4.2 Hospitals

Appendix Table 4-3: *Acute Hospitals. Categories used to describe each hospital, the season it was surveyed in and its size*

NHS Boards	Hospital Code	Hospital	Subtype	Hospital Size[1]	Quarter[2]	Inpatients Surveyed
Ayrshire & Arran	A103	Ayrshire Central Hospital	General	Medium	3	174
	A111	Crosshouse Hospital	General	Large	3	451
	A210	Ayr Hospital	General	Medium	2	280
Borders	B120	Borders General Hospital	General	Medium	2	247
Argyll & Clyde	C121	Lorn & Islands District Hospital	General	Small	2	66
	C206	Vale of Leven District Hospital	General	Medium	3	152
	C313	Inverclyde Royal Hospital	General	Medium	1	222
	C418	Royal Alexandra Hospital	General	Large	2	483
National Hospital	D102	Golden Jubilee National Hospital	General	Small	3	45
Fife	F704	Victoria Hospital, Kirkaldy	General	Medium	2	241
	F705	Forth Park Hospital	Obstetric	Small	2	47
	F805	Queen Margaret Hospital	General	Medium	4	318
Glasgow	G107	Glasgow Royal Infirmary	Teaching	Large	1	545
	G108	Princess Royal Maternity Hospital	Obstetric	Small	1	42
	G207	Stobhill Hospital	Teaching	Large	1	338
	G306	Victoria Hospital, Glasgow	General	Medium	4	474
	G405	Southern General Hospital	General	Large	3	614
	G505	Gartnavel General Hospital	General	Large	3	323

NHS Boards	Hospital Code	Hospital	Subtype	Hospital Size[1]	Quarter[2]	Inpatients Surveyed
Glasgow	G515	Queen Mother's Hospital	Obstetric	Small	3	26
	G516	Western Infirmary	Teaching	Large	4	334
Highlands	H103	Caithness General Hospital	General	Small	4	44
	H202	Raigmore Hospital	General	Large	1	406
	H212	Belford Hospital	General	Small	4	17
	H214	Mackinnon Memorial Hospital	General	Small	1	13
	H217	Ross Memorial Hospital	General	Very Small	2	18
Lanarkshire	L106	Monklands Hospital	General	Large	1	415
	L302	Hairmyres Hospital	General	Large	2	423
	L308	Wishaw General Hospital	General	Large	1	436
Grampian	N101	Aberdeen Royal Infirmary	Teaching	Large	2	711
	N102	Woodend Hospital	General	Medium	4	367
	N161	Aberdeen Maternity Hospital	Obstetric	Small	4	54
	N411	Dr Gray's Hospital	General	Small	3	122
Orkney	R101	Balfour Hospital	General	Small	4	32
Lothian	S116	Western General Hospital	Teaching	Large	2	453
	S308	St John's Hospital at Howden	General	Large	4	354
	S314	Royal Infirmary of Edinburgh	Teaching	Large	3	577
Tayside	T101	Ninewells Hospital	Teaching	Large	4	604
	T202	Perth Royal Infirmary	General	Medium	4	197
	T312	Stracathro Hospital	General	Small	4	22

NHS Boards	Hospital Code	Hospital	Subtype	Hospital Size[1]	Quarter[2]	Inpatients Surveyed
Forth Valley	V102	Falkirk & District Royal Infirmary	General	Medium	2	192
	V201	Stirling Royal Infirmary	General	Medium	2	310
Western Isles	W107	Western Isles Hospital	General	Small	1	119
Dumfries & Galloway	Y104	Dumfries & Galloway Royal Infirmary	General	Medium	3	261
	Y111	Garrick Hospital	General	Very Small	3	12
Shetland	Z102	Gilbert Bain Hospital	General	Small	1	27

1 Size classes based on anticipated bed numbers: Large > 500 beds, Medium 250-499 beds, Small 50-249 beds, Very Small <50 beds

2 Quarter that the hospital was surveyed in: 1 = Oct 05 - Jan 06, 2 = Feb 06 - April 06, 3 = May 06 - Jul 06, 4 = Aug 06 - Oct 06.

Appendix Table 4-4: *Non-acute Hospitals. Categories used to describe each hospital, the season it was surveyed in and its size*

NHS Boards	Hospital Code	Hospital	Hospital Size[1]	Quarter[2]	Inpatients Surveyed
Ayrshire & Arran	A105	Kirklandside Hospital	Small	3	46
	A201	Ailsa Hospital	Large	3	201
	A207	Davidson Hospital	Very Small	4	13
	A208	Biggart Hospital	Medium	3	144
Borders	B114	Kelso Hospital	Very Small	3	20
Argyll & Clyde	C101	Argyll & Bute Hospital	Small	4	63
	C403	Dykebar Hospital	Large	3	218
Fife	F701	Cameron Hospital	Small	3	86
Glasgow	G109	Lightburn Hospital	Small	3	100
Highlands	H106	Lawson Memorial Hospital	Very Small	3	7
	H223	The New Craigs Hospital	Medium	3	97
Lanarkshire	L203	Cleland Hospital	Small	3	37
Grampian	N198	Royal Cornhill Hospital	Large	3	285
Lothian	S114	Royal Victoria Hospital, Edinburgh	Medium	2	194
	S209	Liberton Hospital	Medium	3	157
Tayside	T107	Royal Victoria Hospital, Dundee	Medium	4	156
	T215	Murray Royal Hospital	Medium	3	114
Forth Valley	V105	Bo'ness Hospital	Very Small	3	39
	V202	Bannockburn Hospital	Small	2	72
Western Isles	W108	Uist and Barra Hospital	Very Small	4	16
Dumfries & Galloway	Y103	Crichton Royal Hospital	Small	3	48
Shetland	Z103	Montfield Hospital	Very Small	1	33

1 Size classes based on expected bed numbers: Large > 249 beds, Medium 150 – 249 beds, Small 50-149 beds, Very Small <50 beds

2 Quarter that the hospital was surveyed in: 1 = Oct 05 - Jan 06, 2 = Feb 06 - April 06, 3 = May 06 - Jul 06, 4 = Aug 06 - Oct 06

4.3 Specialty

Appendix Table 4-5: *Acute Hospitals. Number and percentage of inpatients surveyed by admission specialty*

Specialty Name	Inpatients Surveyed	
	N	%
Care of the Elderly - Care of the Elderly	227	2.0
Care of the Elderly - GP Other than Obstetrics	7	0.1
Care of the Elderly - Medicine	1 443	12.4
Dentistry - Oral Surgery	16	0.1
Gynaecology - Gynaecology	208	1.8
Haematology - Haematology	120	1.0
Medicine - General Medicine	2 419	20.8
Medicine - Cardiology	453	3.9
Medicine - Clinical Genetics	1	0.0
Medicine - Infectious Diseases	105	0.9
Medicine - Dermatology	65	0.6
Medicine - Endocrinology	47	0.4
Medicine - Gastroenterology	227	2.0
Medicine - Genito-Urinary Medicine	1	0.0
Medicine - Medical Oncology	152	1.3
Medicine - Renal Medicine	145	1.2
Medicine - Neurology	105	0.9
Medicine - Palliative Medicine	60	0.5
Medicine - Rehabilitation Medicine	882	7.6
Medicine - Respiratory Medicine	424	3.7
Medicine - Rheumatology	46	0.4
Obstetrics - Obstetrics	352	3.0

Specialty Name	Inpatients Surveyed	
	N	%
Obstetrics - Midwifery	94	0.8
Oncology - Clinical Oncology	136	1.2
Orthopaedics - Trauma & Orthopaedic Surgery	1 145	9.9
Homeopathy[1]	10	0.1
Psychiatry - General Psychiatry	169	1.5
Psychiatry - Psychiatry of Old Age	87	0.7
Surgery - General Surgery	1 368	11.8
Surgery - Vascular Surgery	184	1.6
Surgery - Accident & Emergency	1	0.0
Surgery - Anaesthetics	130	1.1
Surgery - Cardiothoracic Surgery	85	0.7
Surgery - Cardiac Surgery	38	0.3
Surgery - Thoracic Surgery	17	0.1
Surgery - Ear, Nose & Throat	160	1.4
Surgery - Neurosurgery	91	0.8
Surgery - Ophthalmology	37	0.3
Surgery - Plastic Surgery	96	0.8
Urology - Urology	255	2.2
Total	**11 608**	**100.0**

1 All Homeopathy inpatients were originally categorised as "Other" specialty group

Appendix Table 4-6: *Non-acute Hospitals. Number and percentage of inpatients surveyed by admission specialty*

Specialty Name	Inpatients Surveyed	
	N	%
Care of the Elderly - Care of the Elderly	250	11.6
Care of the Elderly - GP Other than Obstetrics	12	0.6
Care of the Elderly - Medicine	174	8.1
Medicine - General Medicine	71	3.3
Medicine - Neurology	10	0.5
Medicine - Palliative Medicine	19	0.9
Medicine - Rehabilitation Medicine	463	21.6
Orthopaedics - Trauma & Orthopaedic Surgery	14	0.7
Psychiatry - General Psychiatry	615	28.7
Psychiatry - Forensic Psychiatry	56	2.6
Psychiatry - Psychiatry of Old Age	456	21.2
Surgery - General Surgery	1	0.0
Surgery - Vascular Surgery	3	0.1
Surgery - Neurosurgery	1	0.0
Urology - Urology	1	0.0
Total	**2 146**	**100.0**

4.4 Admission type

Appendix Table 4-7: *Acute Hospitals. Number and percentage of inpatients surveyed by admission type*

Admission Type	Inpatients	
	N	%
Planned	2 776	23.9
Unplanned	8 832	76.1
Total	**11 608**	**100.0**

Appendix Table 4-8: *Non-acute Hospitals. Number and percentage of inpatients surveyed by admission type*

Admission Type	Inpatients	
	N	%
Not Available	1	0.1
Planned	944	44.0
Unplanned	1 201	56.0
Total	**2 146**	**100.0**

Appendix Table 4-9: *Acute Hospitals. Summary of inpatient age by gender*

	Mean	Mode	Median	Interquartile Range
Male	65.9	80	69	56 - 79
Female	67.6	86	74	56 - 83
Total	**66.9**	**80**	**72**	**56 - 81**

Appendix Table 4-10: *Non-acute Hospitals. Summary of inpatient age by gender*

	Mean	Mode	Median	Inter-quartile Range
Male	64.4	80	70	49 - 80
Female	75.5	86	81	71 - 86
Total	**70.5**	**86**	**77**	**60 - 85**

4.5 Boarders

Appendix Table 4-11: *Acute Hospitals. Number and percentage of inpatients in each specialty group that were boarding at the time of survey*

Specialty Group	Boarders	
	N	%
Care of the Elderly	13	0.8
Dentistry	0	0.0
Gynaecology	0	0.0
Haematology	2	1.7
Medicine	327	6.4
Obstetrics	0	0.0
Oncology	3	2.2
Orthopaedics	14	1.2
Other	0	0.0
Psychiatry	0	0.0
Surgery	57	2.6
Urology	7	2.7
Total	**423**	**3.6**

Appendix Table 4-12: *Non-acute Hospitals. Number and percentage of inpatients in each specialty group that were boarding at the time of survey*

Specialty Group	Boarders	
	N	%
Care of the Elderly	0	0.0
Medicine	6	1.1
Orthopaedics	0	0.0
Psychiatry	0	0.0
Surgery	1	20.0
Urology	1	100.0
Total	**8**	**0.4**

APPENDIX 5 - THE PREVALENCE OF HAI

5.1 Overall prevalence

Appendix Table 5-1: *Acute Hospitals. Number and percentage of inpatients diagnosed with HAI using 'CDC' and 'Therapy' criteria*

HAI Diagnosis Type[1]						
	'Therapy' HAI					
'CDC' HAI	No		Yes		Total	
	N	%	N	%	N	%
No	0	0.0	412	33.1	412	33.1
Yes	277	22.3	554	44.6	831	66.9
Total	**277**	**22.3**	**966**	**77.7**	**1 243**	**100.0**

Appendix Table 5-2: *Non-acute Hospitals. Number and percentage of inpatients diagnosed with HAI using 'CDC' and 'Therapy' criteria. Refer to Section 6.2.5 for HAI diagnosis types*

HAI Diagnosis Type[2]						
	'Therapy' HAI					
'CDC' HAI	No		Yes		Total	
	N	%	N	%	N	%
No	0	0.0	67	40.9	67	40.9
Yes	20	12.2	77	47.0	97	59.1
Total	**20**	**12.2**	**144**	**87.8**	**164**	**100.0**

1 Refer to Section 6.2.5 for HAI diagnosis types

2 Refer to Section 6.2.5 for HAI diagnosis types

5.2 Prevalence by HAI Type

The following tables summarise prevalence by HAI type and also illustrate the number of inpatients diagnosed with multiple infections for each HAI type. The total count for each HAI type includes inpatients with only one infection, and those with multiple infections of different types.

Appendix Table 5-3: *Acute Hospitals. Inpatients with HAI categorised by HAI type*

HAI Type	Inpatients with Single HAI	Inpatients with Multiple HAI	Total Number of Inpatients with HAI	Prevalence of HAI[1]
	(A)	(B)	(A + B)	(A + B) / Total x 100
	N	N	N	%
Bone and Joint	1	5	6	0.1
Blood Stream Infection	37	18	55	0.5
Central Nervous System	1	1	2	0.0
Cardiovascular System Infections	7	4	11	0.1
Eye, Ear, Nose, Throat or Mouth[2]	118	36	154	1.3
Gastrointestinal	145	46	191	1.6
Lower Respiratory Tract Infection other than Pneumonia	112	27	139	1.2
Pneumonia	86	23	109	0.9
Reproductive System Infections	12	5	17	0.1
Systemic Infection	1	1	2	0.0
Skin and Soft Tissue Infection	113	24	137	1.2
Surgical Site Infection	163	34	197	1.7
Urinary Tract Infection	181	40	221	1.9

1 Total = Count of all surveyed inpatients in Acute hospitals

2 One patient has two infections of the same broad type. As a single patient, they are only counted once in the table

Appendix Table 5-4: *Non-acute Hospitals. Inpatients with HAI categorised by HAI type*

HAI Type	Inpatients with Single HAI (A) N	Inpatients with Multiple HAI (B) N	Total Number of Inpatients with HAI (A + B) N	Prevalence of HAI[1] (A + B) / Total x 100 %
Bone and Joint	1	0	1	0.0
Cardiovascular System Infections	1	0	1	0.0
Eye, Ear, Nose, Throat or Mouth	21	1	22	1.0
Gastrointestinal	18	2	20	0.9
Lower Respiratory Tract Infection other than Pneumonia	16	3	19	0.9
Pneumonia	4	0	4	0.2
Reproductive System Infections	2	0	2	0.1
Skin and Soft Tissue Infection[2]	40	3	43	2.0
Surgical Site Infection	4	1	5	0.2
Urinary Tract Infection	43	3	46	2.1

1 Total = Count of all surveyed inpatients in non-acute hospitals

2 One patient has two infections of the same broad type. As a single patient, they are only counted once in the table

Appendix Table 5-5: *Acute Hospitals. Number and percentage of HAI cases categorised by specific site of infection*

HAI Type	Specific Site of Infection	HAI Cases	
		N	%
BJ	Osteomyelitis	4	0.3
	Joint or Bursa	2	0.2
BSI	Laboratory Confirmed Bloodstream	43	3.5
	Clinical Sepsis	12	1.0
CNS	Meningitis or Ventriculitis	1	0.1
	Spinal Abscess without Meningitis	1	0.1
CVS	Arterial, Venous Infection	7	0.6
	Endocarditis	4	0.3
EENTM	Otitis Interna	1	0.1
	Upper Respiratory Tract	2	0.2
	Conjunctivitis	41	3.3
	Eye Infection other than conjunctivitis	3	0.2
	Oral cavity	107	8.6
	Sinustis	1	0.1
GI	Gastroenteritis	185	14.9
	Gastro Intestinal Tract Infection	2	0.2
	Intra Abdominal Infection	4	0.3
LRI	Tracheobronchial	138	11.1
	Other Lower	1	0.1
PNEU	Pneumonia	109	8.8
RSI	Episiotomy Site Infection	1	0.1
	Other Infections of the Male and Female Reproductive Tract	16	1.3
SSI	Superfical Incisional Surgical Site Infection	70	5.6

HAI Type	Specific Site of Infection	HAI Cases	
		N	%
SSI	Deep Incisional Surgical Site Infection	75	6.0
	Organ\Space Surgical Site Infection	52	4.2
SST	Skin Infection	48	3.9
	Soft Tissue Infection	80	6.4
	Decubitus Ulcer	9	0.7
SYS	Disseminated Infection	2	0.2
UTI	Asymptomatic Urinary Tract Infection	67	5.4
	Other Infections of the Urinary Tract	5	0.4
	Symptomatic Urinary Tract Infection	150	12.1
	Total	**1 243**	**100.0**

Appendix Table 5-6: *Non-acute Hospitals. Number and percentage of HAI cases categorised by specific site of infection*

HAI Type	Specific Site of Infection	HAI Cases	
		N	%
BJ	Osteomyelitis	1	0.6
CVS	Arterial,Venous Infection	1	0.6
EENTM	Upper Respiratory Tract	1	0.6
	Conjunctivitis	7	4.3
	Oral cavity	14	8.5
GI	Gastroenteritis	20	12.2
LRI	Tracheobronchial	19	11.6
PNEU	Pneumonia	4	2.4
RSI	Other Infections of the Male and Female Reproductive Tract	2	1.2
SSI	Superfical Incisional Surgical Site Infection	2	1.2
	Deep Incisional Surgical Site Infection	2	1.2
	Organ\Space Surgical Site Infection	1	0.6
SST	Skin Infection	29	17.7
	Soft Tissue Infection	13	7.9
	Decubitus Ulcer	2	1.2
UTI	Asymptomatic Urinary Tract Infection	8	4.9
	Other Infections of the Urinary Tract	3	1.8
	Symptomatic Urinary Tract Infection	35	21.3
	Total	**164**	**100.0**

5.3 Prevalence by age and gender

Appendix Table 5-7: *Acute Hospitals. Prevalence of HAI for inpatients categorised by age group and gender*

Age Group	Female Inpatients			Male Inpatients			Total Inpatients		
	Inpatients with HAI		95% CI	Inpatients with HAI		95% CI	Inpatients with HAI		95% CI
	N	%		N	%		N	%	
16-19	3	3.2	(0.0 - 6.7)	3	6	(0.0 - 12.5)	6	4.1	(0.9 - 7.4)
20-24	2	1.3	(0.0 - 3.0)	6	7.3	(1.6 - 13.1)	8	3.3	(0.8 - 5.9)
25-29	8	3.9	(1.2 - 6.6)	4	4.8	(0.2 - 9.3)	12	4.2	(1.8 - 6.5)
30-34	4	1.6	(0.0 - 3.3)	3	3	(0.0 - 6.4)	7	2	(0.5 - 3.5)
35-39	3	1.2	(0.0 - 2.6)	14	9.7	(4.9 - 14.4)	17	4.4	(2.4 - 6.4)
40-44	8	4.3	(1.4 - 7.2)	12	6.6	(3.0 - 10.2)	20	5.4	(3.0 - 7.8)
45-49	11	5.4	(1.7 - 9.1)	16	7.7	(4.2 - 11.2)	27	6.5	(3.9 - 9.1)
50-54	16	6.6	(3.6 - 9.7)	20	7.5	(4.0 - 11.1)	36	7.1	(4.7 - 9.5)
55-59	27	8.1	(5.2 - 10.9)	21	6.2	(3.6 - 8.7)	48	7.1	(5.1 - 9.1)
60-64	44	11.1	(7.9 - 14.3)	54	11.9	(8.7 - 15.2)	98	11.6	(9.1 - 14.0)
65-69	57	10.7	(8.1 - 13.4)	57	10.7	(7.9 - 13.5)	114	10.7	(8.8 - 12.6)
70-74	77	11.5	(9.0 - 13.9)	63	10.2	(7.8 - 12.7)	140	10.9	(9.1 - 12.6)
75-79	86	9.7	(7.7 - 11.7)	85	13.2	(10.6 - 15.8)	171	11.1	(9.5 - 12.8)
80-84	112	11.4	(9.3 - 13.5)	69	11.3	(8.5 - 14.1)	181	11.3	(9.6 - 13.0)
85-89	81	9.9	(7.8 - 12.1)	56	15	(11.2 - 18.9)	137	11.5	(9.6 - 13.5)
90-94	47	11.1	(8.1 - 14.1)	20	15	(9.0 21.1)	67	12.1	(9.4 - 14.7)
95+	11	8.9	(3.6 - 14.3)	3	9.7	(0.0 - 19.8)	14	9.1	(4.5 - 13.7)
Missing	0	0	- -	0	0	- -	0	0	- -
Total	**597**	**8.8**	**(8.0 - 9.7)**	**506**	**10.4**	**(9.4 - 11.5)**	**1 103**	**9.5**	**(8.8 - 10.2)**

Appendix Table 5-8: *Non-acute Hospitals. Prevalence of HAI for inpatients categorised by age group and gender*

Age Group	Female Inpatients			Male Inpatients			Total Inpatients		
	Inpatients with HAI		95% CI	Inpatients with HAI		95% CI	Inpatients with HAI		95% CI
	N	%		N	%		N	%	
16-19	0	0	- -	0	0	- -	0	0	- -
20-24	0	0	- -	0	0	- -	0	0	- -
25-29	0	0	- -	0	0	- -	0	0	- -
30-34	0	0	- -	2	4.9	(0.0 - 11.3)	2	3.6	(1.2 - 8.4)
35-39	0	0	- -	0	0	- -	0	0	- -
40-44	0	0	- -	2	4.3	(0.0 - 10.1)	2	2.6	(0.8 - 6.0)
45-49	2	5.6	(0.0 - 12.4)	1	2.2	(0.0 - 6.6)	3	3.7	(0.3 - 7.7)
50-54	2	8.7	(0.0 - 18.9)	2	5.6	(0.0 - 13.2)	4	6.8	(0.4 - 14.0)
55-59	1	3.2	(0.0 - 8.3)	1	2.3	(0.0 - 6.8)	2	2.7	(0.7 - 6.1)
60-64	1	2.5	(0.0 - 7.0)	5	7.4	(1.9 - 12.8)	6	5.6	(1.7 - 9.4)
65-69	5	9.6	(2.2 - 17.0)	1	1.4	(0.0 - 4.0)	6	4.8	(1.2 - 8.4)
70-74	7	7.1	(2.3 - 12.0)	13	14	(7.5 - 20.4)	20	10.5	(6.6 - 14.3)
75-79	10	6.5	(1.8 - 11.2)	9	7	(2.8 - 11.2)	19	6.7	(3.5 - 10.0)
80-84	24	10	(6.5 - 13.4)	12	8.8	(4.1 - 13.4)	36	9.5	(6.5 - 12.6)
85-89	27	11.7	(7.4 - 16.0)	6	7.1	(1.9 - 12.4)	33	10.5	(7.0 - 14.0)
90-94	13	10	(5.6 - 14.4)	4	10.5	(1.4 - 19.7)	17	10.1	(6.4 - 13.8)
95+	7	13.5	(3.1 - 23.8)	0	0	- -	7	11.3	(2.5 - 20.1)
Missing	-	-	- -	0	0	- -	0	0	- -
Total	**99**	**8.3**	**(6.7 - 10.0)**	**58**	**6.1**	**(4.4 - 7.7)**	**157**	**7.3**	**(6.0 - 8.6)**

Appendix Table 5-9: *Acute Hospitals. Number of HAI cases by specialty group and HAI type*

Specialty Group	HAI Type														Prevalence by specialty	Total Inpatients
	BJ	BSI	CNS	CVS	EENTM	GI	LRI	PNE	RSI	SI	SSI	SST	UTI	Multiple[1]		
	N	N	N	N	N	N	N	N	N	N	N	N	N	N	%	N
Care of the Elderly		4		2	27	33	21	16	1			24	49	22	11.9	1 677
Dentistry							1				1				12.5	16
Gynaecology					1	2					4		2	1	4.9	208
Haematology		1		1		1		1			1		1	2	6.7	120
Medicine		20		4	65	83	50	36	5		31	61	91	45	9.6	5 132
Obstetrics									1		1	2			0.9	446
Oncology		1			1	1	1				3	2		3	8.8	136
Orthopaedics					3	5	9	6	2		46	5	17	12	9.2	1 145
Other																10
Psychiatry					2	2	1					2	1	1	3.5	256
Surgery	1	11	1		16	16	29	27	3	1	72	16	17	37	11.2	2 207
Urology					3	2					4	1	3	3	6.3	255
Total	**1**	**37**	**1**	**7**	**118**	**145**	**112**	**86**	**12**	**1**	**163**	**113**	**181**	**126**	**9.5**	**11 608**

1 Inpatients with more than one HAI are grouped under the 'Multiple' category

Appendix Table 5-10: *Non-acute Hospitals. Number of HAI cases by specialty group and HAI type*

Specialty Group	HAI Type											Prevalence by specialty	Total Inpatients
	BJ	CVS	EENTM	GI	LRI	PNE	RSI	SSI	SST	UTI	Multiple[1]		
	N	N	N	N	N	N	N	N	N	N	N	%	N
Care of the Elderly			5	6	3			2	7	10	1	7.8	436
Medicine	1	1	11	9	6	3		1	13	17	2	11.4	563
Orthopaedics				1								7.1	14
Psychiatry			5	1	7	1	2	1	20	16	3	5.0	1 127
Surgery				1							1	40.0	5
Urology													1
Total	**1**	**1**	**21**	**18**	**16**	**4**	**2**	**4**	**40**	**43**	**7**	**7.3**	**2 146**

5.5 Prevalence by ward type

Appendix Table 5-11: *Acute Hospitals. Prevalence of HAI for inpatients surveyed in each ward type*

Ward Type	Inpatients with HAI		95% CI		
	N	%			
General	1028	9.2	(8.5	-	9.9)
H.D.U.	31	16.5	(10.4	-	22.6)
I.C.U.	35	27.1	(19.2	-	35.1)
Mixed	9	11.4	(1.6	-	21.2)
Total	**1103**	**9.5**	**(8.8**	**-**	**10.2)**

1 Inpatients with more than one HAI are grouped under the 'Multiple' category

5.6 Prevalence by boarder status

Appendix Table 5-12: *Acute Hospitals. Prevalence of HAI for inpatients categorised by boarder status and specialty group*

Specialty Group	Boarders with HAI		95% CI		Non-Boarders with HAI		95% CI	
	N	%			N	%		
Care of the Elderly	0	0.0	-	-	199	12.0	(10.1	- 13.8)
Dentistry	-	-	-	-	2	12.5	(4.1	- 20.9)
Gynaecology	-	-	-	-	10	4.8	(1.2	- 8.4)
Haematology	0	0.0	-	-	8	6.8	(2.1	- 11.5)
Medicine	23	7.0	(4.2	- 9.9)	468	9.7	(8.6	- 10.9)
Obstetrics	-	-	-	-	4	0.9	(0.0	- 1.9)
Oncology	0	0.0	-	-	12	9.0	(2.0	- 16.0)
Orthopaedics	0	0.0	-	-	105	9.3	(7.4	- 11.2)
Other	-	-	-	-	0	0.0	-	-
Psychiatry	-	-	-	-	9	3.5	(0.3	- 6.7)
Surgery	2	3.5	(0.0	- 8.4)	245	11.4	(9.7	- 13.1)
Urology	0	0.0	-	-	16	6.5	(3.1	- 9.8)
Total	**25**	**5.9**	**(3.7**	**- 8.1)**	**1 078**	**9.6**	**(8.9**	**- 10.4)**

Appendix Table 5-13: *Non-acute Hospitals. Prevalence of HAI for inpatients categorised by boarder status and specialty group*

Specialty Group	Boarders with HAI		95% CI		Non-Boarders with HAI		95% CI	
	N	%			N	%		
Care of the Elderly	-	-	-	-	34	7.8	(4.7	- 10.9)
Medicine	1	16.7	(1.2	- 32.1)	63	11.3	(8.5	- 14.1)
Orthopaedics	-	-	-	-	1	7.1	-	-
Psychiatry	-	-	-	-	56	5.0	(3.5	- 6.4)
Surgery	0	0.0	-	-	2	50.0	-	-
Urology	0	0.0	-	-	-	-	-	-
Total	**1**	**12.5**	**(3.8**	**- 21.2)**	**156**	**7.3**	**(6.0**	**- 8.6)**

5.7 Prevalence by hospitals and NHS boards

Appendix Table 5-14 shows unadjusted prevalence of HAI for each hospital surveyed as part of the Scottish national HAI prevalence survey. No adjustments have been made to these data for speciality, patient or seasonal variations. Estimates of the prevalence of HAI vary dependent on the size of the hospital population. Comparisons must be made with caution.

Appendix Table 5-14: *Acute Hospitals. Prevalence of HAI for inpatients categorised by hospital*

Hospital Name	Total Inpatients	Inpatients with HAI		95% CI
	N	N	%	
Aberdeen Maternity Hospital	54	2	3.7	(0.0 - 9.7)
Aberdeen Royal Infirmary	711	62	8.7	(6.6 - 10.9)
Ayr Hospital	280	23	8.2	(5.3 - 11.1)
Ayrshire Central Hospital	174	9	5.2	(2.1 - 8.2)
Balfour Hospital	32	2	6.3	(0.0 - 14.7)
Belford Hospital	17	1	5.9	(0.1 - 11.6)
Borders General Hospital	247	18	7.3	(4.6 - 10.0)
Caithness General Hospital	44	1	2.3	(0.0 - 6.4)
Crosshouse Hospital	451	21	4.7	(2.6 - 6.7)
Dr Gray's Hospital	122	13	10.7	(6.3 - 15.0)
Dumfries & Galloway Royal Infirmary	261	29	11.1	(8.0 - 14.2)
Falkirk & District Royal Infirmary	192	33	17.2	(13.1 - 21.3)
Forth Park Hospital	47	3	6.4	(0.6 - 12.1)
Garrick Hospital	12	0	0.0	- -
Gartnavel General Hospital	323	29	9.0	(5.4 - 12.6)
Gilbert Bain Hospital	27	2	7.4	(0.4 - 14.4)
Glasgow Royal Infirmary	545	65	11.9	(8.6 - 15.2)
Golden Jubilee National Hospital	45	3	6.7	(0.0 - 15.2)
Hairmyres Hospital	423	40	9.5	(6.3 - 12.7)
Inverclyde Royal Hospital	222	19	8.6	(4.9 - 12.3)
Lorn & Islands District Hospital	66	9	13.6	(2.7 - 24.5)

Hospital Name	Total Inpatients	Inpatients with HAI		95% CI
	N	N	%	
Mackinnon Memorial Hospital	13	0	0.0	- -
Monklands Hospital	415	56	13.5	(9.1 - 17.9)
Ninewells Hospital	604	49	8.1	(5.7 - 10.5)
Perth Royal Infirmary	197	22	11.2	(5.6 - 16.7)
Princess Royal Maternity Hospital	42	0	0.0	- -
Queen Margaret Hospital	318	31	9.7	(5.3 - 14.2)
Queen Mother's Hospital	26	0	0.0	- -
Raigmore Hospital	406	41	10.1	(6.9 - 13.2)
Ross Memorial Hospital	18	0	0.0	- -
Royal Alexandra Hospital	483	47	9.7	(6.4 - 13.1)
Royal Infirmary of Edinburgh	577	67	11.6	(6.3 - 16.9)
Southern General Hospital	614	42	6.8	(4.5 - 9.2)
St John's Hospital at Howden	354	33	9.3	(4.2 - 14.5)
Stirling Royal Infirmary	310	28	9.0	(5.3 - 12.7)
Stobhill Hospital	338	62	18.3	(11.9 - 24.8)
Stracathro Hospital	22	1	4.5	(0.0 - 12.6)
Vale of Leven District Hospital	152	7	4.6	(0.9 - 8.3)
Victoria Hospital, Glasgow	474	43	9.1	(6.1 - 12.1)
Victoria Hospital, Kirkaldy	241	23	9.5	(5.4 - 13.7)
Western General Hospital, Edinburgh	453	57	12.6	(8.9 - 16.3)
Western Infirmary, Glasgow	334	31	9.3	(4.2 - 14.3)
Western Isles Hospital	119	10	8.4	(4.3 - 12.5)
Wishaw General Hospital	436	37	8.5	(4.4 - 12.6)
Woodend Hospital	367	32	8.7	(6.2 - 11.2)
Total	**11 608**	**1 103**	**9.5**	**(8.8 - 10.2)**

Appendix Table 5-15: *Acute Hospitals. Prevalence of HAI for inpatients categorised by hospital board*

NHS Board	Inpatients with HAI		95% CI
	N	%	
Argyll & Clyde	82	8.9	(6.6 - 11.2)
Ayrshire & Arran	53	5.9	(4.3 - 7.4)
Borders	18	7.3	(4.6 - 10.0)
Dumfries & Galloway	29	10.6	(7.6 - 13.7)
Fife	57	9.4	(6.5 - 12.3)
Forth Valley	61	12.2	(8.9 - 15.4)
Glasgow	272	10.1	(8.4 - 11.7)
Grampian	109	8.7	(7.2 - 10.2)
Highlands	43	8.6	(5.8 - 11.5)
Lanarkshire	133	10.4	(8.1 - 12.7)
Lothian	157	11.3	(8.5 - 14.2)
National Hospital	3	6.7	(0.0 - 15.2)
Orkney	2	6.3	(0.0 - 14.7)
Shetland	2	7.4	(0.4 - 14.4)
Tayside	72	8.7	(6.5 - 11.0)
Western Isles	10	8.4	(4.3 - 12.5)
Total	**1 103**	**100.0**	**(8.8 - 10.2)**

Appendix Table 5-16: *Non-acute Hospitals. Prevalence of HAI for inpatients categorised by hospital*

Hospital Name	Total Inpatients	Inpatients with HAI		95% CI		
	N	N	%			
Ailsa Hospital	201	11	5.5	(2.2	-	8.8)
Argyll & Bute Hospital	63	0	0.0	-		-
Bannockburn Hospital	72	5	6.9	(4.7	-	9.2)
Biggart Hospital	144	15	10.4	(3.1	-	17.7)
Bo'ness Hospital	39	5	12.8	(6.2	-	19.4)
Cameron Hospital	86	8	9.3	(3.3	-	15.4)
Cleland Hospital	37	1	2.7	(0.0	-	6.7)
Crichton Royal Hospital	48	5	10.4	(1.9	-	18.9)
Davidson Hospital	13	4	30.8	-		-
Dykebar Hospital	218	16	7.3	(4.0	-	10.7)
Kelso Hospital	20	2	10.0	(7.2	-	12.8)
Kirklandside Hospital	46	1	2.2	(0.0	-	4.7)
Lawson Memorial Hospital	7	1	14.3	-		-
Liberton Hospital	157	22	14.0	(9.1	-	18.9)
Lightburn Hospital	100	8	8.0	(1.8	-	14.2)
Montfield Hospital	33	3	9.1	(0.0	-	18.3)
Murray Royal Hospital	114	4	3.5	(0.0	-	7.2)
Royal Cornhill Hospital	285	12	4.2	(1.8	-	6.6)
Royal Victoria Hospial, Dundee	156	11	7.1	(3.1	-	11.0)
Royal Victoria Hospital, Edinburgh	194	21	10.8	(6.7	-	14.9)
The New Craigs Hospital	97	1	1.0	(0.0	-	2.9)
Uist and Barra Hospital	16	1	6.3	-		-
Total	**2 146**	**157**	**7.3**	**(6.0**	**-**	**8.6)**

Appendix Table 5-17: *Non-acute Hospitals. Prevalence of HAI for inpatients categorised by hospital board*

NHS Board	Inpatients with HAI		95% CI		
	N	%			
Argyll & Clyde	16	5.7	(2.6	-	8.8)
Ayrshire & Arran	31	7.7	(4.1	-	11.3)
Borders	2	10.0	(7.2	-	12.8)
Dumfries & Galloway	5	10.4	(1.8	-	19.0)
Fife	8	9.3	(3.2	-	15.4)
Forth Valley	10	9.0	(5.1	-	13.0)
Glasgow	8	8.0	(1.7	-	14.3)
Grampian	12	4.2	(1.8	-	6.7)
Highlands	2	1.9	(0.0	-	4.4)
Lanarkshire	1	2.7	(0.0	-	6.7)
Lothian	43	12.3	(9.0	-	15.5)
Shetland	3	9.1	(0.0	-	18.3)
Tayside	15	5.6	(2.6	-	8.5)
Western Isles	1	6.3	-		-
Total	**157**	**7.3**	**(6.0**	**-**	**8.6)**

5.8 Prevalence by hospital type

Appendix Table 5-18: *Acute Hospitals. Prevalence of HAI for inpatients categorised by hospital type*

Type	Inpatients with HAI		95% CI	
	N	%		
General	705	9.0	(8.2	- 9.7)
Teaching	393	11.0	(9.5	- 12.6)
Obstetric	5	3.0	(0.0	- 5.9)
Total	**1 103**	**9.5**	**(8.8**	**- 10.2)**

Appendix Table 5-19: *Acute Hospitals. Prevalence of HAI for inpatients categorised by hospital size*

Size	Inpatients with HAI		95% CI	
	N	%		
Large > 500 beds	739	9.9	(8.9	- 10.9)
Medium 250-499 beds	317	9.2	(8.1	- 10.3)
Small 50-249 beds	47	7.0	(4.8	- 9.2)
Very Small <50 beds	0	0.0	-	-
Total	**1 103**	**9.5**	**(8.8**	**- 10.2)**

Appendix Table 5-20: *Non-acute Hospitals. Prevalence of HAI for inpatients categorised by hospital size*

Size	Inpatients with HAI		95% CI	
	N	%		
Large ≥ 250 beds	39	5.5	(3.7	- 7.4)
Medium 249-150 beds	74	8.6	(6.3	- 10.9)
Small 50-149 beds	28	6.2	(3.8	- 8.6)
Very Small <50 beds	16	12.5	(7.3	- 17.7)
Total	**157**	**7.3**	**(6.0**	**- 8.6)**

5.9 Microbiology

Appendix Table 5-21: *Acute Hospitals. Number and percentage of ten most frequently occurring organisms reported for inpatients diagnosed with HAI*

Organism	Reporting Frequency	
	N	%[1]
Clostridium difficile	95	17.6
Staphylococcus aureus (MRSA) meticillin-resistant	93	17.2
Staphylococcus aureus (MSSA) meticillin-sensitive	48	8.9
Coliform (unspecified)	46	8.5
Escherichia coli	36	6.7
Staphylococcus, coagulase-negative (CNS)	26	4.8
Enterococcus spp.	21	3.9
Candida spp.	16	3.0
Enterococcus faecalis	12	2.2
All Other organisms[2]	147	27.2
Total	**540**	**100.0**

1 The percentage reported is: (Count of Organisms reported / Count of all organisms reported) x 100

2 The remaining organisms were grouped as 'All Other organisms'

Appendix Table 5-22: *Acute Hospitals. Number of reported organisms categorised by HAI type*

Organism	HAI Type												
	BJ	BSI	CNS	CVS	EENTM	GI	LRI	PNE	RSI	SSI	SST	UTI	Total
	N	N	N	N	N	N	N	N	N	N	N	N	N
Acinetobacter baumanni										1			1
Actinomyces spp		1											1
Anaerobic cocci						1				1			2
Bacillus spp												2	2
Bacteroides spp										1	1	1	3
Candida albicans		1			2					1	2	1	7
Candida spp					3		2		2		4	5	16
Clostridium difficile						95							95
Clostridium perfringens										1			1
Clostridium spp										2			2
Coliform (unspecified)		1					6	3	1	5	2	28	46
Coliform-lactose fermentor (LFC)										1		8	9
Enterobacter cloacae							2			3		1	6
Enterobacter cloacae - ESBL producer										1			1
Enterobacter spp - ESBL producer							1			1		1	3
Enterobacter spp		1										3	4
Enterococcus faecalis		1								4	1	6	12
Enterococcus faecium		1		1									2
Enterococcus spp		2				1				9		9	21
Escherichia coli		2			1					2	2	29	36
Escherichia coli - ESBL producer												2	2

Organism	HAI Type												
	BJ	BSI	CNS	CVS	EENTM	GI	LRI	PNE	RSI	SSI	SST	UTI	Total
	N	N	N	N	N	N	N	N	N	N	N	N	N
Group A Streptococcus[1]										2	1		3
Group B Streptococcus[2]										2		3	5
Group C Streptococcus[3]					1						1		2
Group F Streptococcus[4]										1			1
Group G Streptococcus[5]											6		6
Haemophilus influenzae					2		2	3					7
Haemophilus spp							1						1
Klebsiella pneumoniae (aerogenes)												1	1
Klebsiella spp												5	5
Micrococcus spp		1											1
Moraxella (Branhamella) catarrhalis							1						1
Moraxella spp		1											1
Morganella morganii							1						1
Other												3	3
Other Gram-negative bacteria	1	2								1			4
Other Gram-positive bacteria		1											1
Other anaerobes									2	3		1	6
Other bacteria												2	2
Other fungi/yeasts		2					2	1	1	2			8
Proteus mirabilis		1								1	1		3
Proteus spp										1		5	6

Organism	HAI Type												
	BJ	BSI	CNS	CVS	EENTM	GI	LRI	PNE	RSI	SSI	SST	UTI	Total
	N	N	N	N	N	N	N	N	N	N	N	N	N
Proteus vulgaris												1	1
Pseudomonas aeruginosa					1		1			5	1	3	11
Pseudomonas spp					1	1	3	1		2		2	10
Serratia marcescens							1					1	2
Staphylococcus aureus (MSSA) meticillin-sensitive		7	1	1	3		2	2		14	13	5	48
Staphylococcus aureus (MRSA) meticillin		10			3	1	4	5		32	27	11	93
Staphylococcus, coagulase-negative (CNS)	1	9				1				13	2		26
Stenotrophomonas (Xanthomonas) maltophilia							1	1		1			3
Streptococcus 'viridans group'		1											1
Streptococcus pneumoniae							2	1					3
Streptococcus spp			1							1			2
Total	**2**	**45**	**2**	**2**	**17**	**100**	**32**	**17**	**6**	**114**	**64**	**139**	**540**

1 Group A Streptococcus: (*S. pyogenes*)
2 Group B Streptococcus: (*S. agalactiae*)
3 Group C Streptococcus: (*S. dysgalactiae* subsp.*equisimilis*)
4 Group F Streptococcus: (*S. milleri* group or *S. constellatus*, *S. intermedius* and *S. anginosus*)
5 Group G Streptococcus: (*S. dysgalactiae* subsp.*equisimilis*)

Appendix Table 5-23: *Acute Hospitals. Number of inpatients categorised by organism type and specialty group*

Organism[1]	Specialty Group												
	Care of the Elderly	Dentistry	Gynaecology	Haematology	Medicine	Obstetric	Oncology	Orthopaedic	Other	Psychiatry	Surgery	Urology	Total
Actinomyces spp.					1								1
Anaerobic cocci								1					1
Bacillus spp.	1												1
Candida albicans	1				4							1	6
Candida spp.	1				3			2			1		7
Clostridium difficle	26			1	47		1	4		1	10	1	91
Coliform (unspecified)	3		1		11			2			5		22
Coliform-lactose fermentor (LFC)	4				1								5
Enterobacter cloacae					2		1	1					4
Enterobacter spp - ESBL producer					1						1		2
Enterobacter spp.				1							1		2
Enterococcus faecalis					3						1		4
Enterococcus faecium					1								1
Enterococcus spp.					3			2			1		6
Escherichia coli	7				6					1	2		16
Escherichia coli - ESBL producer	1												1

Organism[1]	Specialty Group												
	Care of the Elderly	Dentistry	Gynaecology	Haematology	Medicine	Obstetric	Oncology	Orthopaedic	Other	Psychiatry	Surgery	Urology	Total
Group A Streptococcus[2]											1		1
Group B Streptococcus[3]	2							1					3
Group F Streptococcus[4]											1		1
Group G Streptococcus[5]	1				2								3
Haemophilus influenzae					2						3		5
Klebsiella spp.	1						1	1					3
Micrococcus spp.	1												1
Moraxella (Branhamella) catarrhalis					1								1
Moraxella spp.					1								1
Morganella morganii											1		1
Other					1			1					2
Other Gram-negative bacteria					1								1
Other Gram-positive bacteria					1								1
Other anaerobes					1						1		2
Other fungi/yeasts					3						3		6
Proteus spp.					2								2

Organism[1]	Specialty Group												
	Care of the Elderly	Dentistry	Gynaecology	Haematology	Medicine	Obstetric	Oncology	Orthopaedic	Other	Psychiatry	Surgery	Urology	Total
Pseudomonas aeruginosa	1				2			2			2		7
Pseudomonas spp.					1						2		3
Serratia marcescens											1		1
Staphylococcus aureus	2				15		1	7			6		31
Staphylococcus aureus (MRSA) meticillin	7		1		22			6		2	27	2	67
Staphylococcus, coagulase-negative (CNS)	1			1	5		1	7			4		19
Stenotrophomonas (Xanthomonas) maltophilia				1									1
Streptococcus spp.											1		1
Multiple	6				13	1		4		1	29	1	55
No Organisms	1 611	16	206	116	4 976	445	131	1 104	10	251	2 103	250	1 1219
Total	**1 677**	**16**	**208**	**120**	**5 132**	**446**	**136**	**1 145**	**10**	**256**	**2 207**	**255**	**11 608**

1 Note that inpatients with reports for multiple organisms have been included in the "Multiple" organism category. For this reason, some organisms may not be represented in this table.

2 Group A Streptococcus: (*S. pyogenes*)

3 Group B Streptococcus: (*S. agalactiae*)

4 Group F Streptococcus: (*S. milleri* group or *S. constellatus*, *S. intermedius* and *S. anginosus*)

5 Group G Streptococcus: (*S. dysgalactiae* subsp.*equisimilis*)

Appendix Table 5-24: *Non-acute Hospitals. Number and percentage of ten most frequently occurring organisms reported for inpatients diagnosed with HAI*

Organism	Reporting Frequency	
	N	%[1]
Clostridium difficile	13	24.1
Staphylococcus aureus (MSSA) meticillin-sensitive	9	16.7
Escherichia coli	6	11.1
Staphylococcus aureus (MRSA) meticillin-resistant	6	11.1
Other anaerobes	3	5.6
Coliform (unspecified)	2	3.7
Group B Streptococcus (Streptococcus agalactiae)	2	3.7
Proteus mirabilis	2	3.7
Pseudomonas aeruginosa	2	3.7
Bacillus spp.	1	1.9
All Other organisms[2]	8	14.8
Total	**54**	**100.0**

1 The percentage reported is: (Count of Organisms reported / Count of all organisms reported) x 100

2 The remaining organisms were grouped as 'All Other organisms'

Appendix Table 5-25: *Non-acute Hospitals. Number of reported organisms categorised by HAI type*

Organism	HAI Type								
	EENTM	GI	LRI	PNE	RSI	SSI	SST	UTI	Total
	N	N	N	N	N	N	N	N	N
Bacillus spp.								1	1
Candida spp.	1								1
Clostridium difficile		13							13
Coliform (unspecified)								2	2
Enterococcus spp.								1	1
Escherichia coli								6	6
Escherichia coli - ESBL producer								1	1
Group B Streptococcus[1]							1	1	2
Group C Streptococcus[2]						1			1
Haemophilus influenza			1						1
Klebsiella spp.								1	1
Other anaerobes					1		2		3
Proteus mirabilis								2	2
Proteus spp.							1		1
Pseudomonas aeruginosa							1	1	2
Serratia marcescens								1	1
Staphylococcus aureus (MSSA) meticillin-sensitive				1		1	5	2	9
Staphylococcus aureus (MRSA) meticillin-resistant	1					2	3		6
Total	**2**	**13**	**1**	**1**	**1**	**4**	**13**	**19**	**54**

1 Group B Streptococcus: (*S. agalactiae*)

2 Group C Streptococcus: (*S. dysgalactiae* subsp.*equisimilis*)

Appendix Table 5-26: *Non-acute Hospitals. Number of inpatients categorised by organism type and specialty group*

Organism[1]	Specialty Group						
	Care of the Elderly	Medicine	Orthopaedic	Psychiatry	Surgery	Urology	Total
	N	N	N	N	N	N	N
Candida spp.				1			1
Clostridium difficle	6	5	1				12
Coliform (unspecified)		1		1			2
Escherichia coli	2	2		2			6
Escherichia coli - ESBL producer	1						1
Group B Streptococcus (Streptococcus agalactiae)		1		1			2
Haemophilus influenza				1			1
Klebsiella spp.	1						1
Other anaerobes				1			1
Proteus mirabilis		1					1
Proteus spp.				1			1
Pseudomonas aeruginosa				1			1
Staphylococcus aureus	1	3		2			6
Staphylococcus aureus (MRSA) meticillin-resistant	1	2		1			4
Multiple	2			2			4
No Organisms	422	548	13	1113	5	1	2102
Total	**436**	**563**	**14**	**1 127**	**5**	**1**	**2 146**

1 Note that inpatients with reports for multiple organisms have been included in the 'Multiple' organism category. For this reason, some organisms may not be represented in this table.

Appendix Table 5-27: *Acute hospitals. Number of patients with positive microbiology reports.*

	Positive microbiology report N	Positive microbiology report %
Bone and Joint Infection	0	0.0
Blood Stream Infection	26	70.3
Central Nervous System Infection	1	100.0
Cardiovascular System Infections	1	14.3
Eye, Ear, Nose, Throat or Mouth Infection	11	9.3
Gastrointestinal Infection	73	50.3
Lower Respiratory Tract Infection other than Pneumonia	19	17.0
Pneumonia	12	14.0
Reproductive System Infections	3	25.0
Systemic Infection	0	0.0
Surgical Site Infection	71	43.6
Skin and Soft Tissue Infection	46	40.7
Urinary Tract Infection	49	27.1
Multiple Infections	77	61.1
Total	**389**	**35.3**

Appendix Table 5-28: *Non-acute hospitals. Number of patients with positive microbiology reports.*

	Positive microbiology report N	Positive microbiology report %
Bone and Joint Infection	0	0.0
Central Nervous System Infection	0	0.0
Eye, Ear, Nose, Throat or Mouth Infection	2	9.5
Gastrointestinal Infection	12	66.7
Lower Respiratory Tract Infection other than Pneumonia	1	6.3
Pneumonia	1	25.0
Reproductive System Infections	1	50.0
Surgical Site Infection	2	50.0
Skin and Soft Tissue Infection	8	20.0
Urinary Tract Infection	13	30.2
Multiple Infections	4	57.1
Total	**44**	**28.0**

APPENDIX 6 - INPATIENT CARE CHARACTERISTICS

6.1 Antimicrobials

Appendix Table 6-1: *Acute Hospitals. Number and percentage of antimicrobials prescribed for surveyed inpatients*

Antimicrobial	Prescribing Frequency	
	N	%
Abacavir	1	0.0
Aciclovir	103	1.8
Amikacin	2	0.0
Amoxycillin	330	5.8
Amphotericin	10	0.2
Ampicillin	6	0.1
Atazanavir	1	0.0
Azithromycin	8	0.1
Benzylpenicillin	117	2.1
Caspofungin	1	0.0
Cefaclor	1	0.0
Cefalexin	79	1.4
Cefotaxime	78	1.4
Cefpodoxime	2	0.0
Cefradine	3	0.1
Ceftazidime	43	0.8
Ceftriaxone	230	4.1
Cefuroxime	155	2.7
Chloramphenicol	94	1.7
Ciprofloxacin	483	8.5
Clarithromycin	366	6.5
Clindamycin	69	1.2
Clotrimazole	70	1.2

Antimicrobial	Prescribing Frequency	
	N	%
Co-Amoxiclav	834	14.7
Co-Trimoxazole	41	0.7
Colistin	10	0.2
Demeclocycline	1	0.0
Doxycycline	30	0.5
Ertapenem	1	0.0
Erythromycin	46	0.8
Ethambutol Hydrochloride	5	0.1
Famciclovir	2	0.0
Flucloxacillin	288	5.1
Fluconazole	135	2.4
Fusidic Acid	30	0.5
Ganciclovir	4	0.1
Gentamicin	99	1.8
Imipenem With Cilastatin	2	0.0
Isoniazid	1	0.0
Itraconazole	19	0.3
Ketoconazole	2	0.0
Lamivudine	4	0.1
Levofloxacin	21	0.4
Linezolid	24	0.4
Lopinavir With Ritonavir	1	0.0
Meropenem	73	1.3
Metronidazole	586	10.4
Miconazole	7	0.1
Minocycline	2	0.0
Moxifloxacin	24	0.4
Mupirocin	70	1.2
Neomycin	7	0.1

Antimicrobial	Prescribing Frequency	
	N	%
Nevirapine	1	0.0
Nitrofurantoin	18	0.3
Norfloxacin	19	0.3
Nystatin	258	4.6
Ofloxacin	11	0.2
Other Drugs	18	0.3
Oxytetracycline	16	0.3
Penicillin	84	1.5
Phenoxymethylpenicillin	7	0.1
Pyrazinamide	5	0.1
Rifabutin	2	0.0
Rifampicin	45	0.8
Ritonavir	1	0.0
Silver sulphadiazine	2	0.0
Sultrin Cream	1	0.0
Tazocin	78	1.4
Teicoplanin	52	0.9
Tenofovir disoproxil	2	0.0
Terbinafine	3	0.1
Tetracycline	3	0.1
Ticarcillin	1	0.0
Tioconazole	1	0.0
Tobramycin	4	0.1
Trimethoprim	206	3.6
Valganciclovir	1	0.0
Vancomycin	189	3.3
Voriconazole	12	0.2
Zidovudine	1	0.0
Total	**5 662**	**100.0**

Appendix Table 6-2: *Non-acute Hospitals. Number and percentage of antimicrobials prescribed for surveyed inpatients*

Antimicrobial	Prescribing Frequency	
	N	%
Aciclovir	6	1.5
Amoxycillin	25	6.1
Benzylpenicillin	1	0.2
Cefalexin	13	3.2
Cefotaxime	2	0.5
Cefuroxime	3	0.7
Chloramphenicol	14	3.4
Ciprofloxacin	30	7.3
Clarithromycin	10	2.4
Clindamycin	2	0.5
Clotrimazole	41	10.0
Co-Amoxiclav	53	13.0
Co-Trimoxazole	3	0.7
Doxycycline	12	2.9
Erythromycin	4	1.0
Flucloxacillin	18	4.4
Fluconazole	6	1.5
Fusidic Acid	8	2.0
Metronidazole	34	8.3
Miconazole	3	0.7
Minocycline	2	0.5
Mupirocin	14	3.4
Neomycin	1	0.2
Nitrofurantoin	4	1.0
Nystatin	25	6.1
Other Drugs	1	0.2

Antimicrobial	Prescribing Frequency	
	N	%
Oxytetracycline	14	3.4
Penicillin	7	1.7
Rifampicin	1	0.2
Silver sulphadiazine	1	0.2
Teicoplanin	1	0.2
Terbinafine	3	0.7
Tetracycline	1	0.2
Tioconazole	1	0.2
Trimethoprim	36	8.8
Vancomycin	9	2.2
Total	**409**	**100.0**

6.2 Invasive devices

Appendix Table 6-3: *Acute Hospitals. Invasive device usage for burden study inpatients categorised by specialty group*

Specialty Group	Mechanical Ventilation		Peripheral Catheter		Central Catheter		Urinary Catheter		Total Inpatients
	N	%	N	%	N	%	N	%	N
Care of the Elderly	0	0.0	85	13.8	0	0.0	161	26.1	616
Gynaecology	0	0.0	5	33.3	0	0.0	5	33.3	15
Haematology	0	0.0	15	48.4	10	32.3	1	3.2	31
Medicine	3	0.2	509	33.8	35	2.3	278	18.5	1 506
Obstetrics	0	0.0	10	10.2	0	0.0	4	4.1	98
Oncology	0	0.0	8	34.8	2	8.7	7	30.4	23
Orthopaedics	0	0.0	85	32.4	3	1.1	55	21.0	262
Psychiatry	0	0.0	0	0.0	0	0.0	0	0.0	59
Surgery	13	2.2	255	43.9	50	8.6	120	20.7	581
Urology	0	0.0	15	20.8	4	5.6	29	40.3	72
Total	**16**	**0.5**	**987**	**30.2**	**104**	**3.2**	**660**	**20.2**	**3 263**

Appendix Table 6-4: *Non-acute Hospitals. Invasive device usage for burden study inpatients categorised by specialty group*

Specialty Group	Mechanical Ventilation		Peripheral Catheter		Central Catheter		Urinary Catheter		Total Inpatients
	N	%	N	%	N	%	N	%	N
Care of the Elderly	0	0.0	3	42.9	0	0.0	21	26.9	141
Medicine	1	100.0	4	57.1	0	0.0	50	64.1	193
Psychiatry	0	0.0	0	0.0	0	0.0	7	9.0	293
Total	**1**	**100.0**	**7**	**100.0**	**0**	**0.0**	**78**	**100.0**	**627**

APPENDIX 7 - PREVALENCE AND INCIDENCE CALCULATIONS

Appendix table 7-1 shows a comparison of SSHAIP inpatient surgical site infection incidence surveillance data and HAI Prevalence acute burden study data from 1 October 2005 to 31st September 2006 by procedure. LN=mean length of stay for inpatients who acquire one or more nosocomial infections; LA=mean length of stay for all inpatients; INT=mean interval between admission and onset of first nosocomial infection for those inpatients who acquire one or more nosocomial infection; P=Prevalence rate; Ic= Calculated incidence rate; I=Incidence rate.

Table key

- Procedures where no LOS data were available
- Pale blue- Procedures where either no prevalence or no incidence data were available
- White- Procedures where comparable data for prevalence and incidence were available.

Appendix Table 7-1: *Comparison of SSHAIP inpatient surgical site infection incidence surveillance data and HAI Prevalence acute burden study data from 1 October 2005 to 31 September 2006 by procedure* [1]

SSHAIP Procedure	No of operations (SSHAIP)	No of HAIs (by type) from SSHAIP Data					Average LOS (days) from SSHAIP		Average time to infection (days) (INT) from SSHAIP	Mapped to Prevalence procedure/s	No of inpatients in Prevalence	No of Inpatients with SSI related to one Procedure	No of Inpatients with Prevalent SSI related to multiple Procedures	Prevalence (P)	Calculated Incidence (I_c)	Incidence (I)
		Superficial	Deep	Organ	Not Recorded	Total	SSI (LN)	All Inpatients (LA)								
Cardiac Surgery	24	0	0	0	0	0	N/A	9.4	N/A	Cardiovascular – Cardiac Surgery	58	2	2	3.4%	N/A	0.0%
CABG	208	1	0	0	1	2	18	7.1	11	Cardiovascular - CABG	47	3	2	6.4%	6.5%	1.0%
Breast Surgery	411	2	0	0	0	2	23	3.1	12.5	Endocrine and Breast – Mastectomy	7	0	0	0.0%	0.0%	0.5%
Abdominal Hysterectomy	802	11	2	0	2	15	7.8	4.6	6.2	Female Genital – Abdominal Hysterectomy	13	0	0	0.0%	0.0%	1.9%
Caesarean Section	5199	91	1	3	8	105	7.1	3.8	5.4	Pregnancy – Caesarean Section	17	0	0	0.0%	0.0%	2.0%

1 LN=mean length of stay for inpatients who acquire one or more nosocomial infections; LA=mean length of stay for all inpatients; INT=mean interval between admission and onset of first nosocomial infection for those inpatients who acquire one or more nosocomial infection; P=Prevalence rate; Ic= Calculated incidence rate; I=Incidence rate

SSHAIP Procedure	No of operations (SSHAIP)	No of HAIs (by type) from SSHAIP Data					Average LOS (days) from SSHAIP		Average time to infection (days) (INT) from SSHAIP	Mapped to Prevalence procedure/s	No of inpatients in Prevalence	No of Inpatients with SSI related to one Procedure	No of Inpatients with Prevalent SSI related to multiple Procedures	Prevalence (P)	Calculated Incidence (I_c)	Incidence (I)
		Superficial	Deep	Organ	Not Recorded	Total	SSI (LN)	All Inpatients (LA)								
Operations for Fractured Neck of Femur	2024	38	14	0	3	55	22.6	13.1	12.2	Bones and Joints – Open reduction of fracture	60	0	1	0.0%	0.0%	2.7%
Hip Replacement	4403	33	9	0	1	43	13	7.1	12.9	Bones and Joints – Hip Prosthesis	112	2	5	1.8%	126.8%	1.0%
Knee Replacement	3589	14	4	0	0	18	15.4	6.9	14.2	Bones and Joints – Knee Prosthesis	20	2	2	10.0%	57.5%	0.5%
Major Vascular Surgery	227	17	4	0	2	23	N/A	11.8	12.7	Arteries and Veins – Vascular surgery	50	3	2	6.0%	N/A	10.1%

APPENDIX 8 - USE OF ANTIMICROBIALS AS AN INDICATOR OF HAI

8.1 Diagnostic tests

Assume that the true status of disease in a person is known (Disease Yes/No). Assume Test + means the person tests positive for the disease.

Appendix Table 8-1: *Explanation of the measures of diagnostic test validity*

	Disease Yes	Disease No	Total
Test +	TP	FP	TP+FP
Test -	FN	TN	FN+TN
Total	**TP+FN**	**FP+TN**	

There are 4 main measures of diagnostic test validity:

- Sensitivity
- Specificity
- Positive Predictive Value (PPV)
- Negative Predictive Value(NPV)

True Positives (TP): person has disease and tests positive

True Negatives (TN): person does not have the disease and tests negative

False Positives (FP): person does not have the disease but tests positive

False negative (FN): person has the disease and tests negative

8.2 Sensitivity

The sensitivity of a test is the probability that the test result will be positive when applied to people with the disease. A sensitive test detects a high proportion of the true cases. It is defined to be

Equation 4: *Formula for the calculation of sensitivity*

$$\text{Sensitivity} = TP/(TP+FN)$$

8.3 Specificity

The specificity of a test is the probability that the test result will be negative when applied to people without the disease. A specific test has few false positives.

Equation 5: *Formula for the calculation of specificity*

$$\text{Specificity} = TN/(TN+FP)$$

8.4 Positive Predictive Value (PPV)

This is the probability that a person with a positive test will have the disease.

Equation 6: *Formula for the calculation of positive predictive value*

$$PPV = TP/(TP+FP)$$

APPENDIX 9 - VALIDATION

9.1 Validation methods

Surveillance investigations require collected data to be both reliable (consistent) and valid (accurate), but there is a wide range of factors that can affect these requirements, particularly when data is collected from a working healthcare environment. A crossover design, where all data collectors survey the same group of inpatients, was selected as a method to repeatedly examine InterRater Reliability (IRR). Every precaution was taken to ensure the patient care pathway remained free from interference during normal data collection. To minimise disruption during the IRR exercise, data collectors were split into two groups, assigned to two separate wards and selected five patients to be surveyed. After completing the first ward, data collectors moved to the other ward and surveyed the same patients as the previous group.

Up to 100 data items could be collected for each patient in the survey. A representative sample of these data items, located at all levels of the data collection tool, including Ward, Patient, Antimicrobial, Surgery, Invasive Device and Infection, were assessed for reliability. Data in a relational database creates unique issues for analysis of reliability. A set of rules were developed to consistently deal with records when, for instance, data was missing due to earlier responses, or it was recorded in one of several similar fields.

Mean percent agreement was calculated for all of the selected data items. While the percent agreement statistic has some weaknesses, notably its inability to account for agreement through chance, its applicability and simplicity makes it useful for revealing inconsistencies (80). Kappa statistics correct for chance agreement but are only applicable where the number of possible responses is small, the number of observations is large and all possible responses have been recorded at least once (81). Where appropriate, this statistic has also been included in our analysis.

9.2 Validation results

Appendix Table 9-1: *Level, field name and data type of data items evaluated with percentage agreement and kappa statistic for the inter-rater reliability (IRR) exercise*

Level	Field	Data Type	Percent Agreement	Kappa
Ward	WARD NAME	Free text	100	NA
Ward	DATE OF CENSUS	dd/mm/yyyy	100	NA
Ward	TRAINED NHS STAFF	Number	100	NA
Patient	GENDER	M / F	100	1.00
Patient	DOB	dd/mm/yyyy	100	NA
Patient	ADMISSION TYPE	Unplanned / Planned	100	NA
Patient	Boarder	Y / N	100	NA
Patient	PATIENT IDENTIFIER	Free text	100	NA
Patient	SPECIALTY	Controlled list	95	NA
Patient	ADMISSION DATE	dd/mm/yyyy	93	NA
Antimicrobials	ANTIBIOTIC THERAPY	Y / N	100	1.00
Antimicrobials	ANTIBIOTIC START DATE	dd/mm/yyyy	82	NA
Antimicrobials	ANTIBIOTIC TYPE	Controlled list	94	NA
Antimicrobials	ANTIBIOTIC ADMIN.	Controlled list	94	0.21
Antimicrobials	ANTIBIOTIC INDICATION	Controlled list	94	0.21
Invasive	HAD INVASIVE DEVICE	Y / N	87	0.70
Invasive	PERIPHERAL CATHETER	Y / N	87	0.75
Invasive	CENTRAL CATHETER	Y / N	100	1.00
Invasive	URINARY CATHETER	Y / N	93	0.87
Surgery	HAD SURGERY	Y / N	93	0.79
Surgery	SURGERY TYPE	Controlled list	82	NA
Infection	CURRENT HAI	Y / N	100	1.00
Infection	INFECTION TYPE	Controlled list	100	NA
		Mean	**95%**	**0.75**

Most of the data items examined in the IRR exercise revealed high levels of agreement. Some inconsistency was observed at the patient detail level for Specialty and Admission Date, which on further investigation, related to differences in the interpretation of definitions and the source of data, respectively. Reduced consistency at the Antimicrobial level stemmed from a singular disagreement, which cascaded down to related fields, resulting in other disagreements. Kappa of 0.21 was calculated for Antimicrobial Administration and Indication, but this was exaggerated by the low occurrence of some responses.

All data collectors identified two patients with a HAI and 100% agreement was recorded for their diagnoses of infection type.

9.3 Validation discussion

In practice, significant limitations were encountered collecting data for IRR analysis in a busy healthcare environment.

The time dependent nature of many prevalence survey variables was evident when Antimicrobial, Surgery and Invasive Device data were analysed for each group of data collectors. Several inpatients were discharged during the exercise and data was continuously updated in case notes, undermining attempts to assess consistency between data collectors. This issue affected an earlier attempt at using gold standard investigators in the healthcare environment and has also compromised a subsequent IRR exercise.

An additional drawback, affecting all of our quality assessment exercises, is the relatively low prevalence of naturally occurring HAI. Consistent and accurate HAI diagnosis was considered to be the most important function in the HAI Prevalence Survey but is also one of the most challenging to assess.

There is a broad range of data types collected in the Prevalence survey with a bewildering number of reasons to explain inconsistencies. No one analytical method was identified that could be applied universally to the data set and account for agreement by chance. We adopted the strategy of using several separate statistics, while keeping in mind the purpose of the analyses and the complexity of their calculation.

This IRR assessment ultimately allowed us to identify and discuss data collection issues. Further, targeted training could be developed to ensure high data quality standards were maintained during the survey period.

APPENDIX 10 - CALCULATIONS FOR SURVEY TIME AND COST TABLES

10.1 HPS team

A pilot study was undertaken in 3 general hospitals within different regions of Scotland (West, East and South). This gave an estimate of the number of inpatients each data collector was able to survey per day on average. During the pilot survey the average number of beds per ward was 22.

Appendix Table 10-1: *Time taken for data collection during pilot prevalence survey for HPS data collectors, infection control staff and clinical staff*

Variable	Observations	Mean Time per Inpatient (min)	Total Time (min)	St.Dev	Min	Max
HPS Data Collectors	1403	10.1	14030	8.5	3	90
Infection Control Staff	1403	0.6	758	2.2	0	35
Clinical Staff	1403	0.6	836	3.8	0	25

PERT (Program Evaluation and Review Technique) requires an estimate of the shortest possible time each activity will take, the most likely length of time, and the longest time that might be taken if the activity takes longer than expected. This helps to bias time estimates away from the unrealistically short time-scales normally assumed.

Equation 7: *The formula to calculate the time to use for each project stage using PERT analysis*

$$\text{Planned time} = \frac{\text{shortest time} + 4 \times \text{likely time} + \text{longest time}}{6}$$

Using a PERT analysis it was calculated that it would take a data collector 22 minutes on average to survey a single patient. This meant that a single data collector could survey an average ward within approximately 8 hours. In practice this calculation held true throughout the main survey. The data collectors worked in teams of two where possible, and visited two wards per day each. This ensured that there was another data collector to assist with interpretation of the CDC definitions and that each ward was completed on the same day it was begun.

It was recognised during the pilot survey that the data collectors would need to have a day during each week in order to validate and send data to HPS. It was also acknowledged that travelling to each hospital took up a considerable part of each working day. The team worked to a flexible working pattern, during the four days data collection the team would work longer shifts and on the home based day they worked a slightly shorter shift. This pattern allowed the team to maximise the data collection, since one ward must be completed in one day and reduced the potential fatigue of travelling to collect data in hospitals 5 days per week. This strategy was successful and allowed flexibility for both the data collection team and the ward staff since data collectors could arrange to visit when ward rounds were completed.

10.2 Local ward staff and data collectors

There was a small impact on the nursing staff when data collectors visited each ward. Approximately 0.6 minutes of nursing staff time per patient (calculated during the pilot survey) was multiplied by 13 800 patients to give a total of 138 hours for all Scotland.

Data collectors also spent approximately 10 minutes per ward introducing themselves to the charge nurse. Visiting 840 (See REF) wards gives a total of 140 hours for the entire survey.

Infection control nurses

Infection control teams played a very large part in the success of the survey. The nominated link member of the infection control team was required to liaise with hospital senior management regarding the survey visits, arrange security passes for the data collectors, where possible arrange a meeting for the Project Manager to inform senior clinical staff about the survey, distribute the information packs and posters and address any queries about the prevalence survey from ward staff. After the survey was complete the nominated link member of the ICT was required to use the local hospital records management system to report discharge dates for the patients within the burden study.

It is estimated that ICNs spent 30 minutes per ward distributing the information packs and posters and addressing any queries about the prevalence survey. Based on an estimate of 840 wards ICNs spent a total of 420 hours informing the local staff about the prevalence survey.

Psychiatric hospital staff

Some Psychiatric Care hospitals provided escorts for the data collectors in certain psychiatric wards costing an additional £500 (approximately 30 hours).

In summary, the total time provided by all hospital staff to the national HAI prevalence survey was 728 hours.

Appendix Table 10-2: *Tolerance defined in the Project Initiation Document (PID) for the national HAI prevalence survey.*

Tolerance	+	-	Comment
Time %	2%	20%	There was very little tolerance available for time in this project. The data collectors were not all working at the same time. Due to the short term nature of the positions it is anticipated that some of the team members would find permanent positions before the end of their contract and therefore to mitigate the risk of losing some staff, additional resources were recruited on short term contracts.
Days	15	146	
Cost %	5%	20%	The main costs were salaries, which are predictable, and there is not anticipated to be a great variation from predicted cost.
£[1]	£30 000.	£118 935.	

1 Costs have been rounded to the nearest £5

APPENDIX 11 - ACRONYMS

Appendix Table 11-1: *List and expansion of acronyms*

Acronym	Expanded Acronym
BJ	Bone and Joint Infection
BSI	Blood Stream Infection
CAUTI	Catheter Associated Urinary Tract Infection
CDC	Centre for Disease Control (US)
CNO	Chief Nursing Officer
CNS	Central Nervous System Infection
CVC	Central Vascular Catheter
CVS	Cardiovascular System Infections
DoH	Department of Health
EENTM	Eye, Ear, Nose, Throat or Mouth Infection
EPINE	[Evolución de la Prevalencia de las Infecciones Nosocomiales] (Spanish)
GI	Gastrointestinal Infection
GP	General Practitioner
HAI	Healthcare Associated Infection
HAITF	Healthcare Associated Infection Task Force
HEAT	Health, Efficiency, Access and Treatment
HELICS	Hospitals in Europe Link for Infection Control through Surveillance
HIS	Hospital Infection Society
HPS	Health Protection Scotland
IC	Infection Control
ICD 10	International Classification of Disease Version 10
ICM	Infection Control Manager
ICN	Infection Control Nurse
ICNA	Infection Control Nurses Association
ICT	Infection Control Team
ICU	Intensive Care Unit
IPC	Infection Prevention and Control
IQR	Interquartile Range
IRR	InterRater Reliability

Acronym	Expanded Acronym
IT	Information Technology
KISS	[Krankenhaus Infektions Surveillance System] (German)
LOS	Length of stay
LRT	Lower Respiratory Tract Infection other than Pneumonia
MRSA	Meticillin Resistant *Staphylococcus aureus*
MSSA	Meticillin Sensitive *Staphylococcus aureus*
NHS	National Health Service
NI	Nosocomial Infection
NNIS	National Nosocomial Infection Surveillance
NV	norovirus
PC	Personal Computer
PERT	Program Evaluation and Review Technique
PII	Patient Identifiable Information
PNE	Pneumonia
PVC	Peripheral Vascular Catheter
RAS	Remote Access Service
ROI	Republic of Ireland
RSI	Reproductive System Infections
SA	*Staphylococcus aureus*
SAB	*Staphylococcus aureus* bacteraemia
SEHD	Scottish Executive Health Department
SIRN	Scottish Infection Research Network
SI	Systemic Infection
SOP	Standard Operating Procedure
SSHAIP	Scottish Surveillance of Healthcare Associated Infection Programme
SSI	Surgical Site Infection
SST	Skin and Soft Tissue Infection
UK	United Kingdom
US	United States of America
UTI	Urinary Tract Infection
VAP	Ventilator Associated Pneumonia

APPENDIX 12 - STEERING GROUP AND TEAM MEMBERSHIP

Appendix Table 12-1: *National HAI prevalence survey project team*

Project sponsor:	Mr Paul Martin, CNO, SEHD
Project Director:	Dr Jacqui Reilly, HPS
Project Manager:	Sally Stewart, HPS
Project Administration:	Netta Horn
Project consultants:	Dr Ahilya Noone Professor Chris Robertson Dr Gwen Allardice Dr Andrew Walker
Data collectors:	Margaret Kennedy Liz Lothian (Pilot only) Andrew Rideout Donald Saunders Julie Wilson Shona Cairns Iveta Krupova Eisin Shakir
Data Manager:	Simon Coubrough
Information Analyst:	Simon Coubrough
Systems Developer:	Chiara Zachary Greg Allan

Appendix Table 12-2: *National HAI prevalence survey project working group*

Project Director:	Dr Jacqui Reilly, HPS
Project Manager:	Sally Stewart, HPS
Project consultants:	Dr Ahilya Noone Dr Gwen Allardice Dr Andrew Walker Dr Julie Bruce

Appendix Table 12-3: *National HAI prevalence survey strategic steering group*

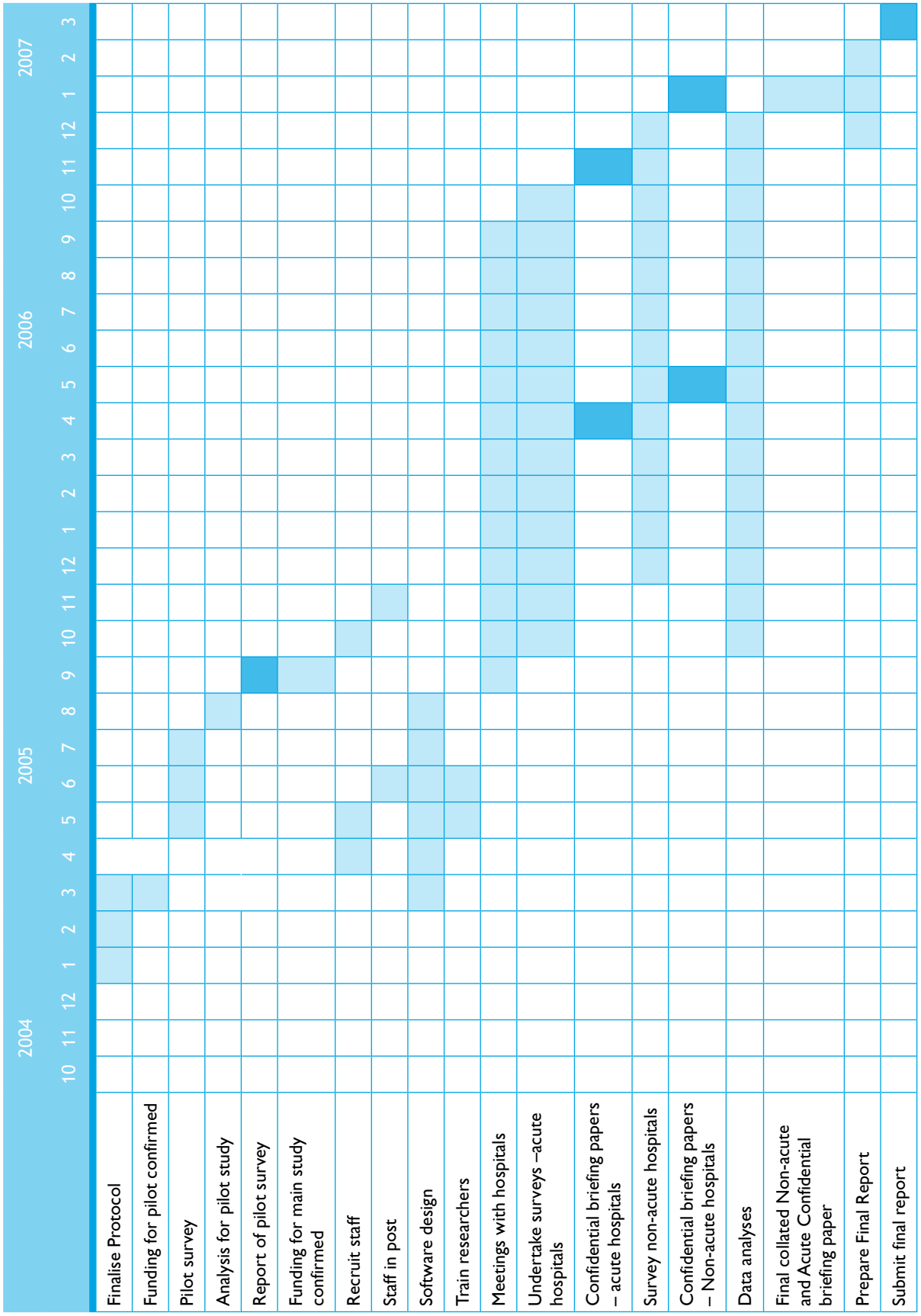
Dr Jacqui Reilly, Project Director, HPS (Chair)
Miss Sally Stewart, Project Manager, HAI Prevalence Study, HPS
Dr Ahilya Noone, Consultant Epidemiologist
Mr Tim Brett, Director, HPS
Dr Peter Christie, Senior Medical Officer, SEHD
Mrs Margaret Tannahill, Nurse Adviser HAI and Communicable Disease, SEHD
Dr Andrew Walker, Economist, HAI Prevalence Study, Glasgow University
Mrs Shona Halley, Senior Health Protection Nurse, ICNA
Mrs Val Leitch, ICN Manager, Fife HB
Mrs June McAlpine, ICN Co-ordinator, Lanarkshire HB

Appendix Table 12-4: *National HAI prevalence survey technical steering group*

Dr Jacqui Reilly, Project Director, HPS (Chair)
Miss Sally Stewart, Project Manager, HAI Prevalence Study, HPS
Dr Ahilya Noone, Consultant Epidemiologist
Mrs Marjorie Russell, Lay Representative, HAITF
Dr Peter Christie, Senior Medical Officer, SEHD
Mrs Margaret Tannahill, Nurse Advisor HAITF, SEHD
Dr Mary Hanson, Chair Scottish Microbiology Forum
Mr Roelf Dijkhuizen, Medical Directors (Deputy)
Dr Gwen Allardice, Statistician, HPS Statistics Group
Dr John Coia, Consultant Microbiologist, Microbiologists SMF
Prof Chris Robertson, Statistician, HPS Statistics Group
Mrs Gillian Stevenson, ICN Representative, ICNA
Mrs Lisa Ritchie, ICN Representative (Deputy), ICNA
Mr Tim Brett, Director, HPS
Dr Andrew Walker, Economist, HAI Prevalence Study, Glasgow University
Representative from Directors of Public Health

APPENDIX 13 - PROJECT TIMETABLE

Appendix Table 13-1: *Timetable for national HAI prevalence survey project*



VOLUME 2 - Protocol for NHS Scotland National HAI Prevalence Survey (Separate Document)

– See additional document for Survey Protocol