

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	<ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 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 ≥ 48 hrs 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 Infection¹ 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 I-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 I-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
<i>Staphylococcus aureus</i> 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 <i>Clostridium difficile</i> 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?