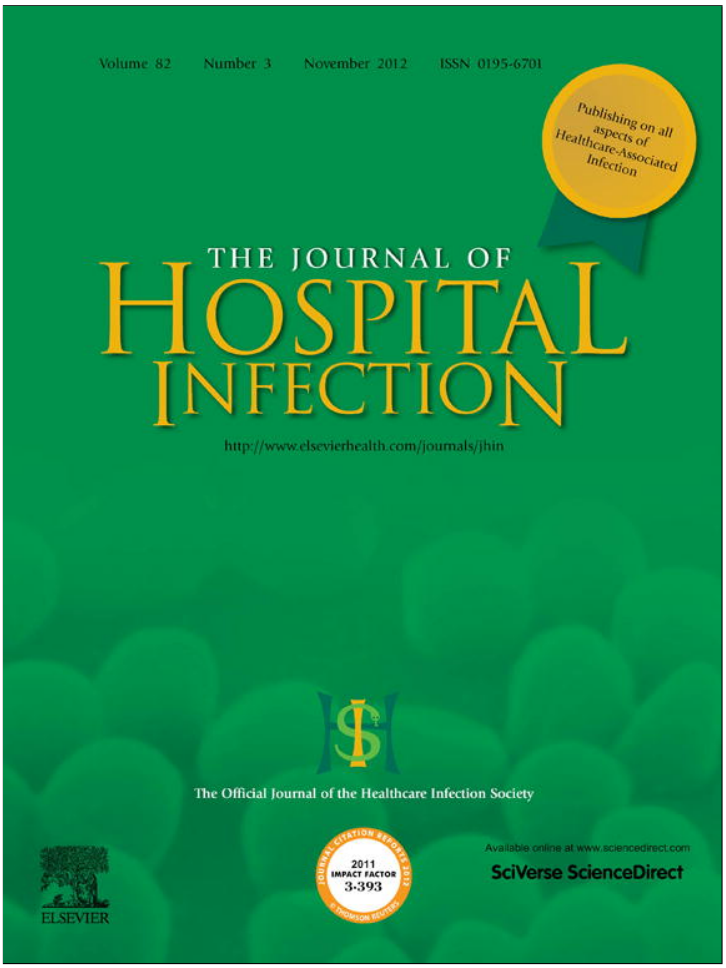

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Results from the second Scottish national prevalence survey: the changing epidemiology of healthcare-associated infection in Scotland

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SUMMARY

Background: Healthcare-associated infections (HAIs) are a recognized public health problem worldwide. Point prevalence surveys (PPSs) can be used to measure the burden of all HAI types.

Aim: To measure the prevalence of HAI and determine any changes in the epidemiology of HAI since the first Scottish national PPS.

Methods: A national rolling PPS in National Health Service (NHS) acute, NHS non-acute, NHS paediatric and independent hospitals was carried out during September and October 2011 using the European Centre for Disease Prevention and Control protocol designed for the European PPS. The prevalence of HAI and distribution of HAI types were measured and the results compared with the first Scottish national HAI point prevalence survey of 2005/2006.

Results: The prevalence of HAI was 4.9%, 2.5%, 6.1% and 1.2% in acute, non-acute, paediatric and independent hospitals respectively. The prevalence of HAI was significantly higher in acute hospitals compared with non-acute hospitals. There were no significant differences between the prevalence in the other hospital types. The prevalence of HAI in acute and non-acute hospitals was lower than the first survey by approximately one-third. The proportion of HAIs that were urinary tract infection, surgical site infection and bloodstream infection was higher and the proportion that were gastrointestinal including *Clostridium difficile* infection was lower in acute hospitals compared with the previous survey.

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Conclusions: The epidemiology of HAI has changed in Scotland since the first national survey in 2005/2006, thus infection prevention and control measures require to be refocused in this regard. The lower prevalence and changing epidemiology of HAI in acute and non-acute care suggest that there may be a temporal relationship with the implementation of the national programme of targeted HAI interventions in the intervening period.

Introduction

Healthcare-associated infections (HAIs) are a recognized public health problem worldwide and contribute significantly to morbidity and mortality in the hospital population.[1] The additional costs arising from treatment of HAI place a significant burden on healthcare resources. Multiple factors contribute to the increasing risk of HAI, including an ageing population, widespread use of complex therapeutic interventions, and emerging and re-emerging antimicrobial resistant micro-organisms.[2,3]

Point prevalence surveys (PPSs) are a useful tool to measure and monitor the burden of HAI.[4] They are less resource intensive relative to measuring the incidence of an outcome in which patients are followed up over time, and can be used to describe the burden of all HAI types on health services including those not routinely monitored.[5]

The first Scottish National HAI Prevalence Survey was carried out by Health Protection Scotland (HPS) between October 2005 and October 2006 and included all acute hospitals and a 25% sample of non-acute hospitals.[6] The survey reported that 9.5% [95% confidence interval (CI): 8.8–10.2] and 7.3% (95% CI: 6.0–8.6) of patients in acute and non-acute hospitals, respectively, had HAIs at the time of survey.

The results from the Scottish survey provided the Ministerial HAI Task Force (HAITF), led by the Chief Nursing Officer with an estimate of the burden of HAI in Scottish hospitals and informed the development of targeted incidence surveillance programmes such as surveillance of central vascular catheter-related infections and catheter-associated urinary tract infections, interventions to reduce HAI, infection prevention and control (IPC) guidance and quality improvement tools.

A second survey was commissioned by the Scottish Government for completion in March 2012. This second survey was considered important because of the dynamic nature of healthcare delivery, the changing nature of the population receiving hospital care, the evolution of micro-organisms, as well as changing healthcare interventions and the infection risks therein.

The European Centre for Disease Prevention and Control (ECDC) requested that all member states carry out a PPS using a standardized protocol by June 2012. The use of a standardized EU protocol will allow benchmarking of prevalence between European countries using a consistent approach. For this reason and to enable Scotland to contribute to the European PPS and the strategy to reduce HAI and antimicrobial resistance, the ECDC protocol was adopted for use in the Scottish national PPS.[7] Furthermore, the protocol was extended to enable comparison with the first survey carried out in 2005/2006 using a different protocol and to address national HAI policy questions.

The aims of the survey were to take stock of the current epidemiology, review any changes in epidemiology which have occurred since 2005/2006 by comparison of the two surveys, inform the development of future interventions, target future incidence surveillance, and to prioritize interventions to reduce the risk of infection in healthcare.

Methods

Study design

A rolling PPS was carried out in Scottish hospitals in September and October 2011. The patient-based ECDC protocol for PPS was adopted.[8]

The survey included all National Health Service (NHS) acute, NHS paediatric and independent hospitals, and, in an extension of the ECDC protocol, a 25% sample of NHS non-acute hospitals was selected using a stratified cluster sample carried out following calculations to determine the necessary sample size. The non-acute hospitals category included hospitals for long-term care of the elderly, psychiatric hospitals and long-term rehabilitation hospitals.

Data were collected by a collaborative team of staff members from local infection prevention and control, and by antimicrobial management teams. A one-day training course was developed using standardized ECDC training materials and was delivered to a total of 171 staff across Scotland.

Data were extracted from all available sources on the ward at the time of survey. Data collectors were advised to seek clarification from ward staff if the information held in the records was not clear.

Full details of the study design and data collection methods are provided in the PPS protocol.[9]

HAI case definitions

HAI data were collected for patients with an active HAI at the time of survey. The ECDC case definitions for HAI were used.[8]

Analysis

Descriptive analyses were carried out using SPSS Version 17® and Stata Version 9®. The survey was analysed as a cluster sample with wards nested within hospitals. For the non-acute hospitals sampling weights were calculated to reflect the slightly differential number of hospitals selected from the boards. The prevalence of HAI was calculated with 95% CIs using exact binomial methods for small samples and Wilson's method, adjusted for the clustering of wards within hospitals.

In order to make a valid comparison between the 2005/2006 survey and the 2011 survey in acute and non-acute hospitals, an adjustment was undertaken to account for differences in the study protocols and the included survey populations. In order to make a valid comparison, HAIs identified during the 2005/

2006 survey that did not meet the case definition on the day of the survey were excluded, as were HAIs present on admission to hospital with the exception of SSI, those originating in another hospital and those occurring in paediatric patients in the 2011 survey.

The CI for the adjusted percentage change between the two surveys in acute hospitals was calculated using a bootstrap simulation (100,000 samples) using a normal approximation to the binomial. The design effects associated with clustering of patients in wards in the two surveys as well as the sampling error in the estimation of the ratio were taken into account. In the non-acute hospitals, it was necessary to compare specialty-adjusted prevalence due to differences in the distribution of specialties between the two surveys. The prevalence in 2011 was adjusted to the bed distribution in 2005/2006 and the CI for the percentage change between the surveys was calculated using the same bootstrap simulation used for the acute hospitals. Full details are provided in the survey report.[10]

Results

A total of 13,558 patients in 75 hospitals in Scotland were included in the survey. All NHS acute ($N = 42$), NHS paediatric ($N = 3$) and independent hospitals ($N = 7$) and a 25% sample of non-acute hospitals ($N = 23$) in Scotland were included. The number of hospitals, wards, and patients surveyed is described by hospital type in Table I. The size of the hospitals ranged from five beds to 891 beds and the median number of beds was 108 [interquartile range (IQR): 35–355].

The median ages of patients aged ≥16 years in acute and non-acute hospitals were 72 years (IQR: 55–81) and 71 years (IQR: 49–83), respectively. Nearly 60% of patients in acute hospitals ($N = 6902$) and non-acute hospitals ($N = 968$) were aged ≥65 years.

Prevalence of HAI

The prevalence of HAI by hospital type is presented in Table II. The prevalence of HAI was significantly higher in acute hospitals compared with non-acute hospitals. There were no significant differences in HAI prevalence between the other hospital types.

The distribution of HAI types in the four hospital categories is described in Table III.

Comparison with the first Scottish prevalence survey

Adjusted analyses indicate that the prevalence of HAI in acute and non-acute hospitals was 33% (95% CI: 24–41) and 32% (95% CI: 9–50) lower than the HAI prevalence reported in 2005/2006, respectively.

Table II
Prevalence of healthcare-associated infection (HAI) by hospital category

Hospital type	No. of patients surveyed	No. of patients with HAI	Prevalence (%)	95% CI
Acute	11,525	559	4.9	4.4–5.4
Non-acute	1647	41	2.5	1.6–3.6
Paediatric	212	13	6.1	2.6–11.2
Independent	84	1	1.2	0.4–6.3

CI, confidence interval.
HAI data were not recorded for 90 patients.

The distribution of HAI types in acute hospitals in the first and second surveys is recorded in Table IV. The percentage of all HAIs that were bloodstream infections (BSIs), pneumonia and urinary tract infections (UTIs) was higher, whereas the percentage of gastrointestinal (GI) infections was lower in this survey compared with the first survey. The number of comparable HAIs in non-acute hospitals was small ($N = 33$) so no further commentary is offered on changes in the distribution of HAIs in these hospitals.

Discussion

Healthcare-associated infections are recognized as a public health threat, a patient safety risk issue and a cause for concern nationally and internationally. Although within the UK there has been a significant reduction in specifically targeted HAIs, such as CDI and *S. aureus* bacteraemia over the last four years, the burden of all HAIs is not routinely monitored.[11,12] PPS studies provide the opportunity to take stock of the current epidemiology and to review any changes in epidemiology which have occurred.[4] Intelligence from PPS can be used to inform the development of future interventions, target future incidence surveillance, and prioritize interventions to reduce the risk of infection in healthcare.[13]

The observed prevalence of HAI in Scottish acute hospitals was 4.9% (95% CI: 4.4–5.4) and in non-acute hospitals 2.5% (95% CI: 1.6–3.6). The results from this national PPS are similar to those reported in other countries though there are major limitations with the differences in the patient population, case definitions and protocols used.[14–17] The adoption of the ECDC PPS protocol for this survey and the completion of the EU PPS in all member states will enable robust benchmarking between European countries. Although adoption of the patient-based

Table I
Total number of patients, ward and hospitals surveyed, by hospital type

Hospital type	No. of hospitals surveyed	No. of wards surveyed	No. of beds	No. of patients	No. of eligible patients	No. of eligible patients surveyed	% of eligible patients surveyed
NHS acute	42	700	14,831	12,600	12,323	11,604	94.2
NHS non-acute	23	110	2042	1678	1670	1656	99.2
NHS paediatric	3	25	397	258	247	213	86.2
Independent	7	9	173	93	86	85	98.8
Total	75	844	17,443	14,629	14,326	13,558	94.6

NHS, National Health Service.

Table III
Number and percentage of different healthcare-associated infections (HAIs) by hospital category

HAI types	No. of HAIs							
	Acute		Non-acute		Paediatric		Independent	
	No.	%	No.	%	No.	%	No.	%
Bone/joint infection	3	0.5	0	0	0	0	0	0
Cardiovascular system infection	1	0.2	0	0	0	0	0	0
Central nervous system infection	4	0.7	0	0	1	7.1	0	0
CVC/PVC-related infection	16	2.7	0	0	0	0	0	0
Eye, ear, nose, throat and mouth infection	55	9.2	7	17.1	2	14.3	0	0
Gastrointestinal tract infection	41	6.8	5	12.2	1	7.1	0	0
Laboratory-confirmed BSI	57	9.5	3	7.3	3	21.4	0	0
Lower respiratory tract infection, other than pneumonia	17	2.8	1	2.4	0	0.0	0	0
Neonatal infection	7	1.2	0	0	2	14.3	0	0
Pneumonia	105	17.5	4	9.8	1	7.1	0	0
Reproductive tract infection	3	0.5	1	2.4	0	0	0	0
Skin and soft tissue	24	4.0	4	9.8	0	0	0	0
Surgical site infection	112	18.6	0	0	1	7.1	1	100.0
Systemic infection	20	3.3	0	0	1	7.1	0	0
Urinary tract infection	136	22.6	16	39.0	2	14.3	0	0
Total	601	100	41	100	14	100	1	100

CVC/PVC, central venous catheter/peripheral venous catheter; BSI, bloodstream infection.

ECDC protocol resulted in very resource-intensive data collection, it provided a full dataset for all patients. This enabled us to control for confounders such as patient case-mix, inclusive of underlying medical condition of the patient, and for benchmarking between Scottish hospitals to be carried out. Results from the pilot of the EU PPS indicate that the prevalence reported in the volunteer pilot hospitals was 7.1% (95% CI: 6.7–7.5), with which the Scottish mean prevalence compares favourably.[18] The prevalence was significantly higher in acute hospitals compared that in non-acute hospitals. However, the large number of younger psychiatric patients included in the non-acute hospital population sample may account for this difference. Comparisons of HAI prevalence in non-acute care excluding psychiatric patients indicated a prevalence of 5.0% (95% CI: 2.6–7.4); this was not significantly different from acute care. The prevalence of HAI in paediatric and independent hospitals was described for the first time and was 6.1% (95% CI: 2.6–11.2) and 1.2% (95% CI: 0.4–6.3), respectively.

Table IV
Number and percentage of different healthcare-associated infections (HAIs) in the 2005/2006 and 2011 surveys

HAI group	2005/2006 survey		2011 survey	
	No.	%	No.	%
Urinary tract infection	130	15.6	117	23.8
Surgical site infection	179	21.4	92	18.7
Pneumonia	78	9.3	89	18.1
Bloodstream infection	32	3.8	52	10.6
Eye, ear, nose, throat or mouth infection	114	13.6	49	10.0
Gastrointestinal infection	168	20.1	28	5.7
Skin and soft tissue infection	81	9.7	18	3.7
Lower respiratory infection other than pneumonia	19	2.3	17	3.5
Systemic infection	12	1.4	16	3.3
Cardiovascular system infection	4	0.5	6	1.2
Reproductive system infection	11	1.3	3	0.6
Central nervous system infection	2	0.2	3	0.6
Bone and joint infection	6	0.7	2	0.4
Total	836	100	492	100

The distribution of HAI types differed between the types of hospital surveyed and was relative to the population at risk within those settings. UTIs placed a significant burden on both acute and non-acute hospitals. Surgical site infections and pneumonia were more frequent in acute hospitals and GI infections were more frequent in non-acute hospitals. BSIs and clinical sepsis were the most frequently occurring HAIs in paediatric hospitals, accounting for more than a third ($N = 5$), although overall the number of HAIs in this setting was small. The number of infections in the independent sector were so few ($N = 1$) that no further commentary is offered on this. It is important to note that the prevalence of HAI within the independent hospitals was not significantly lower than in NHS acute hospitals.

The prevalence of HAI overall in acute and non-acute hospitals was lower than that reported in the first Scottish national HAI prevalence survey carried out in 2005/2006.[6] While there are definitional issues with comparison of the two surveys, after adjustment for differences in the survey population and protocol, the results indicate that the prevalence of HAI was lower than previously reported, by approximately one-third. This finding is consistent with the significant reductions in the mandatory incidence data reported to date in Scotland and suggests an association with the implementation of national policy initiatives such as a hand hygiene campaign and development of standard infection prevention and control precautions policies in the intervening period. Compliance with the World Health Organization 'Five Moments' for hand hygiene has increased from 64% to 95% between 2007 and 2011 in Scotland.[12] A temporal relationship between the implementation of national initiatives and a significant reduction in the

incidence of *Staphylococcus aureus* BSI and *Clostridium difficile* infection (CDI) has previously been reported in England.[19]

The epidemiology of HAI and the distribution of HAI types have changed since the first survey. These changes must be considered when setting local and national IPC priorities. After adjusting for differences in the survey protocols, the proportions of all HAIs that were UTIs, surgical site infections (SSI) and BSIs in acute hospitals were higher than in the first survey, whereas the proportion of GI infections was lower.

In this most recent PPS, UTIs were the most common infection type in both acute and non-acute hospitals and were the leading source of secondary BSIs where the source could be determined. This is an area to date with little focus in patient safety programmes and should be considered for future priority given the preventable nature of UTI associated with catheter use.[20] There is a continuing burden of SSI in the acute inpatient population. This PPS identified SSI following orthopaedic surgery as the most common type of SSI in the inpatient population. The incidence of SSI following hip arthroplasty surgery has fallen significantly since 2003 but has remained stable for the last three years of reporting and consideration for whether the irreducible minimum has been reached is required.[21,22] The higher proportion of BSI in acute hospitals may reflect the underlying medical conditions of the hospital population and the increasing complexity of care during inpatient stays. One-third of all BSIs were of unknown origin at the time of survey indicating the complexity in identifying IPC interventions to reduce these sources of infection and indicating the need for enhanced surveillance to better describe the causes. The lower proportion of gastrointestinal infections reflects the decreasing incidence of CDI in the Scottish hospital population following the implementation of a number of national policy interventions focused on infection prevention and control and antimicrobial stewardship.

Several limitations to prevalence surveys are important to note for the purposes of interpretation of this paper including: methodological issues concerning cross-sectional data, inter-rater reliability with respect to HAI definitions, microbiology availability and seasonality. In addition, comparisons with previous surveys are limited by changes in hospital population demographics and practices over time.

The results of this PPS indicate that HAI is lower in acute and non-acute care than the last survey, and the lower prevalence and changing epidemiology of HAI in acute and non-acute care suggest a temporal relationship with the implementation of the national programme of targeted HAI interventions in the intervening period. This first description of HAI in paediatrics and independent hospitals has identified where potential future IPC measures should be targeted.

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Conflict of interest statement
None declared.

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