1-3-2010

Four country healthcare-associated infection prevalence survey: pneumonia and lower respiratory tract infections.

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Citation

Humphreys H, Newcombe RG, Enstone J, Smyth ET, McIlvenny G, Davies E, Spencer R. Four country healthcare-associated infection prevalence survey: pneumonia and lower respiratory tract infections. Journal of Hospital Infection. 2010;74(3):266-270.

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Four country healthcare-associated infection prevalence survey: pneumonia and lower respiratory tract infections

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Declaration *The study was funded by the respective health agencies of the participating countries, i.e. Department of Health, England, Welsh Healthcare Associated Infection Programme, the Department of Health, Social Services and Public Safety, Northern Ireland and The Health Service Executive, the Republic of Ireland. None of the authors are in receipt of funding for personal or professional use from commercial sources that have an interest in the issues raised in this report.*

Key words: healthcare-associated infection, pneumonia, lower respiratory tract infection, meticillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile*.

Running title Prevalence of healthcare-associated pneumonia

Abstract

In 2006, the Hospital Infection Society was funded by the respective health services in England, Wales, Northern Ireland and the Republic of Ireland to conduct a prevalence survey of healthcare-associated infection (HCAI). Here, we report the prevalence of pneumonia and lower respiratory tract infection other than pneumonia (LRTIOP) in these four countries. The prevalence of all HCAIs was 7.59% (5,743 / 75,694). Nine hundred (15.7%) of these infections were pneumonia, and 402 (7.0%) were LRTIOP. The prevalence of both infections was higher for males than for females, and increased threefold from the under 35s to the over 85s ($p<0.001$). At the time of the survey or in the preceding seven days, 23.7% and 18.2% of patients with pneumonia and LRTIOP, respectively, were mechanically ventilated compared to 5.2% of patients in the whole study population. Meticillin-resistant *Staphylococcus aureus* (MRSA) was the cause of pneumonia and LRTIOP in 7.6% and 18.1% of patients, respectively ($p<0.001$). More patients with LRTIOP (4.2%) had concurrent diarrhoea due to *Clostridium difficile* compared to patients with pneumonia (2.4%), but this failed to reached statistical significance ($p=0.08$). Other healthcare-associated infections were present in 137 (15.2%) of patients with pneumonia and 66 (16.4%) of those with LRTIOP. The results suggest that reducing instrumentation, such as mechanical ventilation where possible, should help reduce infection. The higher prevalence of MRSA as a cause of LRTIOP suggests a lack of specificity in identifying the microbial cause and the association with *Clostridium difficile* emphasises the need for better use of antibiotics.

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Introduction

Prevalence surveys of healthcare-associated infection (HCAI) are conducted in many countries to determine the proportion of patients that have an infection, and to identify those areas that require prioritisation for prevention and control. In Finland, a national prevalence survey carried out in 2005 and involving 30 hospitals found an overall prevalence of HCAI of 8.5%.[1] In the UK and Ireland, over 75,000 patients were surveyed in 2006 in one of the largest surveys of its kind. The overall prevalence of HCAI was 7.59%.[2,3] The most common HCAI involved the gastro-intestinal tract but pneumonia was the third most common infection recorded.[2]

Although pneumonia and other lower respiratory tract infections are particularly prevalent in patients in intensive care units (ICUs) because of the strong association with mechanical ventilation, lower respiratory tract infections account for a substantial proportion of the overall burden of HCAI.[4] Extrinsic risk factors for lower respiratory tract infection include endotracheal intubation, mechanical ventilation and micro-aspiration of the oropharynx and intrinsic factors which relate to the individual patient include their underlying disease, the presence of immunosupression, etc.[4]

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Here, we outline the results from the Hospital Infection Society (HIS) Prevalence survey of HCAI as they relate to pneumonia and lower respiratory tract infection other than pneumonia (LRTIOP), conducted in the UK (excluding Scotland which used different methodologies) and the Republic of Ireland in 2006, and discuss how the results might indicate the priorities for future preventative strategies.

Materials and Methods

All publicly funded acute hospitals with adult in-patients were eligible to participate in the HIS study in 2006. Paediatric hospitals, mental health trusts, military hospitals, non-acute hospitals and private hospitals were excluded, except in the Republic of Ireland where some private hospitals participated.

The Centre for Disease Control (CDC) and Prevention definition of HCAI was used, i.e. a localised or systemic condition resulting from an adverse reaction to the presence of an infectious agent or reagent or its toxins and that was not present or incubating at the time of admission to the participating hospital. It also had to meet the CDC criteria for specific infections, which are widely used for surveillance purposes.[5]

The data were collected between mid-February and the end of May 2006 using standardised data forms. Data were collected for all active healthcare associated system infections recording whether the infection was device- or procedure-related, if MRSA was the causative organism and whether the patient developed a secondary bloodstream infection. Additional information was requested for primary bloodstream infection, pneumonia, surgical site infection and urinary tract infection. For pneumonia, the infection was categorised as either clinically defined pneumonia, pneumonia with specific laboratory findings, or pneumonia in immunocompromised patients, with algorithms provided to guide the categorisation. LRTIOP includes bronchitis, tracheobronchitis, bronchiolitis, tracheitis, without evidence of paneumonia and lung abscess and empyema.[5] The relationship between risk factors or any variables associated with infection are summarised by odds ratios with 95%

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confidence intervals calcuated by the score method.[6] For the variation between age groups, one degree of freedom for linear trend is reported.

Results

The overall prevalence of HCAI was 7.59% (5,743/75,694). Full details of the overall results and risk factors for all HCAIs can be found elsewhere.[2,3] Nine hundred (15.7%) of these infections were classed as pneumonias, of which 719 (79.9%) were clinically defined pneumonia;165 (18.3%) were ventilator-associated pneumonia (VAP); 121 (13.4%) were pneumonia with specific laboratory findings and 30 (3.3%) were in immunocompromised patients. Of all HCAI 402 (7.0%) of the infections were classed as LRTIOP. The prevalence of both infections increased substantially with age, threefold from the under 35s to the over 85s (Table 1; $p<0.001$) and was higher for males than for females, especially for pneumonia (1.53% vs. 0.92%, $p<0.001$), but also for LRTIOP (0.62% vs 0.46%, $p=0.003$).

Mechanical ventilation was used either currently or in the preceding seven days in 23.7% of patients with pneumonia and in 18.2% of patients with LRTIOP, compared to 5.2% of patients in the whole study population (Table 2). The increased risk related much more strongly to current than recent use.

Meticillin-resistant *Staphylococcus aureus* (MRSA) was the cause in 18.1% of LRTIOPs compared to 7.6% of pneumonias, $p<0.001$ (Table 3). These figures exclude 47 and 16 patients with pneumonia and LRTIOP respectively where the question was either not answered or where susceptibility testing results were not available. Rather more patients with LRTIOP (4.2%) had concurrent diarrhoea due to *Clostridium difficile*, compared to patients with pneumonia (2.4%), $p=0.08$. There were other concomitant infections such as surgical site infection, primary bloodstream

infection etc. in 137 (15.2%) of the patients with pneumonia and 66 (16.4%) of patients with LRTIOP.

Discussion

This survey, has confirmed the burden of lower respiratory tract infection in patients with healthcare-associated infection. The limitations of the data reported here include the narrow dataset used; however the focussed dataset was designed to facilitate the participation of as large a number of centres and the inclusion of as many patients as possible, hence the success in recruiting over 75,000 patients. The absence of any data relating to intrinsic risk factors, (apart from age and sex), such as medications, underlying lung disease, other chronic illnesses, etc, means that it is difficult to identify clearly from this survey, all those categories of patients at greatest risk. Other limitations include the seasonal implications of conducting a prevalence study over a relatively prolonged period of time i.e. February to May 2006. Some variations in the data collection between the various health systems in England, Wales, Northern Ireland and the Republic of Ireland may have occurred but all used the same data set and unmodified CDC definitions.

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The CDC definitions have been widely employed for surveillance purposes.[5] Following this prevalence survey an evaluation was carried out in England and Northern Ireland and participants found the pneumonia definitions the most difficult to apply of all the definitions. In particular a number of hospitals commented that the requirement for at least one chest x-ray to complete the pneumonia diagnosis meant that some infections, judged clinically to be pneumonia, could not be categorised as such because x-rays are not necessarily routinely obtained in the management of such patients. In Wales the prevalence of pneumonia was lower (0.68%) than in the other countries (0.86-1.29%)[2], and this was also thought to be due to the difficulty in accessing chest x-ray results to complete the diagnosis in some hospitals.[7]

Much of the data on pneumonia published elsewhere focusses on the ventilated patient in the intensive care unit, where *S. aureus* is a common and important cause,[8-11] but there is relatively little data on patients outside critical care units. In our study, MRSA was more common in LRTIOP, not commonly described in ventilated patients compared with pneumonia, and as LRTIOP includes empyema, it is often a more prolonged illness and this impacts on prevalence.

In recent UK guidelines on the management of hospital-acquired pneumonia, avoidance of endotracheal aspirations, and quantifying the number of pathogens on culture with the presence of intracellular pathogens as predictors of infection were the only guidelines with a strong evidence base.[12] A recent Cochrane review found no evidence that the use of quantitative cultures of respiratory secretions results in reduced mortality, reduced periods of ventilation or better antibiotic use, compared with non-quantitative cultures.[13]

Measures to prevent VAP are well described although the evidence-base is sub-optimal. The use of sucralfate as stress ulcer prophylaxis, the use of oscillating beds, and selective digestive tract decontamination have a scientific base.[16] Developing care protocols for weaning and sedation, sucralfate for stress ulcer prophylaxis, physiotherapy, respiratory therapists and keeping patients in the semi-recumbent position (30-45°C), had the strongest evidence base in recent UK guidelines.[12]

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A higher proportion of infections were recorded as being due to MRSA in patients with LRTIOP (18.1%) compared with pneumonia (7.6%), and *C. difficile* was also more common in the LRTIOP group. This may suggest poor specificity in the diagnosis of LRTIOP, i.e. MRSA from respiratory samples representing colonisation only and not true infection. The consequent overuse of antibiotics to treat patients with suspected LRTIOP contributes to *C. difficile*, being more common than in patients with pneumonia.

There is increasing attention on quality measures of health delivery as they pertain to HCAI, and VAP rates have been suggested as one such measure.[15] However, Klompas and Platt have recently argued against VAP as a quality measure for benchmarking and for public reporting, as the clinical, laboratory and radiological diagnosis is inaccurate and the CDC definitions were developed for epidemiological surveillance, but not necessarily for inter-institutional comparisons.[16] Nonetheless, the 2006 HIS Prevalence Survey has confirmed the important contribution that lower respiratory tract infections make to the overall prevalence of HCAI.

Standard infection prevetion and control precautions together with other measures, e.g. avoiding mechanical ventilation or reducing its duration where possible, sucralfate for stress ulcer prophylaxis, and the management of patients in the semi-recumbent position, are all measures that will contribute to reducing its prevalence. Other interventions such as the more accurate diagnosis of LRTIOP and improved antibiotic stewardship will contribute to reducing MRSA and *C. difficile*.

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Acknowledgements

This survey would not have been completed successfully and within schedule without the cooperation and support of the co-ordinators, microbiologists, infection prevention and control teams and other staff within the participating hospitals. We would like to acknowledge the assistance given by members of the Hospital Infection Society and the Infection Prevention Society (formerly the Infection Control Nurses Association) who helped with the training of the participants. We would also acknowledge the assistance and support of the members of Welsh Healthcare-Associated Infection Programme, Northern Ireland Healthcare Associated Infection Surveillance Centre (Belfast) and the Health Protection Surveillance Centre (Dublin) who contributed to the success of the prevalence survey. In addition, we would like to thank the other members of the HIS Healthcare-Associated Infection Prevalence Survey Steering Group: Dr Robert Cunney, Professor Brian Duerden, Dr Adam Fraise, Ms. Carole Fry, Dr Marjory Greig, Dr Tony Howard, Mr Martin Kiernan, Ms Christine Perry, Dr Jacqui Reilly, Dr Judith Richards, Dr Geoff Ridgway, and Dr Mike Simmons.

This work has been supported by grants from the Department of Health, England, the Department of Health Social Services & Public Safety, Northern Ireland, the Welsh Assembly Government, Wales and the Health Service Executive, Republic of Ireland.

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In a prospective study in Spain, the incidence of hospital-acquired pneumonia was three cases/1,000 hospital admissions and an aetiological agent was obtained in 36.4% of cases.[8] When comparing the outcomes from two different treatments in 544 patients with VAP, *S. aureus* was the most commonly identified pathogen, recovered in 221 patients, including 91 with MRSA.[9] In a retrospective analysis of pooled patient data from multiple clinical trials in France, patients with MRSA VAP were significantly older than those with meticillin-susceptible *S. aureus*who had a median duration of mechanical ventilation of eight days, compared with 13 days for patients with MRSA.[10] In a study by Shorr and colleagues, patients with MRSA had a longer stay in the ICU and their treatment was associated with considerable higher costs (US $7,731) per patient.[11]

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There is increasing attention on quality measures of health delivery as they pertain to HCAI, and VAP rates have been suggested as one such measure.[12] However, Klompas and Platt have recently argued against VAP as a quality measure for benchmarking and for public reporting, as the clinical, laboratory and radiological diagnosis is inaccurate and the CDC definitions were developed for epidemiological surveillance, but not necessarily for inter-institutional comparisons.[13]

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, and the same applies irrespective of whether invasive or non-invasive sampling is carried out.

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Therefore although there is confusion about the approach to the accurate diagnosis of pneumonia, esepcially in ventilated patients, the CDC definitions are used internationally

for surveillance purposes whatever their shortcomings in the management of the individual patient.

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, even if there is concern about the emergence of antibiotic resistance with this approach

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Standard precautions including hand hygiene and good professional practice are also essential. Clearly, avoiding instrumentation, e.g. intubation or tracheostomy, where clinically possible and reducing as much as possible the duration of ventilation, will also contribute to reducing VAP rates.

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the use of but not the routine changing of heat moisture exchangers, non-invasive ventilation where possible,

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Although antibiotic-associated diarrhoea due to *C. difficile* was first described in 1978, the emergence of new strains, particularly ribotype 027 which is associated with increased transmissibility and virulence, has focusssed greater efforts on prevention and control.[17] The association between *C. difficile* ribotype 027 and the use of fluoroquinolones has led to the banning of all such agents in some hospitals together with limitations on the use of cephalosporins and clindamcyin.[18]