Incidence and prevalence of hospital-acquired infections in a cohort of patients admitted to medical departments

Martin Haubro Petersen, Morten Olskjær Holm, Svend Stenvang Pedersen, Annmarie Touborg Lassen & Court Pedersen

ABSTRACT

INTRODUCTION: Hospital-acquired infections (HAI) are a significant cause of morbidity and mortality. Only point prevalence analyses of HAI have been recorded in Denmark. The aim of this study was to investigate the incidence and prevalence of HAI in patients admitted to departments of internal medicine.

MATERIAL AND METHODS: The study involved seven departments and was designed as a cohort study based on reviews of medical records. Except for patients who had previously been admitted within the preceding 30 days, the study included all patients admitted for more than 48 hours during the 45-day study period. HAI was defined according to the criteria established by the Center for Disease Control and Prevention, USA.

RESULTS: The incidence of HAI was 1.7 (62/3,568) per 100 days at risk (95% confidence interval (CI) 1.4-2.2), while the total prevalence of HAI was 9.7% (345/3,568) (95% CI 8.7-10.6). Exposure to bladder catheter was associated with an increased risk of urinary tract infection, incidence rate ratio 4.9; (95% CI 1.8-11.5). For the initial 14 days of hospitalization, the incidence of HAI was independent, while the prevalence increased linearly with duration of admittance.

CONCLUSION: The incidence of HAI was relatively constant during the initial 14-day-period of hospitalization, suggesting that shortening the period will have no major impact on the incidence of HAI. The prevalence was 9.7%, which is in line with results from prior studies.

Hospital-acquired infections (HAI) are a significant cause of increased morbidity and mortality in hospitalized patients [1, 2]. In addition, HAI are a cause of prolonged hospital admittance, are inconvenient for the patient, and constitute an economic burden on health care [3-6].

Previously, only point prevalence analyses of HAI have been recorded in Denmark [7-9]. These studies have shown prevalences ranging from 2% and up to almost 50% with large interdepartmental differences [7, 8]. In medical departments, the prevalence of the four major types of HAI (lower respiratory tract infection and pneumonia (LRT+PNEU), urinary tract infection (UTI), surgical site infections (SSI) and bacteraemia (BSI)) reportedly range from 4.9% to 7.8% [7].

No Danish studies have evaluated the incidence of HAI at departments of internal medicine, which makes it difficult to determine the risk of developing HAI.

The aim of the present study was to investigate the incidence and prevalence of HAI in patients hospitalized at the departments of internal medicine at Odense University Hospital (OUH), Denmark. Furthermore, we wanted to describe the pattern of infections and to investigate possible HAI risk factors.

MATERIAL AND METHODS

With few exceptions, all patients were admitted to the Acute Medical Department (AMA). From here, patients would be assigned to a specialized department, usually within 1-2 work days, unless the duration of their hospitalization was expected to be very short. The study included the AMA and the following specialized departments: Rheumatology, Pulmonary Diseases, Geriatrics, Endocrinology, Infectious Diseases, and Gastroenterology. The Departments of Nephrology and Haematology did not participate.

The study was designed as a cohort study based on a review of medical records immediately after discharge, and it included all patients who were admitted to one or more of the seven departments for at least 48 hours during the study period. The inclusion period began on 24 February 2009 and ended 9 April 2009 (a total of 45 days). The inclusion period was followed by a 14-day follow-up period for patients who had been included, but not yet discharged at the end of the inclusion period.

HAI was defined according to the criteria established by the Centers for Disease Control and Prevention (CDC) Atlanta, USA, 2008 [10]. For HAI to be registered there must be no evidence suggesting that the infection was present or incubating at the time of admission.

To reduce the risk of registering infections that the patients had acquired during a prior contact with the healthcare system, patients with previous hospital admittance within the preceding 30 days were excluded from the study. To reduce the risk of registering commu-

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Odense University Hospital, Department of Infectious Diseases, Denmark

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nity-acquired infections, only infections with symptoms that developed more than 48 hours after hospitalization were registered as HAI.

Demographic data as well as the patients' prior and present health status were registered at the time of admission. The following variables were recorded: gender, age (10-year intervals), presence of chronic disease (defined as a Charlson index > 1) [11], medication with antibiotics or immunosuppressive agents, abuse of alcohol (as defined in the guidelines of the Danish National Board of Health), tobacco or narcotics (defined as any use). At the time of discharge, the medical record for the current episode of hospitalization was reviewed. All invasive procedures as well as treatment with antibiotics or immunosuppressive agents were registered. Finally, it was registered, whether the patient fulfilled the HAI criteria during the period of admission. For those who had HAI, the duration of the infection was also registered, defined as the time from onset of symptoms to either the time of discontinuation of treatment or the last day with symptoms, whichever occurred later.

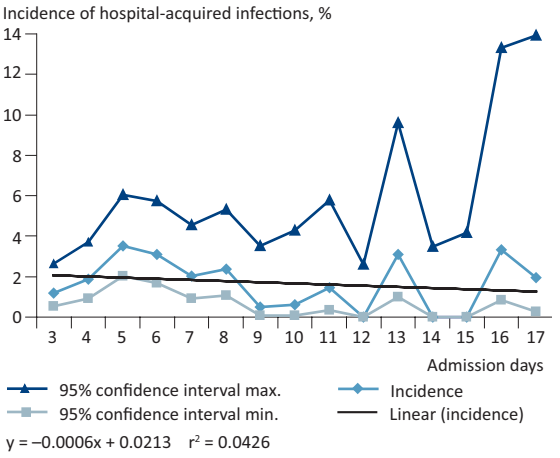
All data were harvested from electronic patient charts (Cambio Cosmis and Funen Patient Administrative System (FPAS)).

The number of patients with HAI was calculated as a proportion of all included patients. The incidence was defined as the number of HAI per 100 admission days at risk. Days at risk was defined as number of days admitted after the initial 48 hours of admission. Point prevalence was defined as the total number of days with HAI per 100 days of admittance. 95% confidence intervals (CI) were calculated using the Poisson distribution. Univariate analysis was performed with the χ^2 test. Test for trend was calculated using the nonparametric test for trend described by Cuzick [12]. All basic calculations and data computing was done in Microsoft Excel version 2007 and Stata (release 8; Stata Corporation, College Station, TX)

The study was approved by the Danish Data Protection Agency.

FIGURE 1

Incidence of hospital-acquired infections and association with duration of hospitalization. Incidence of hospital-acquired infections was defined as the proportion of newly diagnosed hospital-acquired infections in patients who had been hospitalized for more than 48 hours at symptom onset. p for trend = 0.491.



RESULTS

Population

During the inclusion period, 792 patients were admitted and had a hospital admission with a duration exceeding 48 hours. A total of 278 of these patients were excluded because they had been admitted to hospital within the preceding 30 days. Furthermore, eight patients were excluded due to lack of data. In nine cases, follow-up terminated before discharge because patients were still admitted 14 days after the last day of the inclusion period. The 506 patients included in the study represented a total of 4,580 hospital admission days of which 3,568 were days at risk for HAI according to our case definition.

Incidence

During the study period, a total of 62 HAI events were recorded in 55 patients. Consequently, 10.9% (55/506) of the patients (95% CI 8.2-13.6) developed one or several HAI during admittance. In total, the incidence of HAI was 1.7 (62/3,568) per 100 days at risk (95% CI 1.4-2.2). The specific types of HAI were distributed as follows: 21 gastrointestinal infections (GI) (19 norovirus, two *Clostridium difficile*), 15 urinary tract infections (UTI), 15 eye-, ear-, nose- and throat infections, four pneumonias (PNEU), three lower respiratory tract infections (LRI), two bloodstream infections (BSI), one skin and soft tissue infection (SST) and one vaginal tract infection (VI).

The incidence of HAI in relation to days of hospitalization is shown in **Figure 1**. The incidence rate ranged from 0% to 3.5%. Test for trend showed that there was no correlation between the duration of admittance and HAI incidence (p = 0.491).

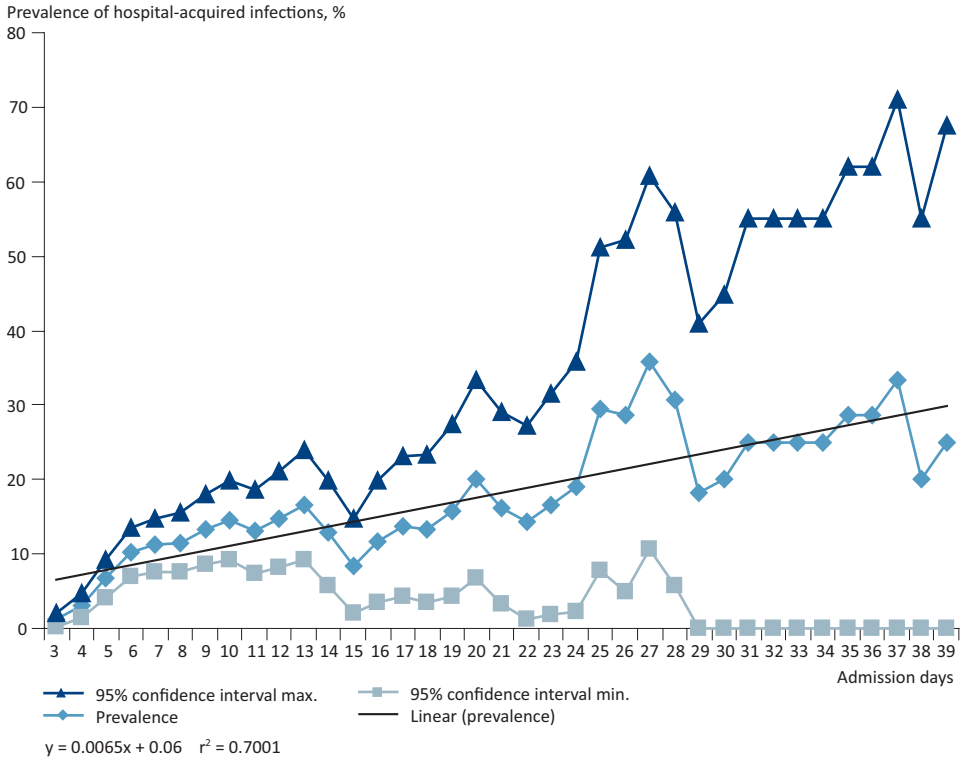
When analyzing the impact of potential HAI predisposing factors, we found no significant correlation between the overall risk of HAI and gender, age, alcohol, tobacco or drug abuse, co-morbidity or use of antibiotics or immunosuppressive agents prior to admittance. Analyses were also performed for each specific type of HAI. There was a significant correlation between bladder catheterization and development of UTI (incidence rate ratio (IRR) 4.9; 95% CI (1.8-13.5)). No other statistically significant correlations were found.

Prevalence

The overall prevalence of HAI for the entire study period was 9.7% (345/3,568) (95% CI 8.7-10.6) calculated as the

FIGURE 2

Prevalence of hospital-acquired infections and association with duration of hospitalization. The fraction of hospital-acquired infections among all patients is reported by day of hospitalization. The prevalence increases with the number of hospitalization days. p for trend < 0.000.



total number of days with HAI (345 days) divided by the number of days at risk (3,568 days).

Figure 2 shows the prevalence of HAI distributed on days of admittance. The prevalence increased with the duration of admittance ($p < 0.001$) by approximately 0.6% per day.

DISCUSSION

We found an incidence of 1.7 HAI per 100 days at risk (95% CI 1.4-2.2). We found no correlation between incidence and duration of admittance, which indicates that the individual risk of infection on a daily basis remained stable throughout the entire period of hospitalization. This is somewhat surprising since patients who have been hospitalized for an extended period are presumably weaker than other patients and therefore more susceptible to infection. Few patients were admitted for more than 10-14 days, and we cannot exclude that the incidence rate may increase with even longer hospitalization periods.

The overall HAI prevalence was 9.7% (95% CI 8.7-10.6). As expected, the prevalence increased with the duration of hospitalization. Point prevalence surveys of HAI will therefore usually show a higher prevalence in departments where the duration of hospitalization is long and a lower prevalence in departments where the duration is short. Point prevalence studies alone can therefore not be used to compare the standard of hygiene or the efficiency of HAI prophylactic initiatives in a specific department over time or to compare departments.

The national Danish prevalence surveys of 2008 and 2009 from ''Statens Serum Instituts Centrale Afsnit for Sygehushygiejne'' (SSI-CAS) showed that prevalences of HAI in internal medical wards ranged from 4.9% to 7.8% (CI not available). These two surveys did not use the exact criteria defined by the CDC, and they only registered four types of infection: LRT+PNEU, BSI, UTI and SSI. It is therefore not surprising that the surveys found a lower prevalence than the present study, as we included more types of infection, most importantly GI infections, which were common in our study. If we had only registered the four types of infection included in the survey from the SSI, we would have found a prevalence of 4.6% (164/3,568) (95% CI 3.9-5.3).

In 2003, the SSI-CAS made a point prevalence survey using the exact criteria established by the CDC and reported a prevalence of 6.0% for internal medical departments, which was lower than in our study. There may be several explanations for this. In the national

Danish prevalence study, all patients were included regardless of the duration of their hospitalization. We only included patients with a hospitalization period exceeding 48 hours. A relatively large group of patients in our study had GI. Disregarding these cases, we still recorded a higher prevalence (8.1%) (95% CI 7.2-9.0%), than in the 2003 survey. Whether this difference reflects a true increase in the incidence of HAI or differences in study design, data registration or duration of hospitalization cannot be determined from the available data.

The strengths of this study include a well-defined patient population and a prospective study design. This ensured that the incidence and prevalence estimates were not made on selected populations, and that the results may be compared to those of other studies using similar designs. The number of patients and the number of days at risk were relatively large, and the exclusion of patients who had been admitted within the previous 30 days minimized the risk of including patients who had acquired the infection before their current hospitalization. However, the study also had some limitations. Patients who had received healthcare in an outpatient setting (general practice, dentists, outpatient clinics) before hospitalization were not excluded, and we cannot rule out that some infections were acquired in such settings. Furthermore, we included only patients admitted to specific medical wards. Our result must be interpreted in this context, and they should not be extrapolated to other types of medical departments.

Prior to the study, we defined several possible HAI predisposing factors, including age, chronic illness, bladder catheter, treatment with immunosuppressive agents or antibiotics, among others. Except for bladder catheterization, which was associated with an increased risk of UTI, we found no statistically significant correlations between the selected predisposing factors and the HAI incidence. This does not rule out, however, that there may be an association between some of these factors and the risk of HAI. Our study did not have sufficient statistical power to detect small differences in risk, and especially for risk factors that were present in only a minority of the patients, the lack of association should be interpreted cautiously. Despite this limitation, our data indicate that the presence of such specific potential risk factors cannot explain the majority of HAI.

Data were extracted from the electronic patient chart or from the FPAS. This type of registration has been used in former surveys [8, 9]. In the majority of HAI surveillance studies, it has been the departments' responsibility to register the occurrence of HAI. This may have an impact on the diagnostic approach to patients with even mild symptoms suggestive of infection, e.g. doing more microbiological tests than usually. We had no influence on the diagnostic tests performed, and although it is possible that we may have underestimated the number of HAI, it seems unlikely that we should have underestimated the number of clinically important episodes. In the present study, we did not evaluate episodes of HAI occurring after discharge. Taking all aspects of our study design in consideration, it is likely that we underestimated the true incidence of HAI.

In conclusion, we found a high HAI incidence rate in patients admitted to departments of internal medicine, and – somewhat surprisingly – the incidence rate was not associated with the duration of hospitalization up to 14 days. Although the study had some limitations, which may have led to an underestimation of the true incidence rate, and even though some of the infections may be considered relatively mild, there is no doubt that the incidence rate of HAI is unacceptably high. There is a need for interventions to reduce this incidence [13-15]. On the basis of the high incidence of UTI and infections caused by norovirus observed in our study and in the light of the current dramatic increase in infections caused by *Clostridium difficile* in some hospital settings [16, 17], it seems that internal medicine departments should prioritize the implementation of strategies aimed at preventing UTI [18], and most urgently take control measures to reduce fecal-oral transmission of infectious agents [19, 20].

CORRESPONDENCE: *Morten Olskjær Holm*, Department of Infectious Diseases, Odense University Hospital, 5000 Odense, Denmark.
E-mail: morten@sjoko.dk.
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