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Healthcare-associated infection among residents of long-term care facilities: a cohort and nested case–control study

H.M. Eriksen [a,*], A.M. Koch [b], P. Elstrøm [a], R.M. Nilsen [b], S. Harthug [a,b], P. Aavitsland [a]

[a] *Department of Infectious Disease Epidemiology, Norwegian Institute of Public Health, Oslo, Norway*
[b] *Department of Infection Control, Haukeland University Hospital, Bergen, Norway*

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Summary Knowledge of infection control measures in nursing homes is limited. This study aimed to assess the incidence of, and potential risk factors for, healthcare-associated infection in long-term care facilities in Norway. Incidence of healthcare-associated infection was recorded prospectively in six long-term care facilities located in two major cities in Norway between 1 October 2004 and 31 March 2005. For each resident with an infection we aimed for two controls in a nested case–control study to identify potential risk factors. Incidence of infection was 5.2 per 1000 resident-days. Urinary and lower respiratory tract infections were the most common. Patients confined to their beds [odds ratio (OR = 2.7)], who stayed <28 days (OR = 1.5), had chronic heart disease (OR = 1.3), urinary incontinence (OR = 1.5), an indwelling urinary catheter (OR = 2.0) or skin ulcers (OR = 1.8) were shown to have a greater risk for infection. Age, sex and accommodated in a two- versus single-bed room were not significant factors. Incidence of infection in nursing homes in Norway is within the range reported from other countries. This study identified several important risk factors for healthcare-associated infection. There is a need to prevent infection by implementing infection control programmes including surveillance in long-term care facilities.

* Corresponding author. Address: Norwegian Institute of Public Health, Department of Infectious Disease Epidemiology, Postboks 4404, Nydalen, N-0403 Oslo, Norway. Tel.: +47 22 04 26 25; fax: +47 22 04 25 13.
E-mail address: hmer@fhi.no

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Introduction

Healthcare-associated infections are common and important causes of illness among elderly residents in long-term care facilities. Prevalence surveys from Norway have shown that at any given time, one in 17 residents (around 6%) had either urinary tract, lower respiratory tract, skin or surgical site infection.[1] Other countries have reported prevalences from 5 to 16%.[2–6] In North America, incidence rates have varied between 1.8 and 13.5 infections per 1000 resident days.[7]

Over the last few years, increased attention has been given to infection control in long-term care facilities. It is clear that the magnitude of the infection problem is comparable to that in acute care hospitals. In addition, residents and staff move between long-term care facilities and hospitals, bringing with them nosocomial pathogens.[8] The increasing problem of meticillin-resistant *Staphylococcus aureus* (MRSA) in long-term care facilities highlights the need for increased focus on infection prevention.[9,10]

Long-term care facilities in Norway are free-standing, usually owned and run by the municipal authorities, and not part of acute hospitals. They provide 24 hrs nursing care and related medical services. While 14% of beds are special units for persons suffering from dementia, about 11% of beds are allocated for short-term stay only.[11] In 2003 there were 1000 long-term care facilities with a total capacity of 41 718 beds in Norway, twice as many as in 1984. Of those living in a long-term care facility, 77% were aged >80 years.[12–14] Most residents have complex medical problems, which may further increase susceptibility to infection.

The main objectives of this study were to measure the incidence of healthcare-associated infection in long-term care facilities and to assess the risk factors in order to improve the knowledge base for infection control measures.

Methods

Incidence of healthcare-associated infection was assessed in an open cohort study of 791 resident-beds in six long-term care facilities between 1 October 2004 and 31 March 2005. There was no post-discharge follow-up. We performed a nested case–control study to identify potential risk factors. Controls were randomly chosen from the cohort.

Study site and population

All residents in six long-term care facilities (three in the capital, Oslo and three in Bergen, a major town of Norway) were included. The institutions were invited to participate based on the size (having >60 beds) and being located in Oslo or Bergen.

Case finding and denominator

The institutions were visited weekly by one of the project workers. In between visits, ward physicians were responsible for listing, on a given form, all residents diagnosed with a healthcare-associated infection. During the weekly visit, medical records were examined for prescribed antibiotics, laboratory reports, additional case finding and to confirm that identified infections were healthcare-associated.

For the denominator we used the number of beds in the facility. Beds are never empty for >12 h. It is therefore possible to use denominator data (resident bed-days) from the institutions' resident records.

Data collection on risk factors

Information on potential risk factors for cases and controls was collected from medical and nursing records and recorded in a questionnaire form. The registered information was confirmed by health personnel to ensure data quality.

Case and control definitions

A case was defined as a person who was a resident during the study period and who met the criteria for healthcare-associated infection listed by McGeers *et al.*[15] If a resident had two episodes of the same type of infection within a month, the ward physician decided whether the second episode should be recorded as a new infection or not. Two different types of infection in the same resident were recorded as multiple infections. Infections appearing <48 hrs after admission were not recorded as healthcare-associated.

A control was defined as a person being a resident for >48 hrs in one of the six facilities during the study period.

Selection of controls

We expected 500 cases and aimed for twice the number of controls. We applied density and risk-set sampling of unmatched controls (13–15) by selecting every week potential controls among all residents. We numbered all beds in the six facilities consecutively and generated 45 random bed numbers each week and chose the occupant of those beds as potential controls.

Statistical analyses

We entered all data in SPSS Data Entry for Windows version 3.0 and analysed the data with SPSS version 12.0.1 for Windows. We calculated incidence rates and their corresponding 95% confidence intervals (CIs) using Episheet 2002. All potential risk variables where the 95% CI of crude odds ratio (OR) did not include '1.0' or with an OR higher than 1.5 were included in a multiple logistic regression model. The model also included the variables age and sex. Risk factors for infection were identified using stepwise forward analyses. The size of the effect of the factors was quantified by ORs with 95% CI. Pneumonia was analysed together with lower respiratory tract infections. We did not include gastroenteritis that occurred as part of a norovirus outbreak in the analyses.

Ethical considerations

The study was recommended by the Regional Committee for Medical Research Ethics and approved by the Data Inspectorate and Directorate of Health and Social Affairs. The study did not entail any contact with, or interventions on, patients. Residents and their relatives were informed about the project through posters placed on information boards in the institutions.

Results

The six enrolled long-term care facilities had 791 beds, ranging from 64 to 198 (Table I). This provided 142 688 days of resident care. Seventy-eight percent of residents were aged >81 years. During the study period 747 healthcare-associated infections were identified. Of these, 57 were gastroenteritis, occurring as part of a norovirus outbreak. Urinary tract and lower respiratory tract infections were most common (Table II). The overall incidence was 5.2 infections per 1000 resident-days, ranging from 3.7 to 6.2 infections per 1000 resident-days with overlapping CIs between facilities.

The incidence rate for the different months varied from 0.7 to 1.0 per 1000. The lowest rate was in December, the highest in January. Antibiotics were given in 94% of episodes.

Adjusted risk factors for any healthcare-associated infection were being bedridden, urinary incontinence, presence of a urinary catheter, skin ulcers, chronic heart disease and having stayed <28 days in the institution. Factors such as age, sex and number of patients in a room did not increase the risk of infection (Table III).

Urinary incontinence, the presence of a urinary catheter and chronic heart disease were associated with urinary tract infection. There was no difference in risk between using an indwelling or intermittent catheter, between the sexes or among females who received or did not receive oestrogen (Tables IV and V). Residents having a chronic pulmonary disease, in need of feeding assistance or being bedridden were associated with lower respiratory tract infections. Lack of influenza vaccination and smoking were not identified as risk factors.

Discussion

The overall incidence rate of healthcare-associated infection was 5.2 per 1000 resident-days (range 3.7–6.2). Urinary tract infection was the most frequently diagnosed healthcare-associated infection followed by lower respiratory tract infection. Risk factors for acquiring urinary tract infections were chronic heart disease, urinary incontinence and urinary catheterization. Risk factors associated with lower respiratory tract infections were chronic pulmonary disease, receiving feeding assistance and being bedridden.

Table I Characteristics of the included facilities recorded on 31 December 2004

Facility	Residents (*N*)	No. of wards	% of females	% aged >81 years	Nursing factor[a]	Physician-hours per resident, per week
1	129	7	76	87	0.8	0.3
2	202	9	70	80	[b]	0.3
3	134	8	72	75	[b]	0.2
4	188	7	71	71	0.8	0.2
5	74	8	75	73	0.9	0.3
6	64	8	75	70	0.9	0.3

[a] Number of full-time nurse positions per resident bed.
[b] Information not available.

Table II Incidence of healthcare-associated infections in six long-term care facilities in Norway, October 2004–March 2005

Type of infection	Infections per month						Total *N* (%)	Incidence by 1000 resident-days	95% CI
	Oct	Nov	Dec	Jan	Feb	Mar			
Urinary tract infection	61	65	33	45	44	37	285 (38.2)	2.0	1.8–2.2
Lower respiratory infection	31	25	31	41	22	53	203 (27.2)	1.4	1.2–1.6
Skin infection	12	21	12	10	13	5	73 (9.8)	0.5	0.4–0.6
Conjunctivitis	25	24	12	21	11	16	109 (14.6)	0.8	0.6–0.9
Gastroenteritis	0	0	15	25	20	0	60 (8.0)	0.4	0.3–0.5
Others	4	1	2	5	0	5	17 (2.3)	0.1	0.0–0.2
Total	133	136	105	147	110	116	747 (100)	5.2	4.9–5.6
Incidence per 1000	0.9	1.0	0.7	1.0	0.8	0.8			
95% CI	0.8–1.1	0.8–1.1	0.6–0.9	0.9–1.2	0.6–0.9	0.7–1.0			

CI = confidence interval.

Strengths and weaknesses of the study

This is the first published study of incidence of healthcare-associated infection in long-term care facilities in Norway. It is also one of few published articles on this topic in Europe. It has used recommended definitions and methods.[7,15]

Data were collected during the cold season. The magnitude of different infection types might vary by season. The highest incidence of lower respiratory tract infections was found in March. This corresponds with the peak of the influenza season. Seasonal variation might also affect the incidence of other types of infection. It can be argued that the incidence could have been different if the study included the summer months.

We only included information available in the resident records. Information on nutrition status was not available, but should ideally have been included, since this may influence the risk of infection.[7]

All diagnoses were made by the medical physicians attached to each facility. This could have lowered the sensitivity of case finding.[15] However, we went through patients' records, antibiotic prescriptions and reports from laboratories to look for additional infections and confirm that the infections reported by physicians were healthcare-associated. Only 6% of the infections in the study were not treated with antibiotics. Infections that do not need medical treatment are rarely reported to the physician or in patient records. Thus, we may have missed some less severe infections.

Table III Risk factors for healthcare-associated infection among residents in six Norwegian long-term care facilities 1 October 2004 to 31 March 2005

	Cases (*N* = 690)	Controls (*N* = 1045)	OR (95% CI)	Adjusted OR[a] (95% CI)
Age <81 years	147/667	232/1024	1.0 (0.8–1.2)	
Female gender	491/688	778/1040	0.8 (0.7–1.0)	
<28 days in the institution	80/686	86/1039	1.5 (1.1–2.0)	1.5 (1.0–2.2)
Chronic pulmonary disease	69/690	75/1045	1.4 (1.0–2.0)	
Chronic heart disease	214/690	242/1044	1.5 (1.2–1.9)	1.3 (1.1–1.7)
Bedridden	56/687	20/1043	4.4 (2.7–7.6)	2.7 (1.5–5.2)
Demented	499/672	775/1017	0.9 (0.7–1.1)	
Urinary incontinence	511/670	681/1031	1.7 (1.3–2.1)	1.5 (1.2–2.0)
Urinary catheter last week	96/686	51/1038	3.2 (2.2–4.5)	2.0 (1.3–3.0)
Faecal incontinence	338/677	424/1023	1.4 (1.2–1.7)	
Skin ulcer	197/685	166/1036	2.1 (1.7–2.7)	1.8 (1.4–2.3)
Feeding assistance	173/679	190/1036	1.5 (1.2–2.0)	
Difficulty swallowing	125/679	134/1038	1.5 (1.2–2.0)	

OR = odds ratio; CI = confidence interval.
[a] Regression model included all variables shown in this table.

Table IV Risk factors for urinary tract infection among residents in six Norwegian long-term care facilities October 1, 2004 to March 31, 2005

	Cases (N = 285)	Controls (N = 1045)	OR (95% CI)	Adjusted OR[a] (95% CI)
Age <81	56/276	232/1024	0.9 (0.7–1.2)	
Female gender	217/284	778/1040	1.1 (0.8–1.5)	
<28 days in the institution	37/284	86/1039	1.7 (1.1–2.5)	
Chronic heart disease	100/285	242/1044	1.8 (1.4–2.4)	1.6 (1.2–2.2)
Oestrogen[b]	31/217	103/778	1.1 (0.7–1.7)	
Urinary incontinence	216/273	681/1031	2.0 (1.4–2.7)	1.7 (1.2–2.4)
Urinary tract catheter	53/284	51/1038	4.5 (3.0–6.7)	3.4 (2.1–5.4)
Intermittent catheter	17/49	13/49	1.6 (0.7–3.7)	
Faecal incontinence	142/276	424/1023	1.5 (1.2–2.0)	
Demented	216/281	775/1017	1.1 (0.8–1.4)	
Bedridden	18/282	20/1043	3.6 (1.9–6.7)	2.5 (1.1–5.3)

OR = Odds ratio; CI = confidence interval.
[a] Regression model included all variables shown in this table, except using estrogens and intermittent catheter.
[b] Oestrogen replacement therapy, only females included.

We expected 500 cases and aimed for twice the number of controls. Altogether we recorded 690 infections (excluding the norovirus outbreak) and 1045 controls. We therefore obtained fewer than two controls per case. We do not believe that this influenced the power of the study to any great extent.

Differences in methodologies and patient population do not allow stringent comparison of incidence between facilities and other countries. However, the incidence rate of healthcare-associated infection in Norway is of the same magnitude as that reported in surveys of selected facilities in other countries. Regardless of methodological differences, urinary tract infections seem to be the most frequent healthcare-associated infection followed by lower respiratory tract infection.[7,16] These similarities indicate that the incidence reported in our study is not atypical.

Identified risk factors are in accordance with those found elsewhere.[7,17,18] Other studies have identified age and number of residents in a room as risk factors.[7] In Norway, impaired physical or mental health is the main reason for admittance into a long-term care facility rather than age. This may be an explanation for age not being associated with infection in our study. Residents who share rooms usually have less physical morbidity. This

Table V Risk factors for lower respiratory tract infection among residents in six Norwegian long-term care facilities October 1, 2004 to March 31 2005

	Cases (N = 203)	Controls (N = 1045)	OR (95% CI)	Adjusted OR[a] (95% CI)
Age <81	37/196	232/1024	0.8 (0.6–1.3)	
Female gender	135/202	778/1040	0.7 (0.5–0.9)	
<28 days in the institution	26/200	86/1039	1.7 (1.1–2.7)	
Chronic pulmonary disease	27/203	75/1045	2.0 (1.3–3.2)	1.9 (1.1–3.2)
Chronic heart disease	64/203	242/1044	1.6 (1.1–2.2)	
Urinary incontinence	146/196	681/1031	1.5 (1.1–2.2)	
Urinary tract catheter	28/201	51/1038	3.2 (2.0–5.2)	2.0 (1.1–3.7)
Currently smoking	12/200	98/1027	0.7 (0.4–1.2)	
Oxygen therapy	8/202	4/1040	9.7 (3.3–28.4)	4.1 (0.9–18.2)
Nebulizer	6/202	19/1041	1.9 (0.8–4.4)	
Skin ulcer	47/202	166/1036	1.6 (1.1–2.3)	
Demented	139/197	775/1017	0.8 (0.5–1.1)	
Needs feeding assistance	62/201	190/1036	2.0 (1.4–2.8)	1.7 (1.2–2.5)
Swallowing difficulties	40/199	134/1038	1.7 (1.2–2.5)	
Bedridden	22/203	20/1043	6.2 (3.3–11.6)	3.3 (1.5–7.3)

OR = odds ratio; CI = confidence interval.
[a] Regression model included all variables shown in this table.

may be one reason why room sharing was not identified as a risk factor in our study.

In this and other studies the strongest predictor for symptomatic urinary tract infections was use of a urinary tract catheter.[17]

Influenza vaccination did not decrease the risk of developing a lower respiratory tract infection in our study. The fact that the influenza season in Norway started late in week 4, and did not peak before the end of this study, might explain this. Together with having a chronic pulmonary disease, those who were bedridden and were unable to eat independently, had an increased risk of lower respiratory tract infection. These variables have been identified in other studies.[7]

Having an infection control programme is one of several factors contributing to the prevention of healthcare-associated infection.[7,19,20] Long-term care facilities in Norway must by law have an infection control programme. Despite this, more than half of facilities lack such programmes (unpublished survey by Norwegian Institute of Public Health). This study highlights the importance of implementing infection control programmes.

It is important to target risk factors that may be influenced; for instance, guidelines for urinary catheters and restriction of their use.

Unanswered questions and future research

The degree to which admittance into a long-term care facility increases the risk of developing infection compared to elderly persons living at home should be examined, exploring whether it is old age and underlying disease or living in this type of facility that increases the risk of infection. As far as we know this type of study has not been performed.

Incidence surveillance is described as a good method, but many regard it as too resource demanding. In traditional incidence surveillance, a data collection form is filled out for all residents. In our study, residents with a healthcare-associated infection were listed on a data form. Denominator data were collected from readily available administrative records. We argue that this method is sensitive and less resource demanding in settings where bed occupancy can be assumed to be close to 100%, and where there are interested and allocated personnel. The sensitivity of this method perhaps should be examined further.

It could be useful to develop a risk index to improve comparability of surveillance data and to be better able to target infection control measures.

In conclusion, one in 200 residents of a long-term care facility develops a healthcare-associated infection every day. Several risk factors for developing such infection are identified. There is a need to focus on and improve infection prevention by implementing infection control programmes including surveillance of healthcare-associated infection in such facilities.

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