Use of antibiotics in nursing homes – surveillance with different methods

BACKGROUND Residents in nursing homes have a heightened risk of developing infections that should be treated with antibiotics. Inappropriate use of antibiotics may generate drug-related problems and increase resistance. In this study, we describe the use of antibiotics in nursing homes on the basis of prevalence surveys and drug sales statistics.

MATERIAL AND METHODS Five nursing homes in Oslo participated in two one-day surveys in 2009. All use of systemic antibiotics was registered. The data collection was undertaken according to a protocol developed by the European Surveillance of Antimicrobial Consumption (ESAC) Network and was part of a European study. The nursing homes' drug sales statistics for systemic antibiotics during 2009, distributed by the number of bed days for each nursing home, were estimated. Information on indications for each antibiotic from the prevalence surveys was collated with sales data to achieve an estimate of how the purchased antibiotics were used.

RESULTS The prevalence surveys showed that more than 8 % of the residents received antibiotics. Prophylactic treatment accounted for 33 % of the prescriptions. A prevalence of antibiotic use of 10 % was estimated from the drug sales statistics. Urinary tract infection was the most frequently registered indication. Pivmecillinam and methenamine were most frequently prescribed and most frequently purchased. Most courses of treatment were prescribed in accordance with the national guidelines for antibiotic use.

INTERPRETATION The results from the drug sales statistics concurred well with the prevalence surveys, and the methods can thus be relevant for purposes of monitoring the use of antibiotics.

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MAIN MESSAGE

The use of antibiotics varied among the five nursing homes included, but concurred with findings made by other Norwegian studies.

On the whole, the prescription pattern was in line with the national guidelines for the use of antibiotics in the primary health services.

Use of the institutions' drug sales statistics and prevalence surveys are relevant methods for monitoring the use of antibiotics in nursing homes.

The risk of developing an infection that ought to be treated with antibiotics is relatively high in the nursing home population, and the infections often entail serious consequences (1–3). From drug sales statistics, it has been estimated that the use of antibiotics in nursing homes accounts for approximately 6 % of all use of antibiotics on humans (4). Even when used in accordance with the guidelines, antibiotics may have adverse effects (6). Inappropriate use may give rise to increased cost for individual nursing homes and for society as a whole, in addition to development of resistant microbes (7). Proper use of antibiotics is therefore a general political goal, and monitoring of their use is a recommended measure (8).

Since 2009, use of antibiotics has been included as an optional part of the national prevalence surveys of healthcare-associated infections in hospitals. According to the *National strategy for prevention of infections in the health services and resistance to antibiotics (2008–2012)*, the Norwegian Institute of Public Health should assess whether to extend this option to nursing homes (8). Prevalence surveys are considered to be a surveillance method that requires a fairly limited amount of resources and is able to provide a snapshot of the prescribing practice. They can elucidate why residents are prescribed with antibiotics, but in the case of minor institutions in particular, the results are fraught with uncertainty (9). The use of antibiotics can also be estimated with the aid of the nursing homes' drug sales statistics. These provide information on the volume of the compounds for each department, but not on whether the correct type and dosage of antibiotics have been administered. To obtain such information, data at the patient level are required.

The purpose of this study was to describe the use of antibiotics in five nursing homes with the aid of two different methods – prevalence surveys and drug sales statistics – and to investigate how these two methods may supplement each other.

Material and method

Five nursing homes in the Oslo region were invited and agreed to participate (Table 1). These were selected because they had participated in registration of healthcare-associated infections on a previous occasion (n = 2) and/or the pharmacists in the research group had been in regular contact with them (n = 5).

Prevalence surveys

The data collection was undertaken on two days, one in April and one in November 2009. The protocol for the data collection was prepared by the European Surveillance of Antimicrobial Consumption (ESAC)

Table 1 Residents – number (%) – with various characteristics and the number of hours of medical attention per resident in five nursing homes in Oslo. Prevalence survey, November 2009

	Nursing home A n = 92		Nursing home B n = 107		Nursing home C n = 151		Nursing home D n = 126		Nursing home E n = 40		Total N = 516	
Urinary catheter	6	(6.5)	5	(4.7)	11	(7.3)	8	(6.3)	0		30	(5.8)
Vascular catheter	0		1	(0.9)	0		2	(1.6)	0		3	(0.6)
Incontinence	66	(71.7)	79	(73.8)	142	(94.0)	95	(75.4)	38	(95.0)	420	(81.4)
Wounds	9	(9.8)	18	(16.8)	30	(19.9)	8	(6.3)	2	(5.0)	67	(13.0)
Dementia	65	(70.7)	73	(68.2)	126	(83.4)	67	(53.2)	34	(85.0)	365	(70.7)
Immobile	32	(34.8)	36	(33.6)	49	(32.5)	38	(30.2)	9	(22.5)	164	(31.8)
Number of hours of medical attention per resident per week	0.4		0.5		0.5		0.4		0.5		0.5	

Network, now coordinated by the European Centre for Disease Prevention and Control (ECDC) (10). All residents in the five nursing homes were included. The number of residents and the number who had been prescribed antibacterial drugs (hereafter called antibiotics) at 8 a.m. on the days of study were registered. The antibiotics were registered with their trade names and classified according to the ATC system (11). Systemic antibiotics (ATC group J01), oral and rectal metronidazole (P01AB01) and vancomycin capsules (A07AA09) were registered. The use of locally acting antibiotics was not included.

The following information was defined in accordance with the ESAC protocol, totalled and registered at the department level and for residents who used antibiotics on the day of study: gender, age, urinary catheter, vascular catheter, urinary incontinence and/or faecal incontinence, wounds, «dementia condition» (disoriented about time and/or unable to recognise places and people), mobility status (persons who require a wheelchair in order to move or are bedridden are considered immobile), generic name of antibiotic, the, daily dose, mode of administration, indication and whether the treatment was given as prophylaxis or therapy (empirically or microbiologically documented).

The information was collected by the responsible nurse at the various departments from medication curves, prescription cards and patient records. If there was doubt regarding the information on a particular resident, the nursing home's doctor was consulted. All data that were recorded and taken out of the nursing home for analysis were anonymised, with no possibility for retracing of individuals. The members of the project group have had no access to the residents' records or other documents at the level of individual residents. We have only registered anonymous information provided by the nurses on relevant residents. Since the project collaborators had no access to personally identifiable information, and since this type of surveillance is pursuant to regulations, it was not necessary to apply for permission from the data Protection Official for research.

Drug sales statistics

The nursing homes' procurement of antibiotics, measured in terms of the number of defined daily doses (DDDs), for the same ATC groups as those included in the prevalence studies, were retrieved from the dispensing pharmacy (three nursing homes) and from the supplying wholesaler (two nursing homes) for all of 2009.

DDD is an internationally determined value, defined as the assumed average daily dose used for its main indication in adults, in the case of antibiotics the main indication is regarded to be moderate to severe infections. The DDD unit enables comparisons of medicine consumption between different healthcare institutions as well as descriptions of the use of pharmaceuticals over time. We used the 2011 version of ATC/DDD (11).

Information on the total number of bed days in 2009 for the different nursing homes was collected from their administrative systems. The consumption in each nursing home could subsequently be calculated and expressed as the number of DDDs per 100 bed days.

Collation of data from different sources

Information on the indications for the use of antibiotics, which had been recorded by the prevalence surveys, was transferred to the drug sales statistics. We did this by identifying the substances that were prescribed for the various indications. The following substances were used to treat respiratory tract infections (RTI) and categorised as «RTI therapy»: phenoxymethylpenicillin, amoxycillin, erythromycin. The following substances were used to treat urinary tract infections (UTI) and included as «UTI therapy»: pivmecillinam, trimethoprim, nitrofurantoin. The group «UTI prophylaxis» included methenamine, pivmecillinam, trimethoprim and nitrofurantoin. In the prevalence survey, some substances were used for several indications. If a substance had been used most frequently for one and the same indication, and had been administered in accordance with Norwegian guidelines, this therapy group was chosen. For example, if phenoxymethylpenicillin had been used nine times, of which six times for RTI, this therapy group was chosen. If a categorisation was impossible, the substance was included in the category «other indications».

To obtain a measure of the number of DDDs of a substance that was used for therapy versus prophylaxis. Hence, the dose prescribed to individual patients for the respective indications in the prevalence surveys was recalculated into DDDs. We assumed that all prophylactic treatment was being dosed continuously and administered throughout the six months covered by each prevalence survey. For example, if a patient used 100 mg of trimethoprim as prophylaxis on a daily basis in April, we assumed that this patient had used this every day during the six-month period 1 January–30 June, i.e. a total of 45 DDD (the official DDD for trimethoprim amounts to 400 mg). The total number of DDDs used as «UTI therapy» is therefore equal to the total DDDs used, minus the estimated number of DDDs used for «UTI prophylaxis» for the substance in question.

To assess the representativeness of the prevalence surveys, the drug sales statistics were produced as an annual prevalence

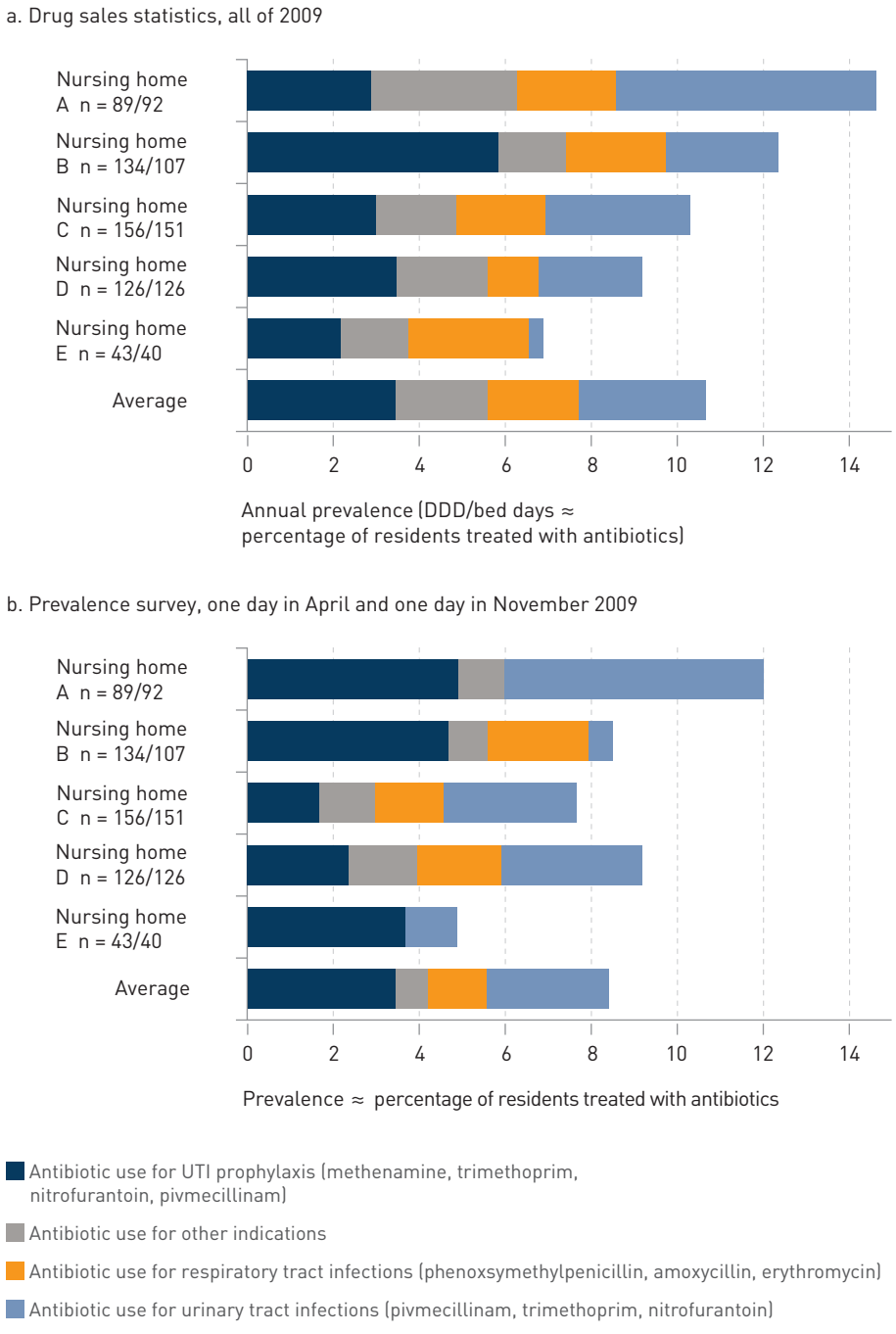

Figure 1 *Use of antibiotics for urinary tract infections, respiratory tract infections and other indications in five nursing homes in Oslo, estimated by a) drug sales statistics and b) registered in two prevalence surveys in 2009*

(DDD/100 bed days/year) and collated with the results from the prevalence surveys.

Statistics

Microsoft Excel and Stata 10.0 were used for the data analyses. The association between the use of antibiotics and characteristics of the residents (Table 1) was estimated in terms of the prevalence ratio. This measure is used in cross-sectional studies as an effect estimate for association (corresponding to «risk ratio» used in cohort studies) – i.e. the prevalence ratio is a measure of the likelihood of being administered with antibiotics, for example for residents with a urinary catheter, compared to the likelihood among residents who have no catheter. The prevalence ratio is reported with a confidence interval (CI) of 95 %.

Results

Prevalence surveys

The prevalence surveys included 548 residents in April and 516 in November. Characteristics of the residents in the various nursing homes in November are shown in Table 1. Corresponding characteristics were recorded in April (not shown).

The prevalence of residents who were prescribed with antibiotics amounted to 8.6 % (47/548) in April and 8.1 % (42/516) in November. Variations between the nursing homes are shown in Figure 1. Altogether 89 residents were prescribed with a total of 95 antibiotic courses. Some of these 89 residents may have been registered in both April and November. Altogether 64 of the antibiotic courses (67 %) were prescribed as treatment for an infection, while 31 residents (33 % of the prescriptions) were provided with prophylactic antibiotic treatment, all of which to prevent urinary tract infections. A total of 34 (53 %) of the infections treated with antibiotics were urinary tract infections. Ten residents were treated with antibiotics for respiratory tract infections (16 %), five were treated for skin infections (8 %), three for postoperative wound infections (5 %) and two for gastroenteritis (3 %). Ten residents (16 %) had other types of infections.

Pivmecillinam was the most frequently used antibiotic for purposes of treatment, and was administered to 19 residents. Four different types of antibiotics (methenamine, trimethoprim, pivmecillinam and nitrofurantoin) were used prophylactically. Methenamine was used in 21 of 31 prophylactic regimes. The doses administered and the substance chosen varied somewhat between the nursing homes for the different indications (data not shown), although for a majority of the courses of treatment, the choices of drugs as well as dosages were in accordance with national guidelines (5).

Table 2 shows an overview of risk factors associated with the use of antibiotics. Residents who had wounds used antibiotics 3.1 times more frequently than residents who had no wounds (PR 3.1; 95 % CI 2.1–4.5). Residents who used a urinary catheter (prevalence ratio 2.3; CI 95 % 1.2–4.7) or were immobile (prevalence ratio 1.4; CI 95 % 1.1–1.8) were provided with antibiotic treatment more frequently than residents who were not exposed to these risk factors. Residents with dementia were provided with antibiotics more rarely than residents who did not suffer from dementia (prevalence ratio 0.7; 95 % CI 0.5–0.9). Those who had a urinary catheter (prevalence ratio 4.6; 95 % CI 2.4–8.8) or were immobile (prevalence ratio 1.5; 95 % CI 1.1–2.2) were more often provided with prophylactic antibiotic treatment than residents with no such characteristics.

The nursing homes' drug sales statistics

The drug sales statistics show that on average, the nursing homes purchased 10.6

Table 2 Risk factors for prophylactic and therapeutic use of antibiotics in 1 064 residents in five nursing homes in Oslo in 2009

	Number of residents with relevant factors			
Factors	Received therapeutic antibiotics (n = 58)	Received prophylactic antibiotics (n = 31)	No antibiotics (n = 975)	Residents without relevant factors
Urinary catheter	8	8	55	993
Vascular catheter	0	1	5	1 058
Urinary incontinent	46	26	840	152
Wounds	23	4	118	919
Dementia	31	21	726	286
Immobile	29	16	331	688

DDD/100 bed days of antibiotics in 2009 (i.e. an annual prevalence of 10.6 %). As shown in Figure 1, the total volumes of substances in the different therapy groups varied between the nursing homes. In 2009, the two nursing homes with the smallest number of residents purchased the largest and the smallest volumes of antibiotics respectively, measured in terms of defined daily doses. The most frequently purchased antibiotic was methenamine (2.7 DDD/100 bed days), followed by pivmecillinam (2.5 DDD/100 bed days) (e-Table 3).

Drug sales statistics collated with prevalence surveys

A lower prevalence of antibiotic use (approximately 8 %) was recorded in the prevalence surveys than what was estimated with the aid of the drug sales statistics (approximately 10 %). Penicillins, trimethoprim and methenamine accounted for approximately 82 % of all purchases of antibiotics and 88 % and 71 % of the use in April and November, respectively. Substances defined as «UTI prophylaxis», «UTI therapy» and «RTI therapy» accounted for more than 80 % of the antibiotics purchased by four of the nursing homes (Figure 1). In the final nursing home, these accounted for 60 %. In this nursing home, methenamine was not used for purposes of prophylaxis.

In 2009, the five nursing homes purchased a total of 24 different antibiotic substances, 15 of which were registered in the prevalence surveys. These 15 accounts for 98 % of the DDDs in the drug sales statistics. Antibiotics registered in the prevalence surveys accounted for 73–91 % of the total number of DDDs in four of the nursing homes' drug sales statistics, while the nursing home with the smallest number of residents stood out from the others in that the antibiotics that were registered in the prevalence surveys accounted for only 36 % of the total number of DDDs in the nursing home's drug sales statistics.

Discussion

Our study showed that the prevalence surveys and the drug sales statistics provided similar estimates for both the total use of antibiotics and the therapy pattern. Both methods have their limitations, but more precise knowledge on how antibiotics are used can be obtained by collating the data.

The prevalence of antibiotic use in the five Norwegian nursing homes exceeded 8 %. This was higher than the average for the participating nursing homes in other European countries, where it amounted to approximately 6 % (12, 13). However, the results from the nursing homes included are not necessarily representative for all nursing homes. For example, the nursing homes in our study were selected because of their interest in infection control and because they had active pharmacists. .

The prescription pattern in this study is within the area of what has been found in other Norwegian studies (4, 14–17). Both methods used in our study revealed differences in the use of antibiotics between the five nursing homes. Such differences between nursing homes are known also from previous studies undertaken in Norway as well as abroad (4, 12, 18, 19). The causes of these variations may include risk factors associated with the residents, such as the use of catheters, or linked to the institution, such as measures for infection control (20). Different assessments as to whether an indication for treatment is present may also account for some of the variation. Differences in the use of methenamine account for a large proportion of the variation between the nursing homes – the reason is perhaps that the effect of methenamine is controversial (21). The European study showed that methenamine was used only in Norway, Finland and Denmark (13).

The antibiotics used by the nursing homes were of a variety of types, but they were mainly in line with the national guidelines for the use of antibiotics in the primary health services (5).

Prevalence surveys are characterised by their rough methodology, which makes it difficult to control for random fluctuations. Repeated registrations may provide more precise estimates (22). We undertook only two measurements, and this may explain the poorer correspondence between findings from the prevalence surveys and the findings made on the basis of drug sales statistics in the smallest of the four nursing homes.

Drug sales statistics also have their limitations. For antibiotics that are used rarely, the drug sales statistics may falsely indicate a high rate of use, if the package sizes purchased are large and thus left in storage. A Norwegian study that compared the true amounts of antibiotics administered to drug sales statistics found that use of the sales data from pharmacies was reliable, provided that the study periods exceeded six months (23). Our study used data for an entire year.

To improve practice related to antibiotic prescribing in nursing homes, it will be essential that results from the studies are discussed and used locally. It has been shown that measures such as training courses and antibiotic stewardship have reduced and changed the use of antibiotics (24, 25). In this context, surveillance of the use of antibiotics is a key tool.

Continuous surveillance is assumed to be the optimal method for showing the use of antibiotics, but as long as medication overviews in electronic patient records remain unavailable, this method will be highly resource-intensive. The combination of prevalence surveys and drug sales statistics requires relatively few resources, but the extent to which these will provide results corresponding to those from continuous registration of the use of antibiotics is not known. Further research on this topic is recommended.

To sum up, our study shows that the methods provide similar estimates, and by combining prevalence surveys with drug sales statistics the nursing homes obtain information on the total amount of antibiotics purchased as well as an indication of whether their prescribing practice is in line with national guidelines. Pharmacist advisors could be a resource in the surveillance of antibiotic use.

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