Background: The elderly use a large number of medications, which exposes them to an increased risk for medication-related errors, especially in nursing homes.

Objectives: The aim of this study was to investigate the impact of an educational session addressing good medication administration practices on the medication administration error rate in 2 nursing homes.

Method: A before-after study was performed, comparing outcome measurements 1 month before and 1 month after implementation of a formal training session on “good medication administration principles.” Medication administration errors were detected using a direct observation method. Two experts (a geriatrician and a clinical pharmacist) scored the clinical relevance of these errors. The study was carried out between March 2007 and June 2007.

Results: In both nursing homes, the overall error rate (preparation errors and administration errors) decreased after the intervention. This decrease was significant both in nursing home 1 (P < .001) and nursing home 2 (P = .049). None of the observed errors was rated highly likely to cause harm according to the experts.

Conclusion: An educational session about good medication administration practices provided by a pharmacist is a very simple way to decrease medication administration error rates and to raise awareness on the possible clinical significance of the errors. (J Am Med Dir Assoc 2010; 11: 275–283)

Keywords: Nursing homes; pharmaceutical care; quality assurance

It is well known that the elderly often suffer from multiple comorbidities and consequently are prescribed a large number of medications, which exposes them to an increased risk for medication-related errors. In this context, a medication-related error can be defined as a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient. Medication-related errors may occur from the moment of prescribing until the administration of medications and can be associated with a substantial increase in patient morbidity and mortality rates. Prevention of these errors is likely to improve patient outcomes, especially in nursing home settings where nurses have the primary responsibility for medication administration as a part of a varied and demanding set of patient care activities.

This concern about medication-related errors and the safety of medication use is not new and several studies have investigated the types, frequency, and causes of medication-related errors. Such errors have been commonly found during the administration stage of the medication-use process, with an incidence varying between 6% and 22%. The most frequently reported types of errors were omissions, wrong doses, wrong techniques, and unauthorized drug administrations. Table 1 shows an overview of the possible categories of medication administration errors.

To prevent medication administration errors from reoccurring, different strategies or approaches are possible. Computerization of medication dispensing (electronic error reporting systems, electronic administration records, automated dispensing or bar codes), education and training of the nursing home staff, implementation of pharmaceutical care services,
and changes in nursing care all offer the potential for error prevention; however, studies undertaken to test these approaches have been very limited in the nursing home setting. Data from hospitals are more comprehensive, but the available resources differ strongly among the different sectors of health care, and consequently study results in one type of setting should be applied with great caution to any other kind of setting.

The aim of the present study was to identify the frequency of medication administration errors in nursing homes using a direct observation method, and to investigate the impact on these error rates of an educational intervention that addressed good medication administration practices. To our knowledge, this is the first study of this type in the long-term care setting.

METHODS

Study Design

A 1-month before-and-after study was performed, which compared outcome measurements 1 month before and 1 month after implementation of a formal training session on “good medication administration principles” in 2 nursing homes. The study was conducted between March 2007 and June 2007 and was performed in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. All nursing staff members involved in medication administration procedures at the 2 nursing homes were invited to participate in the study and all gave written informed consent. Approval for this study was granted by the ethics committee of the Ghent University Hospital.

Setting

The study was conducted in 2 nursing homes (NH) in Belgium (NH1: 90 beds, NH2: 230 beds, but only 1 ward of NH2 with 32 residents was included in the study).

To assess whether the intervention succeeded, regardless of the organization of the medication process, we were interested in working with 2 nursing homes each having a very different organization of the medication administration process. Therefore, we decided to purposely recruit 2 nursing homes rather than randomly select 2 study sites. Figure 1 provides a comparison of the organizational characteristics of the medication administration process in both participating nursing homes. In NH1 there were 15 nurses and 25 nursing aides (ie, people who help nurses with the daily care of the residents but who are not authorized to prepare or administer medications, nor to provide wound care) or logistical aides (ie, people who assist nurses and nursing aides in their care activities by transporting residents, providing meals, changing linens, and so forth, but who are not involved in the direct care of residents and are not allowed to manipulate medications); in NH2 there were 3 nurses and 3 nursing aides.

### Intervention

The nursing education curricula in Belgium do not spend much time on pharmacology and pharmacotherapy. Thus, nurses have little knowledge on controlled release, enteric-coated dosage forms, or toxicity of drugs. Formal training programs on medication administration did not exist in either participating nursing home.

The intervention evaluated in this study consisted of a formal training session about “good medication administration principles” for the nursing staff of the participating nursing homes. All staff included in the study were required to attend. This interactive training session, provided by a pharmacist using a 1.5-hour PowerPoint presentation comprising 60 slides addressed the following issues: crushing and splitting of medications; drug-drug and drug-food interactions; correct use of inhalation medication (eg, pressurized metered dose inhalers); generic drug names; frequently occurring drug administration errors; and special warnings concerning the administration of warfarin and alendronate. These items were determined by the researchers and were selected based on a literature review and on the errors observed in the “before” phase of the study. The same PowerPoint presentation was used in both nursing homes. As a mnemonic to help the nurses during preparation and administration of drugs, 3 plasticized cards were prepared with an overview of (1) medications that cannot be crushed and/or split, (2) the most important drug-drug and drug-food interactions, and (3) generic names versus brand drug names. A file containing device-specific checklists for inhalation techniques (of inhaled medications) was also provided.

<table>
<thead>
<tr>
<th>Error Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omission</td>
<td>The patient has not received his or her medication by the time the next dose is due</td>
</tr>
<tr>
<td>Wrong dose</td>
<td>The amount of medicine received by the patient is greater than or less than the amount ordered</td>
</tr>
<tr>
<td>Unauthorized drug</td>
<td>The patient receives a medication for which the general practitioner did not write an order</td>
</tr>
<tr>
<td>Wrong dosage form</td>
<td>The drug is administered in a dosage form different from the one that was ordered</td>
</tr>
<tr>
<td>Wrong time</td>
<td>The patient did not receive his or her medication within a predefined interval</td>
</tr>
<tr>
<td>Wrong route</td>
<td>The correct form of drug is administered, but at the incorrect site on the patient’s body</td>
</tr>
<tr>
<td>Deteriorated drug</td>
<td>The physical or chemical integrity of a medication dosage form has been compromised</td>
</tr>
<tr>
<td>Wrong rate of administration technique</td>
<td>Use of an inappropriate procedure during administration of a drug</td>
</tr>
<tr>
<td>Wrong dose preparation</td>
<td>A product is incorrectly made or manipulated before administration</td>
</tr>
<tr>
<td>Extra dose</td>
<td>The patient receives one or more dosage units in addition to those that were authorized</td>
</tr>
</tbody>
</table>
Nurses’ Evaluation of the Training Session

After the educational session, the nurses were asked to fill out an anonymous evaluation form to assess the practical usefulness of the session.

Nurses’ Knowledge About Medication

At baseline, the nurses’ knowledge about medication was evaluated using a short self-developed nonvalidated questionnaire. This questionnaire consisted of 9 questions concerning medication administration knowledge (Appendix 1).

Data Collection

Determination of Error Types and Rates

Medication preparation (ie, when medicines are put on trays for distribution to the residents) and administration (ie, when medicines are actually given to the residents) was observed during 5 consecutive weekdays per resident (there were no observations during weekends), according to the direct observation method of Barker et al. Two observers accompanied the nurses during medication administration on day and evening shifts, observing the preparation and administration of each dose, each recording separately on a standardized data collection form the following: (1) the individual patient code (ie, the code attributed to each individual resident included in the study, in order to preserve anonymity during further data processing); (2) the drug product, dose, and dosage form; (3) time of administration; and (4) all nurses’ medication-related procedures. The observers were a clinical pharmacist and a fourth-year pharmacy student from Ghent University (Belgium). The unit of analysis for this study was each medication administered or omitted (so-called opportunity for error).

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**Fig. 1. Organization of medication administration in both nursing homes.**

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**Nursing home 1**

**Medication prescription**

**Medication delivery per ward**

**PREPARATION**

Preparation on daily basis
At night, 2 days in advance by a nurse
Nurse also has to respond to night calls

**ADMINISTRATION**

Administration per moment by 2 nurses
OR care aids, without medication charts.
Separate from meal
Syrups and other liquids were prepared half a day in advance

No intake control

Signature for medication administration afterwards

**Nursing home 2**

**Medication prescription**

**Medication delivery per ward**

**PREPARATION**

Preparation on weekly basis
Every Monday afternoon by a nurse
Nurse does not take part in routine during medication preparation

**ADMINISTRATION**

Administration per moment by a nurse + care aid, with medication charts
At meal time
Syrups and other liquids are stocked in the cart and are poured out at the moment of administration

Intake control

Immediate signature for administration after each resident

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£: Preparation = putting medication on trays for the administration rounds
†: Administration per moment = administration at each predetermined moment (8 AM, 12 PM, 5 PM, 8 PM) per opposition to administration once a day
‡: Intake control = the nurse stays at the bedside until the medication is swallowed by the resident.
After the observations, the residents’ medication records (ie, the prescriber’s orders) were collected and compared with the observations of medication administration. Any deviation between the medication record and the medication administered was recorded as an error, provided that both observers recorded an error (this was to exclude observation errors). These errors were categorized according to established definitions of wrong drug, extra dose, wrong dose, omission, wrong technique (subcategorized in the following: division of nondivisible drugs, crushing of noncrushable drugs, and inhalation technique error), and wrong time.18 The category “deteriorated drug” was used for medications that could possibly be adversely affected by exposure to environmental factors, such as air, humidity, and heat (eg, effervescent tablets kept outside their packaging for more than 8 hours). The medication error rate was calculated per nursing home by dividing the number of errors by the sum of the number of medications given plus the number of omissions, and then multiplying by 100.11

In both nursing homes, the study consisted of 2 observation periods: 1 month before the training session and 1 month after the training session. In each nursing home, error rates were compared before versus after the training sessions.

**Determination of Potential Clinical Significance of the Errors**

A geriatrician and a clinical pharmacist (with specialized training in geriatrics) evaluated all medication administration errors for potential clinical significance. To allow thorough evaluation of the clinical relevance of each error, clinical information on the patient (age and gender, medical history) was obtained from the treating physician. The geriatrician and the pharmacist independently determined whether each observed medication administration error could theoretically result in an adverse drug event (defined as injuries resulting from medical interventions related to a drug), using a scoring range of 0 (no clinical impact), 1 (mild clinical impact), 2 (moderate clinical impact), 3 (severe clinical impact), and 4 (very severe clinical impact; ie, lethal error). For any discrep-

**Table 2. Classification and Frequency of Medication Administration Errors in Nursing Homes 1 and 2 Before and After the Intervention**

| Type of error                              | Before the intervention | | | | After the intervention | | | |
|-------------------------------------------|-------------------------| | | |-------------------------| | | |
|                                           | NH1 | n | % | NH2 | n | % | NH1 | n | % | NH2 | n | % |
| Deteriorated drug                         | 69  | 35.0 | 4  | 12.9 | 2  | 14.3 | 4  | 7.5 | 2  | 14.3 |
| Wrong dose                                | 35  | 17.8 | 0  | 0.0  | 0  | 0.0  | 2  | 3.8 | 4  | 28.6 |
| Omission                                  | 27  | 13.7 | 5  | 16.1 | 32 | 60.4 | 3  | 21.4 |
| Wrong technique                           |     |     |    |      |     |      |     |     |    |      |
| - crushing of noncrushable drugs          | 20  | 10.2 | 5  | 16.1 | 0  | 0.0  | 0  | 0.0  | 2  | 14.3 |
| - wrong inhalation technique              | 19  | 9.6  | 8  | 25.8 | 0  | 0.0  | 2  | 14.3 |
| - division of nondivisible drugs          | 17  | 8.6  | 8  | 25.8 | 6  | 11.3 | 1  | 7.1  |
| Extra dose                                | 8   | 4.1  | 1  | 3.2  | 4  | 7.5  | 1  | 7.1  |
| Wrong drug                                | 1   | 0.5  | 0  | 0.0  | 5  | 9.4  | 0  | 0.0  |
| Wrong time                                | 1   | 0.5  | 0  | 0.0  | 0  | 0.0  | 0  | 0.0  |
| Total                                     | 197 | 100 | 31 | 100 | 53 | 100 | 14 | 100 |

* P < .001 (before – after comparison, chi-square test). † P = .049 (before – after comparison, chi-square test).

Data Analysis

Data were analyzed using the statistical package SPSS 17.0 (SPSS, Inc., Chicago, IL).

The error rates before and after the training session were analyzed using the chi-square test for 2 × 2 tables. The significance level was set at α = 0.05.

**RESULTS**

**Characteristics of the Sample**

Each resident who received at least 1 medication in the 5-day observation period was included in the study (72 residents in NH1 and 27 residents in NH2). The mean age of the nurses was 35 years in NH1 and 45 years in NH2. The mean age of nursing aides was 31 years in NH1 and 30 years in NH2. Nurses had an average of 11 years of experience in NH1 and 22 years in NH2. For nursing aides, the mean experience was 7 years in NH1 and 12 years in NH2.

The residents in NH1 and NH2 had a mean age of 86.4 years (SD 7.1, range 63–99) and 85.8 years (SD 5.3, range 70–93), respectively. In NH1, 81.4% of the residents were women, whereas in NH2 the percentage was 66.7%. The number of morbidities ranged from 1 to 18 in NH1 (mean 6, SD 3.3) and from 1 to 9 in NH2 (mean 5.5, SD 2.9).

The average number of medications was comparable between both nursing homes, both before and after the intervention, offering the same number of potential opportunities for errors. Before the intervention, respective residents of NH1 and NH2 used an average of 8.1 (SD 3.5, range 2–17) and 8.2 (SD 3.9, range 2–21) chronic medications, and 1.3 (SD 1.3, range 0–5) and 1.1 (SD 1.1, range 0–3) “if needed” medications. After the intervention, the average number of chronic medications was 8.2 (SD 3.5, range 2–21) and 7.9 (SD 3.0, range 3–15) in nursing homes 1 and 2, respectively. The average number of “if needed” medications was 1.4 (SD 1.3, range 0–6) and 1.2 (SD 1.0, range 0–3).
Determination of Error Types and Rates

Before the intervention, 3116 and 978 drug preparations and administrations in 67 and 27 residents were observed in NH1 and NH2, respectively. After the intervention, 2650 and 817 drug preparations and administrations in 67 and 26 residents were observed in NH1 and NH2, respectively. Not all residents were present during all observation rounds, which explains the difference between the number of residents that were included in the study and the number of residents that were observed.

Before the intervention, the overall medication administration error rate was 6.3% (ie, 197 errors or omissions on 3116 observations) and 3.2% (ie, 31 errors or omissions on 978 observations) in NH1 and NH2, respectively (Table 2). The most common types of errors were exposure to air/humidity/heat and preparation or administration of wrong doses in NH1, and wrong technique errors (wrong inhalation technique and division of nondivisible drugs) in NH2.

After the intervention, the error rate was reduced to 2.0% (ie, 53 errors or omissions on 2650 observations) in NH1 and 1.7% (ie, 14 errors or omissions on 817 observations) in NH2. The most common types of errors were exposure to air/humidity/heat and preparation or administration of wrong doses in NH1, and wrong technique errors (wrong inhalation technique and division of nondivisible drugs) in NH2. The number of wrong doses was higher after the intervention than before, but all other types of errors decreased. The decrease in overall error rate was statistically significant in NH1 (P < .001), as well as in NH2 (P = .049).

Clinical Significance of the Errors

The experts scored each type of error only once per drug and per resident, resulting in 107 scores before and 45 scores after the intervention for NH1. For NH2, 15 scores remained before the intervention and 11 scores remained after the intervention. The number of errors to be scored is displayed in Table 3. The consensus scores for potential clinical significance of the errors attributed by the experts are displayed in Table 4. None of the observed errors was rated highly likely to cause harm. Four errors were rated as having a moderate clinical impact: a wrong dose of warfarin, an extra dose of sotalol, an omission of fentanyl, and a transdermal fentanyl patch administered more than 12 hours earlier than the time indicated on the medication chart. All other errors were rated as having a smaller clinical impact. There was no significant difference in severity of the clinical impact before and after the intervention.

Nurses’ Evaluation of the Training Session

The training sessions were attended by 69 nurses, nursing aides, and logistic aides. All attendees evaluated the educational sessions as well as using the plasticized mnemonic

<table>
<thead>
<tr>
<th>Type of error</th>
<th>Before the intervention</th>
<th>After the intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NH1</td>
<td>NH2</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Deteriorated drug</td>
<td>36</td>
<td>33.6</td>
</tr>
<tr>
<td>Wrong dose</td>
<td>25</td>
<td>23.4</td>
</tr>
<tr>
<td>Omission</td>
<td>20</td>
<td>18.7</td>
</tr>
<tr>
<td>Wrong technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- crushing of noncrushable drugs</td>
<td>6</td>
<td>5.6</td>
</tr>
<tr>
<td>- wrong inhalation technique</td>
<td>5</td>
<td>4.7</td>
</tr>
<tr>
<td>- division of nondivisible drugs</td>
<td>7</td>
<td>6.5</td>
</tr>
<tr>
<td>Extra dose</td>
<td>6</td>
<td>5.6</td>
</tr>
<tr>
<td>Wrong drug</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>Wrong time</td>
<td>1</td>
<td>0.9</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Clinical Impact (Score)</th>
<th>Before the Intervention</th>
<th>After the Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nursing Home 1</td>
<td>Nursing Home 2</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>None (0)</td>
<td>18</td>
<td>16.7</td>
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<tr>
<td>None to mild (0–1)</td>
<td>45</td>
<td>41.7</td>
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<tr>
<td>Mild (1)</td>
<td>24</td>
<td>22.2</td>
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<tr>
<td>Mild to moderate (1–2)</td>
<td>16</td>
<td>14.8</td>
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<tr>
<td>Moderate (2)</td>
<td>4</td>
<td>3.7</td>
</tr>
<tr>
<td>Moderate to severe (2–3)</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Severe (3)</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Severe to very severe (3–4)</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Very severe (4)</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>107</td>
<td>100</td>
</tr>
</tbody>
</table>
cards. About half of the participants (53.6%) found that medication preparation and administration practices were not sufficiently addressed during their education. The information on the crushing of tablets was appreciated the most (88.4%).

Nurses’ Knowledge About Medication

At baseline, only 9 nurses completed the questionnaire on medication knowledge. The mean score was 4.6/10. Worst scores were obtained on the questions concerning generic names of medicines, splitting of nondivisible drugs, and interactions of medications with alcohol.

DISCUSSION

Medication administration is a critically important nursing care responsibility in nursing homes. This feasibility study investigated the medication administration error rates before and after an educational session on good medication administration principles provided by a pharmacist to the entire nursing staff. We found that medication administration errors were quite common in the nursing home setting, but that relatively few observed errors resulted in a clinically significant effect. These findings are consonant with the scarce reports retrieved from the literature.11,12

The most frequently occurring medication administration errors in our study were deteriorated drug, drug omission and preparation, or administration of wrong doses. The important decrease of errors related to drug exposure to environmental factors after our intervention can be explained by the purchase of lids for liquid dosage cups that was stimulated by the pharmacists. Unlike previous studies, we did not frequently encounter wrong time errors. This may be because there was no strict policy on administration times at the selected nursing homes. Medications were not administered at a given hour, but they were administered with (or just before) breakfast, lunch, or dinner rounds, or at bedtime. In other studies, time schemes were stricter, resulting in a wrong time error when a deviation of more than 60 minutes of the intended hour was observed.12 For some residents, errors occurred after the intervention, whereas no errors were seen during the preintervention period. Concerning the increase of the number of omissions in NH1, this can be explained by the confusing layout of some medication charts. When the section for “tablets” was full, some medications were sometimes put under the wrong section, eg, “injections.” This resulted in omissions, because the nurse preparing the tablets did not always look under that particular section. This problem seemed to occur more frequently after the intervention. The increase in the number of wrong drugs observed in NH1 can be partially explained by 1 wrong drug dispensed by the pharmacist. The resident was prescribed lormetazepam, but lorazepam was dispensed. Both packages are very similar and the nurses did not notice the error. We found no obvious reason for the other wrong drug errors after the intervention, or the increase of wrong dose errors in NH2. Therefore, the need for double-checking every medication that is prepared or administered should be emphasized during the educational session. Moreover, new medications demanding particular precautions might have been started between both observation rounds, whereas the educational session was targeted at problems identified using a literature search and the results of the first observation round. Repeating education sessions on a regular basis with an emphasis on different problematic medications could eliminate this effect in the long term.

The reported medication administration error rates in the literature vary considerably from 6% to 22%.9–12 Our findings were situated in the lower part of this range. The decrease in medication administration error rate was significant in both nursing homes but the significance was less in NH2. It is difficult to explain this difference with certainty, for multiple reasons. First, the sample size was much lower in NH2 than NH1; a larger sample might have resulted in a more significant effect. Second, the difference might be explained by the organization of the medication administration in both nursing homes (Figure 1). In NH2, this organization has been modified in order to prevent as many errors as possible. In this study, however, we cannot assess the impact of this organization; a large randomized controlled study involving multiple nursing homes with the same type of medication administration organization would be needed. However, as almost all nursing homes in Belgium are organized in a different way, this would be difficult. Third, the staff in NH2 was older and more experienced compared with NH1. However, as no details were recorded regarding who actually administered each medication for protective reasons (ie, avoiding punitive measures), it is impossible for us to comment on the effect of experience on the medication administration error rate.

Even though the expert panel did not score any of the errors as likely to cause harm, we must be aware that this depends more on the drug involved than on the type of error. A wrong dose of ascorbic acid does not have the same clinical significance as a wrong dose of digoxin or warfarin, which is why it is important to pay special attention to drugs with a narrow therapeutic window and to emphasize this in the educational session.

Both nursing homes included in the study did have a paper-based nonpunitive anonymous error reporting system. However, during all our observation rounds, we established that no single error was reported. The reasons for this are likely to be multiple: the error did not reach the patient, the nurse judged the error to do no harm to the resident, the nurse was not aware that an error was made, or there could still be a certain fear of punishment if the nurse making the error was identified. Whatever the underlying reasons were, we clearly saw that such a system is not sufficient on its own to prevent further medication administration errors.

This study has shown that an educational session provided by a pharmacist has the potential to decrease medication administration error rates in nursing homes. In many European countries, the role of the pharmacist in long-term care is often restricted to the mere delivery of medication or to the redaction of therapeutic drug formularies for the nursing home to which he or she delivers. In the United States and other English-speaking countries, such as Australia and the United Kingdom, pharmacists perform medication reviews to
optimize the quality of prescribing.\textsuperscript{19} However, the quality of medication use does not only depend on the quality of prescribing, and therefore, medication administration should not be neglected. Unlike other interventions for preventing medication administration errors, such as the implementation of computerization or the training of dedicated medication nurses, our intervention is facile and easily applicable. It does not involve substantial financial needs or extra staff. The sessions could be provided by the delivering community pharmacist, who is a medication specialist and is already familiar with the nursing home.\textsuperscript{19} As the pharmaceutical profession is shifting more toward pharmaceutical care instead of the "shopkeeper" role, this would be a welcome opportunity.

In Belgium, nursing homes are not specialized with regard to specific illnesses but accept frail elderly residents with different medical problems. Moreover, residential homes for the elderly are spread all over the country and nearly every municipality has its own nursing home. The facilities can be publicly or privately funded. Residents continue to be treated by their general practitioner (GP), resulting in large numbers of GPs visiting the nursing homes, although a coordinating and consulting GP is assigned to monitor the quality of medication use in each nursing home, without real power to intervene however. In the United States, most nursing homes are privately funded, and are not generally specialized, similar to Belgian nursing homes. However, one difference between Belgian and US nursing homes is that in the latter, physician and pharmacy services are often contracted out, often using primary care physicians from the community in which the nursing home is located. Such primary care physicians take the place of GPs in Belgium. Unlike Belgian nursing homes, there is no GP to oversee the quality of medication use in US nursing homes, and this area is usually the responsibility of the medical director or the nursing home administrator. Despite these differences, our findings are likely to be equally applicable to US nursing homes and others located in Western countries as medication administration errors are common in all such facilities, regardless of the country in which they are located.

There are several limitations to this study. First, we selected a small convenience sample of 2 nursing homes, as this study was an explorative pilot study. A larger, but randomly selected sample would strengthen the study and make the generalization of the results easier. Second, the observation period lasted for only 5 days per ward. This period may have been too short, resulting in too few errors. Moreover, weekends were not included and only the 2 most important administration moments (in medication volume) were taken into account. However, because staffing patterns are identical throughout weeks and weekends, the effect seems small. A third important limitation is the concern about the effect of the observer on the error rates and a possible Hawthorne effect (just the fact that the nurses are involved in a study on medication administration can increase their awareness and result in fewer errors). However, it has already been established that this is not a major problem when the subjects are observed doing an activity familiar to them and when the observer is trained to be unobtrusive and nonjudgmental.\textsuperscript{17,18,20} Fourth, we assumed that the medication charts were always up-to-date and accurate, which may not always be true. Fifth, for the evaluation of the clinical significance, it was assumed that the observed errors were 1-time errors only, or that the errors occurred only for the given number of times. It would be important to determine the rate at which errors are repeated over a longer period and to analyze the clinical significance of such recurrent errors. Sixth, the success of educational interventions depends highly on the goodwill of the nursing staff to adapt their behavior. Because we worked with a convenience sample of cooperative nursing homes, the sessions were well received; however, this might not always be the case. Last, staff turnover is high in the nursing home setting. This may decrease the effect of the intervention over time and illustrates the need to repeat the sessions on a regular basis, for example every 6 months, with a possible emphasis on different medications or different practices. For this reason, we did not perform a follow-up study to see if the effect was maintained.

Strengths of the study were the validity of the direct observational method,\textsuperscript{20} the simplicity, and the low additional costs of the intervention.

CONCLUSION

This study supports the assertion that medication administration is an important concern in nursing homes. Nursing home residents daily use a large amount of medications, for which they depend entirely on the nursing staff. Whenever medication administration errors occur, they seem to be of low clinical risk for the residents. However, an educational session on good medication administration provided by a pharmacist is an easy and accessible way to decrease medication administration error rates and raise awareness on the possible clinical significance of the errors. For a larger and more permanent effect, we advise nursing homes to repeat the training sessions on a regular basis.

ACKNOWLEDGMENT

The authors thank Pharm. Nele Verhaeghe for her valuable help during the data collection, as part of her Master’s thesis.

REFERENCES

Appendix 1

Questionnaire for testing nurses’ knowledge about medication

In this questionnaire, a few situations are presented in which the administration of medication can potentially be problematic. Different answers or solutions are suggested. Please indicate the solution you would choose if you were confronted with the given situation in your nursing home. For questions 1 to 7, indicate only one possibility. For questions 8 and 9, multiple answers are possible. Question 10 is just an informative question and will not be scored.

1. Mrs. X is bedridden and was prescribed Fosamax (alendronate) by her physician. How will you administer this medication?
   A. I will administer this medication while she is lying down.
   B. I will first set Mrs. X upright in her bed and only then, I will administer Fosamax. After the administration, I will immediately lie Mrs. X back down.
   C. I will first set Mrs. X upright and only then, I will administer Fosamax. After the administration, I will leave her in the upright position for a while (± half an hour).
   D. I will not administer this medication and will ask the physician for advice.

2. Mrs. Y has pneumonia and her physician prescribed Augmentin (amoxicillin + clavulanic acid). However, she cannot swallow the tablets. What will you do?
   A. I will crush the tablets, in the same way that all other tablets are crushed.
   B. I will crush the tablets, paying special attention to powder that might fly up (eg, using a mask).
   C. I will not administer the tablet.
   D. I will contact the physician and ask for advice.
   E. I will administer Augmentin powder instead of a tablet, based on my own decision.

3. Mr. Z takes a tablet Cipramil (citalopram) every day with his supper. Tonight, he asks for a beer with his meal. What do you do?
   A. You give him the beer he asks for.
   B. You make him take the tablet with some water and let him drink beer with the rest of his supper.
   C. You refuse to give him beer and give only water.
   D. You give her grapefruit juice, because the amount in the bottle is too small to cause problems with the medication.
   E. You make her take the medications with water.

4. Mr. A takes Lorazepam. Which drinks cannot be combined with this medication?
   A. Alcohol
   B. Coffee
   C. Water
   D. Alcohol and coffee
   E. Coffee and water

5. Mrs. B has been taking different chronic medications for multiple years. She asks for grapefruit juice with her breakfast. What do you do?
   A. You give her grapefruit juice, because the amount in the bottle is too small to cause problems with the medication.
   B. You will first check what medication Mrs. B takes, then will only give the grapefruit juice after you made sure that it will not cause any problem.
   C. You make her take the medications with water and give her grapefruit juice with the rest of the breakfast.
   D. You give her grapefruit juice, without any special consideration.

6. Mrs. C has a daily prescription for Cardioaspirine (acetylsalicylic acid) 150 mg. How will you execute this prescription?
   A. I will administer an entire tablet of Cardioaspirine 100 mg and half a tablet obtained by splitting a tablet of Cardioaspirine in 2 with a knife.
   B. I will administer an entire tablet of Cardioaspirine 100 mg and half a tablet obtained by splitting a tablet of Cardioaspirine in 2 with a device (eg, Pilomat).
   C. I will contact the physician and ask for advice.
   D. On my own initiative, I will administer another form of acetylsalicylic acid that does exist in a dosage of approximately 150 mg (eg, Asaflow 160).
7. Mrs. D has a daily prescription for Loramet. Only the generic form is present in the nursing home. Which generic medication will you administer?
A. Lorazepam
B. Tetrazepam
C. Lorametazepam
D. None of the drugs cited above

8. Which of the following medications can be crushed?
A. Asaflow
B. Glucophage
C. Temesta
D. Adalat Oros
E. Cardioaspirine
F. Dafalgan

9. It is preferable not to combine coffee with:
A. Bromazepam
B. Asaflow
C. Motilium
D. Xanax
E. Temesta

10. Who will you ask for advice when you are uncertain about the administration of a certain medication to a patient?
A. A colleague
B. The physician
C. The pharmacist
D. Nobody, but you will consult the package insert
E. Nobody and you will not consult the package insert