Quality of prescribing in Belgian nursing homes: an electronic assessment of the medication chart

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Abstract

Objectives. To develop a computerized assessment tool for monitoring the quality of prescribing in Belgian nursing homes.

Design. In an observational cross-sectional study of the medication charts of nursing home residents, potentially inappropriate medication (PIM) was investigated using three scoring systems for the elderly (Beers, ACOVE, BEDNURS) complemented with a list of drug–drug interactions.

Setting. A representative stratified sample of Belgian nursing homes (n = 76).

Participants. A random sample of nursing home residents with a complete data set (n = 1730) excluding palliative care patients.

Main Outcome Measure. A combination of PIM scores to assess inappropriate, under- and overprescribing.

Results. Included residents had a mean age of 85, 78% were female. They used a mean of 7.1 chronic medications. Most PIMs were detected by the application of the ACOVE criteria for underprescribing with 58% of patients having at least one PIM. Using the BEDNURS and the Beers criteria, at least one PIM was noticed in 56 and 27% of patients, respectively. Patients’ characteristics showing a positive relationship with the PIM score were age, female gender, amount of clinical and nursing care problems, number of prescriptions and the use of psychotropic drugs (multiple regression analysis R² = 0.332).

Conclusions. In Belgian nursing homes, the observed high level of drug utilization was associated with potentially inappropriate prescribing. The development of a combined assessment tool and the implementation of a computerized monitoring system of PIMs is highly recommended to improve the quality of prescribing.

Keywords: elderly, nursing home, drug utilization, prescribing quality, inappropriate prescribing, potentially inappropriate medication

Introduction

The emerging high level of drug utilization in the elderly, especially in nursing home residents, is well known and documented in many countries. Poly-pharmacy with a particularly high consumption of psychotropic drugs has been recently reported in the USA, Canada, Sweden and Austria [1–4]. The PHEBE study (Prescribing in Homes for the Elderly in Belgium) revealed that also Belgian residents had a high level of drug utilization with a mean of 7.1 prescriptions per resident for chronic treatment [5, 6]. The hazards of poly-pharmacy, with increasing risk of side effects, interaction and non-compliance, have been recognized as particular problems when prescribing for the elderly [7–9].

Several studies investigated the preventability of drug-related problems in older age and listed potentially inappropriate medications (PIMs) that should be avoided in the elderly. Criteria for inappropriate prescribing has been defined from the 1990s on, with medications that should be avoided in general, or in the presence of specific co-morbidities, or when dosages or frequencies exceed tolerable levels [10–14]. Also undertreatment gained recognition as a serious problem in the elderly leading to the development of an additional set of prescribing criteria [15]. More recently, the Priscus list, mainly based on the original and revised Beers criteria was published, offering a more European-oriented list of inappropriate medications for the elderly [16].

As yet, prospective studies using a combination of PIM scores to assess inappropriate as well as under- and overprescribing, are lacking. Moreover, the association between inappropriate prescribing and the long-term negative impact on...
health outcome is only poorly documented, particularly in institutionalized elderly. One of the reasons could be that a rigorous, regular scoring of PIMs is difficult to perform in the specific setting of a nursing home. First, professionals capable to perform a PIM score (medical doctors, clinical pharmacists) spent only limited time in a nursing home. Secondly, a regular PIM assessment means a high extra workload except when it could be performed electronically. For the latter, however, a minimum set of clinical information of the residents is needed which is not accessible in a standardized format in the nursing homes of many countries.

The main objective of our study is to explore the opportunities and limitations of an automated computerized scoring system based on a selection of published PIM scores to assess the quality of prescribing in Belgian nursing home residents.

**Methods**

Data of the PHEBE study was used to develop a computerized system for the assessment of prescribing quality in Belgian nursing homes. The PHEBE study was a cross-sectional, descriptive study of a representative sample of Belgian nursing home residents aiming to investigate the pharmaceutical consumption within this setting. Participants of the PHEBE study were selected by a two-stage procedure based on a stratified random selection of nursing homes and a random sample of 30 residents from each consenting nursing home.

**Data collection**

Data collection was based on medical chart review supplemented with clinical information from general practitioners (GPs). Details of the selection procedure and data collection were described elsewhere [5, 6].

Clinical information collected within the PHEBE study, classified in 16 clinical and 10 care problems, focused on items with relevance for the appraisal of prescribing quality (e.g. it was necessary to know whether a resident had a history of myocardial infarction for scoring the ACOVE PIM: ‘myocardial infarction and no aspirin’). Clinical problems included hypertension, vascular disease, myocardial infarction, heart failure, angina, gout, convulsion, glaucoma, Parkinson, prostate disease, diabetes, COPD, osteoporosis, peptic ulcer, liver failure and renal failure.

Care problems, defined as problems with a predominant nursing care burden, included chronic pain, constipation, pressure ulcers, fall risk, incontinence, insomnia, obesity, malnutrition, dementia and depression.

Data on functional assessment and mental health were derived from the Katz score, an obligatory assessment tool in Belgian nursing homes. The Katz score is based on a dependency scale for daily living activities (eating, clothing, washing, mobility, going to the bathroom independently and continence status) and an evaluation of dementia using a five-stage grading to judge disorientation in time and place ranging from ‘cognitively healthy’ to ‘full dementia’ [17].

A special data entry program was used to transfer the data from the medication charts into computerized databases classified according to the fifth level (i.e. the level of the active ingredient) of the Anatomical Therapeutic and Chemical (ATC) classification. Additionally, medications were classified in chronic, acute and ‘if needed’ medication, with ‘chronic’ defined as more than 3 months of use.

**Selection of PIM lists**

In order to cover inappropriate prescribing as well as under- and overprescribing, we selected three published PIM lists for the elderly: the Beers list of inappropriate drugs [10, 18], a number of ACOVE criteria focusing on underprescribing [15] and the BEDNURS criteria specific for nursing home residents and focusing on psychotropic drugs [19]. In addition, a list of prevalent drug–drug interactions was selected based on a large observational study utilizing a computerized scoring system [20]. Retrospectively, the Priscus list was added to this set of PIM scores to make a comparison with the more US-oriented Beers list. A limited number of clinical and care characteristics needed for scoring the selected PIMs were listed and the treating physician was asked to indicate their presence for each included resident.

**Electronic assessment of potentially inappropriate prescribing**

The PHEBE PIM score was calculated as a sum score with each identified PIM counting for one extra point in the composite score. Details of the selected lists and included PIMs are given in Table 1. All included lists were slightly adapted for

<table>
<thead>
<tr>
<th>Name of the list</th>
<th>Total number of items in the original list</th>
<th>Number of items included in PHEBE</th>
<th>Number of items scoring within PHEBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACOVE (underuse)</td>
<td>9</td>
<td>7</td>
<td>7/7 (100%)</td>
</tr>
<tr>
<td>BEDNURS</td>
<td>34</td>
<td>32</td>
<td>26/32 (81%)</td>
</tr>
<tr>
<td>Beers</td>
<td>48</td>
<td>40</td>
<td>23/40 (58%)</td>
</tr>
<tr>
<td>Drug–drug interactions</td>
<td>69</td>
<td>60</td>
<td>12/60 (20%)</td>
</tr>
<tr>
<td>PRISCUS</td>
<td>83</td>
<td>72</td>
<td>46/72 (64%)</td>
</tr>
</tbody>
</table>

*Items with required clinical information available in the PHEBE database and with the active ingredient available on the Belgian market.*
this project, mainly because of a lack of more detailed data of doses or duration of the prescription or because of missing more detailed clinical information.

Statistical analysis

Data analysis was performed with the statistical package SPSS version 16.0. A P-value of P < 0.05 was used as the significance level. Non-parametric statistics were used in case of skewed distributions and for semi-quantitative variables (i.e. scores with a limited range).

A general exploration of the databases was performed using descriptive statistical techniques. The relationship between different PIM lists and with the composite PIM score was assessed using Spearman rank correlation \( R^2 \). For the association of the PIM score with personal and clinical characteristics, explorative univariate analysis was performed using Pearson correlations and ANOVA. Based on significant results of the univariate analysis, multiple regression analyses was used to determine residents’ characteristics showing a significant association with the composite PHEBE PIM score.

Ethical considerations

The protocol of this study was submitted to and approved by the Ethical Commission of the Scientific Society of GPs of Flanders (EC WVVH 2005/007).

Results

A data set of 1730 residents of the PHEBE study was used, including all cases with complete data collection and excluding palliative care patients. The mean age of included residents was 85, with 78% being female. Most frequently diagnosed clinical problems were hypertension, heart failure and post-myocardial infarction. Most frequently diagnosed care problems were fall risk, insomnia and constipation. Dementia was diagnosed in half of residents, one-third had a depression. Residents had a mean of 7.1 prescriptions for chronic medication. Particularly psychotropic (88%), cardio-vascular (75%), alimentary tract and metabolic medications (75%) were used (Table 2).

Electronic assessment of potentially inappropriate prescribing

The selected assessment tools delivered a total of 139 items that could be used for the assessment of PIMs (Table 1). All included items of the ACOVE criteria for underprescribing scored for Belgian nursing home residents with a range from 23% for residents having heart failure without treatment with a beta-blocker to 8% of residents with osteoporosis treated with bisphosphonates without calcium (Fig. 1a).

The BEDNURS criteria scored for 26 of the 32 included criteria. Highest frequencies were observed for the combination of psychotropic medication with 32, 26 and 9% for the combined use of ATC classes N05 (psychoanaleptics) + N06 (psychoanaleptics), N05 + N05 and N06 + N06, respectively. A high score was also noted for residents having heart failure only treated with mono-therapy (11%), long-acting benzodiazepines use (9%) and NSAID use (8%) (Fig. 1b).

Only 23 of the 40 included Beers criteria for inappropriate prescribing scored in Belgian nursing home residents with 13/23 scoring in less than 1% of cases. Highest frequencies were noted for digoxin (7%), oxybutynin (5%) and amiodarone (4%) (Fig. 1c).

The list of included drug–drug interactions showed limited scores with only 12 of the 60 criteria having any score and with 11/12 items scoring only in a few cases. The combination of digoxin and high-ceiling diuretics was most prevalently noticed (4%).

Comparison between the different PIM assessment tools

As shown in Fig. 2, ACOVE delivered the highest number of PIMs with 58% of patients having at least one PIM, followed by BEDNURS (56%), Beers (27%) and drug–drug interactions (5%). The overlap between the selected PIM lists was investigated using a Spearman rank correlation matrix. Inter-correlations were limited, particularly between ACOVE and BEDNURS \( R^2 = 0.158 \). The highest relationship was observed between the Beers criteria and drug–drug interactions \( R^2 = 0.334 \). An ad hoc

<table>
<thead>
<tr>
<th>Table 2 Demographic and clinical characteristics of included residents</th>
<th>n = 1730</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic characteristics</td>
<td></td>
</tr>
<tr>
<td>Age (mean, range)</td>
<td>84.8 (60–104)</td>
</tr>
<tr>
<td>Gender (% female)</td>
<td>78.1%</td>
</tr>
<tr>
<td>Most frequently diagnosed clinical problems (%)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>53.6</td>
</tr>
<tr>
<td>Heart failure</td>
<td>32.0</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>27.2</td>
</tr>
<tr>
<td>Peptic ulcer</td>
<td>24.6</td>
</tr>
<tr>
<td>Vascular disease</td>
<td>21.4</td>
</tr>
<tr>
<td>Mental disorders diagnosed by GP (%)</td>
<td></td>
</tr>
<tr>
<td>Dementia</td>
<td>47.7</td>
</tr>
<tr>
<td>Depression</td>
<td>35.7</td>
</tr>
<tr>
<td>Main classes of medication prescribed (ATC) (%)</td>
<td></td>
</tr>
<tr>
<td>Alimentary tract and metabolism (A)</td>
<td>75.5</td>
</tr>
<tr>
<td>Cardio-vascular (C)</td>
<td>75.3</td>
</tr>
<tr>
<td>Nervous system (N)</td>
<td>88.4</td>
</tr>
<tr>
<td>Type of medical consumption (%)</td>
<td></td>
</tr>
<tr>
<td>Chronic</td>
<td>98.9</td>
</tr>
<tr>
<td>Acute</td>
<td>15.1</td>
</tr>
<tr>
<td>‘If needed’</td>
<td>44.7</td>
</tr>
<tr>
<td>Volume of medical consumption (mean, range)</td>
<td></td>
</tr>
<tr>
<td>Total number of prescriptions</td>
<td>8.0 (0–22)</td>
</tr>
<tr>
<td>Chronic medication</td>
<td>7.1 (0–22)</td>
</tr>
<tr>
<td>Acute medication</td>
<td>1.5 (0–5)</td>
</tr>
<tr>
<td>If needed medication</td>
<td>1.6 (0–7)</td>
</tr>
</tbody>
</table>

Safety and electronic health records

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comparison between the Beers and Priscus list revealed a correlation between both with $R^2 = 0.468$, with Priscus having a better performance for the Belgian market but still leaving one-third of the criteria without any score.

The composite PHEBE PIM score

Residents of Belgian nursing homes had a median composite PHEBE PIM score of 2 ranging from 0 to 11 PIMs per resident. The medication chart of 82% of residents showed prescribing problems, including 22% with one PIM, 18% with two PIMs, 16% with three PIMs and the remaining 26% with more than three PIMs.

Mainly psychotropic medication (ATC classes N05 and N06) was involved. In the BEDNURS criteria, psychotropic medication accounted for 81% of PIMs, in the Beers criteria it was the case in 22% of PIMs.

The PHEBE PIM score showed a wide variation between nursing homes ranging from a mean of 0.8 to 3.8 PIMs per resident.

Influence of residents’ characteristics on the PHEBE PIM score

In univariate analysis, the composite PHEBE PIM score was positively related to age, female gender, the use of psychotropic medication, the amount of chronic medications and the number of clinical and care problems. Multivariate analysis revealed that all these factors had an independent significant influence on the PIM score. Together, they explained 33% of the variation of the PHEBE PIM score ($R^2 = 0.332$) (Table 3).

Discussion

This study demonstrated that it seems feasible to combine a selection of published PIM lists for an automated screening of inappropriate, under- and overprescribing in the specific nursing home setting. The application of this scoring system to evaluate the quality of prescribing in Belgian nursing homes showed a high number of quality problems with a considerable variation between residents and between institutions.
Table 3 Demographic and clinical factors related to the composite PIM score of potentially inappropriate medication in univariate and multivariate regression analyses (n = 1730 residents)

<table>
<thead>
<tr>
<th></th>
<th>Univariate analysis</th>
<th></th>
<th>Multivariate analysis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>P uni</td>
<td>B</td>
<td>SE</td>
</tr>
<tr>
<td>Age</td>
<td>0.067</td>
<td>0.006</td>
<td>0.018</td>
<td>0.005</td>
</tr>
<tr>
<td>Female</td>
<td>0.055</td>
<td>0.022</td>
<td>0.281</td>
<td>0.099</td>
</tr>
<tr>
<td>Number of clinical problems</td>
<td>0.480</td>
<td>&lt;0.001</td>
<td>0.402</td>
<td>0.026</td>
</tr>
<tr>
<td>Number of care problems</td>
<td>0.254</td>
<td>&lt;0.001</td>
<td>0.077</td>
<td>0.025</td>
</tr>
<tr>
<td>Number of chronic medication</td>
<td>0.459</td>
<td>&lt;0.001</td>
<td>0.132</td>
<td>0.014</td>
</tr>
<tr>
<td>Use of psychotropics</td>
<td>0.268</td>
<td>&lt;0.001</td>
<td>0.263</td>
<td>0.041</td>
</tr>
</tbody>
</table>

R is the correlation coefficient of the univariate analysis; P uni is the P-value testing the significance of the correlation between each factor and the PIM score; B is the uncorrected regression coefficient of the multivariate analysis; SE is the standard error on B; Beta is the standardized regression coefficient of the multivariate analysis; P multi is the P-value testing the significance of the correlation between each factor and the PIM score corrected for all other factors included in the multivariate analysis; \( R^2 \) gives the percentage variance in the PIM score explained by all factors included in the multivariate analysis.

**Strengths and limitations**

With our composite PIM score, we tried to cover the complete field of inappropriate prescribing (in strict sense), as well as under- and overprescribing exploring the associated opportunities and limitations. First, it is clear that, within this context, one has to handle a broad interpretation of PIMs, considering also underprescribing as inappropriate. Secondly, there is expected overlap between the selected PIM lists resulting in an overestimation of inappropriate prescribing problems. Our study revealed that this overlap was less than expected with Beers and drug–drug interactions showing the highest correlation.

It has to be clear, however, that we did not had the intention to present the current approach, with the composite score simply derived from a sum of all identified PIMs, as the preferred methodology to obtain an overall score. We only explored the possibility of combining several scoring systems for automated screening. A more in-depth review and critical comparison of all included PIMs is needed to combine the different scoring systems to one comprehensive system for electronic evaluation of the quality of prescribing in nursing homes.

Another shortcoming of this study is the global approach of selected PIMs where the IF-THEN part of the associated logarithms was incorporated, not the UNLESS part focusing on rather exceptional conditions. As long as a complete medical chart (including a coded list of all diagnoses) is not electronically available in most nursing homes, we were obliged to limit our list of clinical conditions associated with PIMs. Therefore, we worked with a list of 16 clinical and 10 care problems, asking only a few minutes of the prescriber to provide the information.

Additionally, the selected PIMs need an update according to more recently published guidelines of qualitative prescribing in the elderly. For example, the ACOVE item, ‘Diabetes and no aspirin’ is no longer considered as a valid criterion of underuse based on current evidence.

Finally, as this study had a cross-sectional design, it was impossible to associate the PIM score with a health-related outcome parameter. Ideally, a cohort study with long-term follow-up is needed to evaluate the predictive value of a PIM score on the health outcome of the patient.

**General discussion**

Among the published PIM lists, the most widely known explicit indicator for inappropriate prescribing in the elderly is the Beers list, developed in 1991 and most recently updated in 2012 [10, 21]. In more recent years several adaptations of the Beers list have been published, mainly aiming to include more products available at the local pharmaceutical market (e.g. IPET in Ireland [22], NORGEP in Norway [23] and PRISCUS in Germany [16]). Previous studies, using the Beers criteria in a European setting showed limited and uninformative results. Using the Beers criteria, Ryan et al. [24] screened 1329 Irish patients older than 65 and identified only 18% with one or more PIMs. In the PHEBE study, we found a PIM score in 27% of residents, with 23 of the 40 selected criteria scoring, albeit at a low frequency.

To investigate the performance of a PIM list developed in a European country with products more available on the European market, we selected the PRISCUS criteria [16]. An ad hoc comparison with Beers revealed a limited correlation between both with PRISCUS having a better performance for the Belgian market but still leaving one-third of the criteria without any score.

A more innovative approach of PIM detection has been proposed by the more recently published STOPP (Screening Tool of Older Person’s Prescriptions) and START (Screening Tool to Alert doctors to Right Treatment) criteria [25]. Although this tool already showed promising results in hospitalized patients [26], STOPP and START criteria have not been validated for routine use in the nursing home setting, as yet.

In the past, the implementation of published PIM scores for regular monitoring of the quality of prescribing was hindered by the time-consuming workload of chart reviews (e.g.
the Medication Appropriateness Index, evaluating each mediation by 10 criteria taking into account efficacy, safety and cost aspects [13]. In the nursing home setting, the limited availability of professionals capable to perform chart reviews forms an additional obstacle to perform routine scoring of PIMs. From the early start, we clearly choose for an electronic automated screening that could be implemented in the information system of each nursing home.

The number of PIMs detected with the electronic PHEBE scoring system was high. A number of clinically relevant prescribing problems could be identified as a possible target for prescribing quality improvement programs. The question remains, however, how to implement these programs, given a (Belgian) situation where most residents are still treated by their own GP and where the role of the pharmacist is mostly limited to the delivery of the ordered medications [5]. It has been clearly demonstrated that written, individual feedback to prescribers has only limited effect (reviewed by Arnold and Straus [27]). Improvement can merely be expected using a feedback system including individual or collective education of prescribers, repeated on a regular base [28]. At the macro healthcare level, new strategies are needed to limit inappropriate prescribing, maybe by introducing a composite PIM score as a quality indicator of health care, inviting healthcare organizations to reduce their PIM score in order to comply with regulations [29]. Additionally, multidisciplinary collaboration has been mentioned as an important factor to improve prescribing quality. In this model, the responsibility of the prescribing physician might be shared by a clinical pharmacist guarding the appropriateness of prescribing and by a nursing team involved in the clinical observation of drug effects and adverse drug reactions (reviewed by Logathan et al. [30]).

Since longevity continues to increase, drug utilization in the elderly will expand and the problem of potentially inappropriate prescribing will emerge also in the future. A composite PIM score, taking into account under-, over- and misuse of drugs might be a helpful tool for regular automated screening. The implementation of a computerized monitoring system of PIMs, with regular personalized feedback to the responsible prescribers, is highly recommended to improve pharmaco-therapeutic care in nursing homes.

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