Inappropriate drug prescribing in older adults: the updated 2002 Beers criteria – a population-based cohort study

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Keywords

inappropriate prescribing, elderly,
Beers criteria, population-based

Received

23 September 2004

Accepted

20 December 2004

Background

In 1997, Beers and colleagues developed explicit criteria for potentially inappropriate drug prescribing in ambulatory older adults aged 65 years and over. Several studies have been performed to estimate the prevalence of inappropriate drug prescribing based on these criteria. In 2002, the criteria were updated.

Aims

To examine the extent and trend of inappropriate drug prescribing to ambulatory older adults in the Netherlands between 1997 and 2001, according to the 1997 and the updated Beers criteria.

Methods

Data were retrieved from the Integrated Primary Care Information (IPCI) project, a general practice research database with data from computer-based patient records of a group of 150 general practitioners in the Netherlands. All subjects aged 65 and over were included. Prescriptions were classified as inappropriate if they fulfilled the Beers criteria of prescriptions that generally should be avoided in older adults because of a high risk of adverse effects, while also considering dose and comorbidity.

Results

Between 1997 and 2001, the 1-year risk of receiving at least one inappropriate drug prescription for older adults ranged between 16.8% (95% CI: 16.3–17.3%) and 18.5% (18.3–18.7%) according to the 1997 criteria and between 19.1% (18.6–19.6%) and 20.0% (19.5–20.5%) according to the updated Beers criteria. According to the updated criteria, the most frequently prescribed inappropriate drugs were nitrofurantoin, long-acting benzodiazepines, amitriptyline, promethazine and cimetidine. Temazepam and zolpidem were mostly prescribed in supratherapeutic dose. Conventional NSAIDs in persons with a history of gastric/duodenal ulcer were the most frequently prescribed contra-indicated drugs.

Conclusions

Prescribing potentially inappropriate prescriptions to ambulatory older people in the Netherlands is substantial. Compared with other studies using the 1997 Beers criteria, inappropriate prescribing to the elderly is lower than in the USA but similar to Finland. Despite a restrictive medication policy and a growing attention for medication surveillance in Europe, inappropriate drug prescribing is still a substantial problem.

Introduction

Inappropriate medication use is a major patient safety concern, especially for the growing older population. Polypharmacy and use of inappropriate drugs in this group increase the risk of adverse drug reactions [1]. Inappropriate medications for older adults are defined as medications for which the potential risk outweighs the potential benefit and for which a good alternative drug is available [2].

In 1997, Beers and colleagues developed a comprehensive set of explicit criteria for potentially inappropriate drug use in ambulatory elderly aged 65 years and over. These criteria were developed with the intention of providing a useful tool for assessing the quality of prescribing in older persons, regardless of their level of frailty or their place of residence [2]. Drugs were classified as inappropriate in three categories: (1) drugs that generally should be avoided in older adults; (2) drugs that exceed a maximum recommended daily dose; and (3) drugs to be avoided in combination with specific comorbidity. Although for individual cases the listed drugs may be appropriate, the set of criteria may be used in drug utilization reviews, as the basis for educational materials and for assessing the quality of prescribing [3]. Recently, Beers *et al.* presented the results of updating the 1997 criteria which was done by a panel of experts in the USA [4], now called the 2002 criteria.

Previous studies using the Beers criteria were limited to the first category, i.e. drugs that generally should be avoided in older adults (general list). Studies in the USA estimated that between 17.5% and 23.5% of the ambulatory elderly population use at least one inappropriate drug from the general list [1, 5–7]. A population-based survey in Finland estimated a prevalence of 12.5% [8], also based on the general list of the 1997 criteria. The other two categories (considering dose and comorbidity) have never been properly evaluated in an older population.

In the updated Beers criteria (2002 criteria), changes mainly involve new medications which were added to the general list, but also several drugs were removed and there was a modification of the comorbidity list. To our knowledge, no studies have been performed yet with these new criteria and few European data on inappropriate drug use in the elderly are available. Therefore, we performed a population-based cohort study to estimate inappropriate medication prescribing to older adults in the Netherlands based on the updated Beers criteria while considering all three categories of inappropriate use. To compare our results with previous studies and to evaluate the impact of the updated criteria, we also assessed the 1997 Beers criteria.

Methods

All data were retrieved from the Integrated Primary Care Information (IPCI) project, a general practice research database, containing data from computer-based medical patient records of a group of 150 general practitioners (GPs) in the Netherlands. In the Dutch health care system, the GP has a pivotal role by acting as a gatekeeper for all medical care. Details of the database have been described elsewhere [9, 10]. Briefly, the database contains the complete medical records of approximately 500 000 patients. The electronic records contain coded and anonymous data on patient demographics, symptoms (in free text), diagnoses (using the International Classification for Primary Care [11] and free text) from GPs and specialists, referrals, laboratory findings, hospitalizations, and drug prescriptions. The drug prescription records include the following information: brand and generic name, indication, dosage regimen and Anatomical Therapeutic and Chemical (ATC) codes [12]. To maximize completeness of the data, general practitioners participating in the IPCI project are not allowed to maintain paper-based records besides the electronic medical records. The system complies with European Union guidelines on the use of medical data for medical research and has been proven valid for pharmaco-epidemiological research in several studies that evaluated the quality of the available information [10]. The population in this database is representative of the Dutch population regarding age and sex. The Scientific and Ethical Advisory Board of the IPCI project approved this study.

We conducted a population-based cohort study in a dynamic population of older adults aged 65 and over, with at least 1 year of valid database history. The study period started on 1 January, 1997 and ended on 31 December, 2001. All subjects in the study population were followed from 1 January, 1997, the date of their 65th birthday, or the date of 1 year of valid history, whichever was latest, until the earliest of one of the following censoring points: death, transferring out of the practice, or end of the study period.

Recently, Beers *et al.* presented the results of updating the 1997 criteria [4]. The initiative to revise and update the 1997 criteria had three main aims: (1) to re-evaluate the 1997 criteria, to include new drugs and incorporate new information available from the scientific literature; (2) to assign or re-evaluate a relative rating of severity for each of the medications; and (3) to identify any new conditions or considerations not addressed in the 1997 criteria [4]. New conditions and diagnoses were added, such as depression, cognitive impairment and Parkinson's disease. A total of 15 medications and medication classes were dropped or modi-

fied from the 1997 to the 2002 update. Most of the medications dropped since 1997 were those that were associated with comorbidity. Medications that were dropped include: phenylbutazone; dipyridamole; beta-blockers in persons with diabetes mellitus, chronic obstructive lung disease (with exception of propranolol), peripheral vascular disease, syncope and falls; and narcotics in persons with bladder outflow obstruction. Oxybutynin was modified by not including the extended-release formula. The update also includes several medications that have new information or have come to the market since the 1997 criteria, including amiodarone, fluoxetine, nitrofurantoin and cimetidine.

Three categories of inappropriate drug prescriptions according to the 1997 and 2002 Beers criteria were generated, namely: (1) drugs that generally should be avoided in older adults because of a high risk of adverse effects; (2) drug prescriptions that exceed a maximum recommended daily dose; and (3) drugs to be avoided in combination with certain comorbidity. Drugs were coded according to the ATC classification system [12]. To assess supra-therapeutic doses according to the Beers criteria, we used the prescribed daily dose which was available in the prescription records. Co-morbidities (diagnoses) were coded according to the International Classification of Primary Care (ICPC) [11]. The prevalence of comorbidities was obtained by searching on ICPC diagnostic codes and was assessed during or prior to the year of interest. For assessment of an inappropriate drug-comorbidity combination it was required that the disease or condition occurred prior to the prescription of interest. Several of the listed drugs are not marketed

in the Netherlands and were therefore excluded from the analysis. These concerned: meperidine, trimethobenzamide, dicyclomine, chlorpropamide, propantheline, carisoprodol, chlorzoxazone, cyclobenzaprine, metaxalone, methocarbamol, chlorpheniramine, hyoscyamine, diphenhydramine, tripeleminamine, reserpine, ticlopine, guanethidine, guanadrel, quazepam, halazepam, methyltestosterone, mesoridazine, desiccated thyroid and amphetamine.

Per calendar year we calculated the 1-year risk of receiving at least one inappropriate prescription according to both the 1997 and the 2002 criteria. The 1-year risk was calculated as the number of patients aged 65 years and older who received at least one inappropriate prescription divided by the total number of patients aged 65 years and over present during that whole year. We did this for the three categories separately and combined. Drug specific risks are shown for the most recent study year only. Ninety-five per cent confidence intervals around risk estimates were calculated based on the normal distribution.

Results

The study population for each year ranged from 18 030 to 29 605 persons aged 65 years and older over the years 1997–2001. The mean age of the study population remained reasonably stable, at approximately 74 years. Almost 60% was female and around 85% of the study population received at least one drug prescription per year (Table 1).

Taking all three Beers categories together (i.e. general list, dose-related list and comorbidity list), the 1-year

Table 1

Baseline characteristics of the study population in each calendar year

Characteristics ↓	1997 <i>n</i> = 18 030	1998 <i>n</i> = 20 947	1999 <i>n</i> = 29 605	2000 <i>n</i> = 26 378	2001 <i>n</i> = 25 258
Demographics					
Mean age (years)	74.5	74.5	74.7	74.8	74.9
Female sex (%)	59.7	59.2	59.1	58.8	58.5
Any drugs prescribed (%)	84.9	85.0	85.7	85.8	85.9
Comorbidity (%)					
Heart failure	5.3	5.8	5.5	5.8	5.9
Diabetes mellitus (treated)	8.5	9.3	9.8	10.2	11.0
Hypertension	18.4	18.1	17.6	19.2	20.1
COLD*	5.4	6.1	6.1	6.5	6.6
Gastric/duodenal ulcer	6.2	6.5	6.5	7.2	7.7

*COLD, chronic obstructive lung disease (asthma/COPD).

Figure 1

Prevalence of inappropriate prescribing in elderly between 1997 and 2001, according to the 1997 and 2002 Beers criteria, bars represent 95% CI. 1997 (□), 1998 (■), 1999 (□), 2000 (■), 2001 (□)

risks of receiving any inappropriate prescription ranged between 16.8% (95% CI: 16.3–17.3%) and 18.5% (18.3–18.7%) over calendar time according to the 1997 criteria and from 19.1% (18.6–19.6%) to 20.0% (19.5–20.5%) according to the 2002 criteria (Figure 1). The higher risk following the 2002 criteria was caused by an increase in prevalence of inappropriate prescribing from the general list. According to the 1997 criteria, the annual risk of receiving an inappropriate prescription increased from 1997 to 2002. This trend was not observed with 2002 criteria. For the 'overdose' list (drugs that should not exceed a maximum dose), the annual risk of receiving an inappropriate prescription was the same comparing the old and the new criteria. For the comorbidity list (drugs to be avoided in combination with certain comorbidity), the 1-year risk of receiving an inappropriate prescription was higher according to the 1997 criteria (risk ranges from 5.9% (5.6–6.2%) to 8.5% (8.2–8.8%)) than according to the 2002 criteria (risk ranges from 4.1% (3.8–4.4%) to 5.1% (4.8–5.4%)). However, both showed a trend of increasing annual risks.

In 2001, the most frequently prescribed inappropriate

drugs from the general list were long-acting benzodiazepines, amitriptyline, dipyridamole and promethazine according to the 1997 criteria. Nitrofurantoin, long-acting benzodiazepines, amitriptyline, promethazine and cimetidine were the most frequently prescribed inappropriate drugs according to the 2002 criteria (Table 2).

The drug most frequently prescribed in a supratherapeutic dose was temazepam (2% of the study population used temazepam and almost 30% of users received a supratherapeutic dose). Of the zolpidem users, 92% received a supratherapeutic dose according to the Beers criteria, but this drug is not prescribed frequently (0.9% of the study population) and the potential adverse effects are minor (Table 3).

Table 4 shows the prevalence of inappropriate prescribing in relation to comorbidity. According to the 1997 criteria, the most frequent inappropriate use was that of beta-blockers in diabetes patients (28.7%). Since this criterion was removed in 2002, the most frequent inappropriate use given comorbidity according to the 2002 criteria was of conventional NSAIDs in persons with a history of gastric/duodenal ulcer (26.6%) and of short-intermediate long-acting benzodiazepines in subjects with (previous) syncope or falls (26.4%). The prevalences were about the same in other years.

Discussion

According to this population-based cohort study, 20% of ambulatory older adults receive at least one inappropriate drug prescription per year. This is the first study that applies all the categories of the Beers criteria and evaluates the impact of the updated criteria compared with the previously used 1997 criteria. Using the newest criteria, we observed that inappropriate drug prescribing remained reasonably stable over the years 1997–2001.

Compared with previous studies in the USA [1, 5–7,13], the use of inappropriate drugs from the general 1997 list by older adults in the Netherlands is relatively low, but still substantial (9.3% in 2001, Table 2). The use of inappropriate drugs from the general 1997 list was similar to what has been found in Finland [8]. However, when using the 1997 criteria including dose and comorbidity, the risk of receiving inappropriate prescriptions almost doubles (18.5% in 2001, Figure 1). This probably means that inappropriate drug use in the USA is significantly higher than around the estimated 20% [1, 5–7], when dose and comorbidity are included.

While considering dose, the drugs most frequently prescribed in a supratherapeutic dose in the Netherlands were zolpidem and temazepam (Table 3). This finding was remarkable, because in our national drug information guides the recommended dose for temazepam in

Table 2Inappropriate drug prescribing from general list in year 2001, $n = 25\,258$

Type of medication	Severe potential adverse effects	Criteria 1997	Criteria 2002
Any general inappropriate drug prescribed (list below) (%) (95% CI)		9.3 (9.0–9.7)	14.3 (13.9–14.7)
Indomethacin	Yes	0.5	0.5
Pentazocine	Yes	<0.1	<0.1
Oxybutynin (immediate release)	Yes	0.7	0.7
Amitriptyline/chlordiazepoxide-amitriptylline	Yes	2.0	2.0
Doxepin	Yes	0.1	0.1
Meprobamate	Yes	<0.1	<0.1
Long-acting benzodiazepines:	Yes		
flurazepam		0.5	0.5
chlordiazepoxide		0.2	0.2
diazepam		2.8	2.8
chlorazepate*			0.4
Disopyramide	Yes	0.1	0.1
Methyldopa/methyldopa-hydrochlorothiazide	Yes	0.1	0.1
Belladonna alkaloids	Yes	0.3	0.3
Antihistamines and anticholinergics (hydroxyzine, cyproheptadine promethazine, dexchlorpheniramine)	Yes	Hydro 0.3 Cypro <0.1 Promethazine 0.9 Dexchlorphen. 0.1	Hydro 0.3 Cypro <0.1 Promethazine 0.9 Dexchlorphen. 0.1
Barbiturates except phenobarbital	Yes	0.1	0.1
Ketorolac*	Yes		0.2
Daily fluoxetine*	Yes		0.4
Amiodarone*	Yes		0.7
Orphenadrine*	Yes		<0.1
Nitrofurantoin*	Yes		4.5
Doxazosine*	Yes		0.5
Thioridazine*	Yes		<0.1
Cyclandelate	No	<0.1	<0.1
Clonidine*	No		0.1
Cimetidine*	No		0.8
Isoxsuprine*	No		<0.1
Propoxyphene and combination drugs	No	0.1	0.1
Phenylbutazone†	No	<0.1	
Dipyridamole†	No	1.4	

*Drugs added to list by 2002 criteria; †drugs removed from list by 2002 criteria.

elderly is a maximum of 10 mg day⁻¹ (normal dose 10–20 mg day⁻¹ in adults) and for zolpidem 5 mg day⁻¹ (normal dose 10 mg day⁻¹). Apparently, there is a huge gap between recommendations and clinical practice. We think that physicians should be made more conscious how to prescribe risky drugs in elderly. For example, a separate chapter in drug guides dealing with a list of risky drugs for the elderly and how (not) to prescribe these drugs, like the Beers criteria, could be an option to improve drug prescribing in this group.

While considering comorbidity, we found relatively

high risks for receiving inappropriate drugs: 26.6% of the elderly with (a history of) gastric/duodenal ulcer received conventional NSAIDs in 2001, most of them (>80%) without concomitant gastro-protective drug [14]. This result is in line with an earlier finding by Visser *et al.* [15]. Furthermore, 26.4% of elderly with (previous) syncope or falls received benzodiazepines with a longer elimination half-life. As a result of updating the criteria, beta-blockers combined with asthma/COPD are no longer contra-indicated, except for propranolol. This is roughly in line with our national guide-

Table 3Inappropriate drug prescribing considering maximum dose in year 2001, $n = 25\,258$

Type of medication	Maximum dose	Severe potential adverse effects	Patients prescribed drug (%)	Overdosing in patients prescribed drug (%)	Overdosing in study population (%)
Lorazepam	3 mg	Yes	1.0	11.5	0.1
Oxazepam	60 mg	Yes	8.8	0.9	0.1
Alprazolam	2 mg	Yes	0.6	0	0
Temazepam	15 mg	Yes	6.7	29.6	2.0
Triazolam	0.25 mg	Yes	0	0	0
Zolpidem	5 mg	No	0.9	92.5	0.8
Iron†	325 mg	No	2.4	0	0
Ferrous sulphate*	325 mg	No	0.8	0	0
Reserpine*	0.25 mg	No	0	0	0
Digoxin	0.125 mg, except when treating atrial arrhythmia	No	4.3	12.2	0.5
Any of above			20.8	16.3	3.4

*Drugs added to list by 2002 criteria; †drugs removed from list by 2002 criteria.

lines: only nonselective beta-blockers are contraindicated in asthma/COPD patients. Indeed, we did not observe any asthma/COPD patients in our study population who were prescribed propranolol, while propranolol is a regularly prescribed drug in the Netherlands.

The Beers criteria have been criticized, since they do not identify all causes of potentially inappropriate prescribing (e.g. drug–drug interactions are not included) and sometimes define appropriate prescribing as inappropriate [16]. Furthermore, the criteria only focus on prescribing inappropriate medications and not on potential underprescribing of indicated drugs and other drug management issues, such as medication monitoring and documentation [17]. This is a limitation of the Beers criteria. However, these criteria represent a widely used and standardized tool for pharmacological research, despite the fact that they can not be used as a substitute for careful clinical judgement [2].

Interestingly, the prevalences of inappropriate prescribing in the Netherlands and Finland seem to be remarkably lower than in the USA. However, 24 of the 78 drugs on the Beers list are not marketed in the Netherlands, some of which are commonly used in the USA. Hence, the differences in pharmaceutical marketing and drug policy among countries may have a great impact on the extent of inappropriate drug prescribing. On the other hand, the Beers list may not be complete enough to adequately assess inappropriate drug prescribing in

Europe including the Netherlands. Drugs which could be inappropriate for older persons may be marketed in Europe and not included in the Beers list, because they are not marketed in the USA. Considering this, the extent of inappropriate drug prescribing observed in this study may be an underestimation of the real situation. We therefore propose to adjust the Beers criteria to European standards to be more useful in Europe. However, we think the Beers criteria can give us a rough idea of inappropriate prescribing in medical practice.

Furthermore, it may be interesting to assess in future studies the consequences of inappropriate prescribing according to the Beers criteria, such as comparing the risk of falls and fractures in patient groups with and without inappropriate drug use. Comparing outcomes could give us an idea to what extent these criteria are relevant in clinical practice and influence the prognosis of older patients.

A limitation of this study is that the IPCI database may miss drug prescriptions that are directly written by medical specialists. However, in the Netherlands these prescriptions are commonly continued by the GP, especially if they concern chronic medication use. Hence, prescription data include all GP prescriptions and prescriptions initiated by the specialists which are continued by the GP. Nevertheless, missing some of the specialist prescriptions could lead to an underestimation of the extent of inappropriate prescribing. Another

Table 4Inappropriate drug prescribing considering comorbidity in year 2001, $n = 25\,258$

Disease and type of medication	Severe potential adverse effects	Patients prescribed drug, having the disease (%)	
		Criteria 1997	Criteria 2002
Heart failure ($n = 1479$)			
With disopyramide	Yes	0.1	0.1
With drugs with high sodium content	Yes	0.2	0.2
Diabetes receiving treatment ($n = 2777$)†		28.7	
With beta-blockers			
Hypertension ($n = 5074$)	Yes		
With amphetamines		0	0
With pseudoephedrine		0	0
With phenylpropanolamine		0	0
Chronic obstructive lung disease ($n = 1655$)			
With propranolol	Yes		0
With long-acting benzodiazepines	Yes	3.9	3.9
With beta-blockers†		15.8	
Gastric/duodenal ulcers ($n = 1952$)			
With NSAIDs	Yes	26.6	26.6
Epilepsy or seizures ($n = 139$)			
With clozapine, chlorpromazine, thioridazine or chlorprothixene	Yes	0	0
With Bupropion*	Yes		0
Peripheral vascular disease ($n = 550$) †			
With beta-blockers		24.4	
With metoclopramide		0.7	
Anticoagulant therapy ($n = 953$)			
With aspirin	Yes	9.7	9.7
With NSAIDs	Yes	20.1	20.1
With dipyridamole, clopidogrel* or ticlopidine	Yes	3.8	3.8
Bladder outflow obstruction ($n = 1209$)			
With anticholinergic antidepressants	Yes	4.3	4.3
With anticholinergic antihistamines	Yes	3.6	3.6
With gastrointestinal antispasmodics	Yes	0.1	0.1
With anticholinergics*	Yes		6.9
With decongestants*	Yes		2.4
With oxybutinin, flavoxate or tolterodine*	Yes		3.5
Syncope or falls ($n = 560$)			
With short-intermediate/long acting benzodiazepines	Yes	26.4	26.4
With tricyclic antidepressants	Yes	3.9	3.9
With beta-blockers†		20.9	
Arrhythmias ($n = 1198$)			
With tricyclic antidepressants	Yes	2.3	2.3
Parkinson's disease ($n = 265$)*	Yes		
With metoclopramide			1.5
With conventional antipsychotics			17.7
With tacrine			0
Cognitive impairment ($n = 196$)*	Yes		
With barbiturates			0
With anticholinergics			3.5
With antispasmodics			0.5
With CNS stimulants			0

*Comorbidity/drugs added to list by 2002 criteria; †comorbidity/drugs removed from list by 2002 criteria.

limitation is that we may have overestimated inappropriate *use*, since we only have the prescription and not the dispensing data of the drugs. Pharmacists may have intercepted inappropriate prescribing with their medication surveillance system.

In conclusion, for this study we were able to use very comprehensive drug and diagnosis data to assess potentially inappropriate prescribing to older adults applying the most complete and recent Beers criteria. Despite a restrictive medication policy and a growing attention for medication surveillance in Europe, inappropriate drug prescribing is still a substantial problem. Other aspects of medication care, such as underprescribing and drug monitoring and documentation, also deserve attention [17]. Therefore, for example, criteria that emphasize these aspects [18] and the Beers criteria should be applied in a complementary way, to improve drug prescribing in this vulnerable group.

This research was not supported by external funds. None of the authors has a conflict of interest.

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