

Research article

Open Access

## Potentially inappropriate prescriptions for older patients in long-term care

Carol Rancourt<sup>1</sup>, Jocelyne Moisan<sup>2</sup>, Lucie Baillargeon<sup>3</sup>, René Verreault<sup>4</sup>,  
Danielle Laurin<sup>5</sup> and Jean-Pierre Grégoire\*<sup>2</sup>

Address: <sup>1</sup>Health Economics and Outcomes Research, Merck Frosst Canada Ltd, Montreal, Qc, H9H 3L1, Canada, <sup>2</sup>Population Health Research Unit and Faculty of Pharmacy, Université Laval, Hôpital St-Sacrement, 1050 Chemin Ste-Foy, Québec, Qc, G1S 4L8, Canada, <sup>3</sup>Family Medicine Unit, Centre hospitalier universitaire de Québec, 2701 boul. Laurier, Québec, Qc, G1V 4G2, Canada, <sup>4</sup>Geriatric Research Unit, and Faculty of Medicine, Université Laval, Hôpital St-Sacrement, 1050 Chemin Ste-Foy Québec, Qc, G1S 4L8, Canada and <sup>5</sup>Geriatric Research Unit and Faculty of Pharmacy, Université Laval, Hôpital St-Sacrement, 1050 Chemin Ste-Foy Québec, Qc, G1S 4L8, Canada

Email: Carol Rancourt - carol\_rancourt@merck.com; Jocelyne Moisan - jocelyne.moisan@pha.ulaval.ca;  
Lucie Baillargeon - lucie.baillargeon@crchul.ulaval.ca; René Verreault - rene.verreault@mshp.ulaval.ca;  
Danielle Laurin - danielle.laurin@pha.ulaval.ca; Jean-Pierre Grégoire\* - jean-pierre.gregoire@pha.ulaval.ca

\* Corresponding author

Published: 15 October 2004

Received: 27 February 2004

BMC Geriatrics 2004, 4:9 doi:10.1186/1471-2318-4-9

Accepted: 15 October 2004

This article is available from: <http://www.biomedcentral.com/1471-2318/4/9>

© 2004 Rancourt et al; licensee BioMed Central Ltd.

This is an open-access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

### Abstract

**Background:** Inappropriate medication use is a major healthcare issue for the elderly population. This study explored the prevalence of potentially inappropriate prescriptions (PIPs) in long-term care in metropolitan Quebec.

**Methods:** A cross sectional chart review of 2,633 long-term care older patients of the Quebec City area was performed. An explicit criteria list for PIPs was developed based on the literature and validated by a modified Delphi method. Medication orders were reviewed to describe prescribing patterns and to determine the prevalence of PIPs. A multivariate analysis was performed to identify predictors of PIPs.

**Results:** Almost all residents (94.0%) were receiving one or more prescribed medication; on average patients had 4.8 prescribed medications. A majority (54.7%) of treated patients had a potentially inappropriate prescription (PIP). Most common PIPs were drug interactions (33.9% of treated patients), followed by potentially inappropriate duration (23.6%), potentially inappropriate medication (14.7%) and potentially inappropriate dosage (9.6%). PIPs were most frequent for medications of the central nervous system (10.8% of prescribed medication). The likelihood of PIP increased significantly as the number of drugs prescribed increased (odds ratio [OR]: 1.38, 95% confidence interval [CI]: 1.33 – 1.43) and with the length of stay (OR: 1.78, CI: 1.43 – 2.20). On the other hand, the risk of receiving a PIP decreased with age.

**Conclusion:** Potentially inappropriate prescribing is a serious problem in the highly medicated long-term care population in metropolitan Quebec. Use of explicit criteria lists may help identify the most critical issues and prioritize interventions to improve quality of care and patient safety.

## Background

Inappropriate medication use is a major health care issue for the elderly population [1-3]. Older patients are more at risk for adverse medication outcomes because they often have complex drug regimens and because of the age-related changes in drug pharmacokinetics and pharmacodynamics [1]. Potentially inappropriate prescriptions (PIPs), defined as prescriptions in which risks outweigh benefits, have been assessed in various settings using lists of explicit criteria most often based on that developed by Beers [4]. PIPs have been estimated to affect 4.8% to 45.6% of the elderly population [5-12].

Prevalence estimates of PIPs are likely to vary with the criteria that are applied. Some authors have based their assessment on the Beers criteria [5-7,9-12]. However, in all these studies but one [7], criteria applied were a subset only of Beers criteria as dosage and duration was not evaluated. Despite controversy about which explicit criteria should be used, there is a strong body of evidence showing that suboptimal prescribing is disturbingly common in older patients.

In Canada, a list of explicit criteria was developed by a panel of experts in 1997 [13]. The Canadian criteria required diagnostic information which is not easily accessible in the long-term care setting [6,14]. Using various methodologies, several studies have investigated the extent of the problem in Canada. A 1995 study of community-dwelling and institutionalized older patients reported large variations in PIPs among provinces, ranging from 4.8% in the prairies to 12.8% in Quebec [9]. More recently, the prevalence of PIPs in long-term care patients in Ontario was reported to range between 14.9% and 20.8% [15-17]. In Quebec, a 1990 retrospective database survey of 63,268 older Medicare patients reported that 45.6% of non-institutionalized patients received high-risk prescriptions of questionable appropriateness [8], while a recent survey of 3,400 elderly patients in the Quebec general population reported that 6.5% had a potentially inappropriate prescription (PIP) [18]. A 1995 physician survey reported that 77.1% of nursing home patients in Quebec had been taking benzodiazepine for over one year [19].

The long-term care elderly population is particularly vulnerable to inappropriate medication use; it is composed of frail older patients who typically have functional disabilities and acute and chronic medical histories that require complex medication regimens [20,21]. Assessing PIPs using the data available in long-term care, in particular data on dosage and duration of use, may help designing efficient interventions to improve prescribing practices in one of the frailest populations. The objectives of this study were (1) to describe prescribing patterns in

elderly patients residing in long-term care facilities in the Quebec metropolitan area, (2) to assess the prevalence of PIPs in this long-term care setting using published explicit criteria [4,13,22] adapted for this study, and (3) to identify patient-related predictors of PIPs.

## Methods

### **Design and data sources**

A cross-sectional chart review of long-term care patients aged 65 years and over living in the Quebec City area was performed in the period between April 1995 and December 1996. All long-term care facilities located in the Quebec City area were contacted and the majority (29 out of 33) agreed to participate in the study. Within the 29 participating facilities, there were a total of 71 long-term care units. Numbers of beds in these units averaged 41 (10 to 190). Units were visited once during the study period. Data on drugs currently being prescribed the day of the visit was collected using medication charts. Demographic data included age, gender and length of stay. This study was approved by the ethics committees at Université Laval, Hôpital Saint-François d'Assise and Hôpital de l'Enfant-Jésus.

For each medication order, the name, dosage, frequency of dosing and nature of prescription (scheduled or given on an as-needed basis) were collected. To capture the fullest possible extent of potentially inappropriate prescribing, it was assumed that all medications prescribed on an as-needed basis were taken. The total daily dose of an as-needed prescription was calculated by multiplying the prescribed unit dose with the indicated daily frequency of administration. Prescriptions for creams, ointments and drops were not included. Each medication was classified using the Anatomical Therapeutic Chemical (ATC) classification system [23]. The maximal prescribed daily dose was calculated for each medication order.

### **Classification of potentially inappropriate prescribing**

A list of explicit criteria for PIP in older patients was developed based on a review of the literature [4,6,10,11,13,14,22]. Criteria referring to medications unavailable in Canada were excluded. Because diagnostic information is difficult to obtain in the long-term care setting [6,14], criteria involving clinical information were also excluded. The list of criteria was elaborated using a modified Delphi method [24]. A consensus panel of four local experts was convened including a general practitioner with a geriatric practice (RV), a family physician (LB), a clinical pharmacist and a pharmacoepidemiologist (JPG), all involved in practice or research on medication issues in the elderly population. In the first step, experts were asked to review and comment independently on the preliminary list of published criteria. Responses from the experts were used to revise this list. In the second step, the

panel discussed each criterion until a consensus was reached. A total of 111 explicit criteria were included in the list to assess the quality of prescribing (Appendix).

Medication charts were reviewed and compared with the list of explicit criteria. PIPs were categorized as:

- Potentially inappropriate medication;
- Potentially inappropriate duration;
- Potentially inappropriate dosage; and
- Potentially inappropriate drug-drug interaction.

#### **Data analyses**

Drug prescribed and PIP data were stratified by age and gender. Chi-square and Student *t* tests were used to compare proportions and means, respectively. Association between age and drug utilization was evaluated by analysis of variance. Factors predicting PIP were identified by logistic regression analyses. Independent variables were age, sex, number of prescribed drugs and length of stay. An initial bivariate analysis allowed calculation of crude odds ratios, identification of variables individually associated with the risk of PIP, and determination of the appropriate scale for each variable. A multivariate analysis with a significance threshold of 0.10 for the inclusion of variables subsequently yielded adjusted odds ratios for the number of prescribed medications, age and length of stay. Data were analyzed for collinearity and overdispersion. Data analyses were performed using SAS version 6.12 (SAS Institute Inc. Cary, NC).

## **Results**

### **Study population**

The study population included 2,633 individuals, aged 65 years and older, residing in long-term care facilities for a mean duration of 8.5 years. Mean age was  $82 \pm 8$  years and the majority of individuals were women (74.2%). Women were older than men ( $84 \pm 8$  years versus  $79 \pm 8$  years,  $p = .0001$ ).

### **Drug utilization**

Most residents (94%,  $n = 2,481$ ) had one or more prescribed medications and 48% ( $n = 1,266$ ) of the total population had five or more medications. Residents had on average 4.8 prescribed medications. Proportions of patients by number of prescribed medications were similar for men and women, but varied according to age. The oldest patients, aged 85 years and more, received significantly less medications than their youngest counterparts aged between 65 and 74 years; 43.8% of patients aged over 85 years received five medications or more, compared to 59.4% of those aged 65 to 74 years. Of the

12,707 medications prescribed, 86% were scheduled administrations and 82% were prescribed for more than three months.

A majority of patients (85.5%,  $n = 2,251$  patients) had a prescription for medications of the central nervous system (CNS). Cardiovascular medications (46.4%,  $n = 1,221$  patients) and medications of the alimentary tract and metabolism (29.3%,  $n = 772$  patients) were the following most frequently prescribed anatomical groups of medications. Most commonly prescribed therapeutic classes included analgesics (48.0%), anxiolytics (41.4%), antipsychotics (35.0%) and loop (high-ceiling) diuretics (18.6%) (Table 1). There were differences in therapeutic classes prescribed to men and women. Acetaminophen (36.7% of patients), haloperidol (20.5% of patients) and lorazepam (20.2% of patients) were the three most frequently prescribed drugs (Table 2).

### **Potentially inappropriate prescribing**

Overall, 51.5% of the population under study had one or more PIPs. Of the 2,481 patients with at least one prescribed drug, more than half (54.7%) had one or more PIPs; 29.5% had one PIP, 12.5% had two PIPs, 7.5% had three PIPs and 5.3% had four or more PIPs.

A total of 12,707 drugs were prescribed of which 1807 were given on an as-needed basis. The proportion of PIPs among scheduled and as-needed prescriptions were 9.2% and 11.5%, respectively. If we exclude as-needed prescriptions, 46.4% of all residents had one or more PIPs.

The most common type of PIP was drug-drug interaction, affecting 33.9% of patients treated with drugs, followed by potentially inappropriate duration (23.6%), potentially inappropriate medication (14.7%), and potentially inappropriate dosage (9.6%) (Figure 1). The proportion of patients receiving any type of PIP decreased with age, from 66.7% for patients aged 65 to 74 years to 56.4% for those aged 75 to 84 years and 47.7% for patients aged 85 years and more. PIPs were the most frequent for CNS medications, representing 9.3% of prescribed medications.

The most common PIP was a potentially inappropriate duration for intermediate and short-acting benzodiazepines for more than one month (22.9%); more than half of those PIPs were for the anxiolytic oxazepam (Table 3). A substantial number of patients treated with pharmacotherapy were receiving repeat (dual) prescriptions of antipsychotics (16.5%) or benzodiazepines (14.9%). Almost 6% of patients treated with pharmacotherapy were prescribed potentially inappropriate long-acting benzodiazepines and 5.2% were receiving haloperidol at

**Table 1: Proportion (in %) of elderly patients on medication by therapeutic class and sex\***

Therapeutic class	Proportion of patients (%)			
	All (n = 2,633)	Men (n = 680)	Women (n = 1,953)	p value
Analgesics & antipyretic	48.0	44.6	49.2	0.037
Anxiolytics	41.4	41.4	41.4	0.983
Antipsychotics	35.0	39.5	33.5	0.004
Loop (high ceiling) diuretics	18.6	16.2	19.4	0.062
Antiepileptics	14.9	21.6	12.6	<0.001
Thyroid preparations	14.6	8.4	16.8	<0.001
Vasodilators	14.6	11.0	15.8	0.002
Antidepressants	13.7	11.0	14.7	0.017
Cardiac glycosides	12.4	11.6	12.7	0.462
Drugs for peptic ulcer	11.0	11.3	10.9	0.765
Hypnotics & sedatives	10.9	9.8	11.3	0.293
Anticholinergics	10.9	11.2	10.8	0.788
Selective calcium channel blockers	10.6	7.2	11.7	0.001
Angiotensin converting enzyme inhibitors	10.0	10.0	10.0	0.991

\* Only therapeutic classes prescribed to 10% or more of the elderly are displayed

**Table 2: Most frequently prescribed medications among the elderly in long-term care**

ATC code	Medication	Proportion of patients (%)		
		Men (n = 680)	Women (n = 1,953)	All (n = 2,633)
N02BE01	Acetaminophen	30.5	38.9	36.7
N05AD01	Haloperidol	21.9	20.1	20.5
N05BA06	Lorazepam	20.2	20.2	20.2
C03CA01	Furosemide	16.2	19.2	18.6
N02BA01	Acetyl salicylic acid	19.1	16.7	17.3
N05BA04	Oxazepam	16.3	17.1	16.9
H03AA01	Levothyroxin sodium	8.4	16.8	14.6
C01DA02	Nitroglycerin	10.0	14.6	13.4
C01AA05	Digoxin	11.6	12.7	12.4

ATC: Anatomical Therapeutic Classification

a potentially inappropriate dosage. The most common PIP among cardiovascular drugs was repeat prescription of calcium channel blockers, affecting 3.1% of treated patients.

#### Predictors

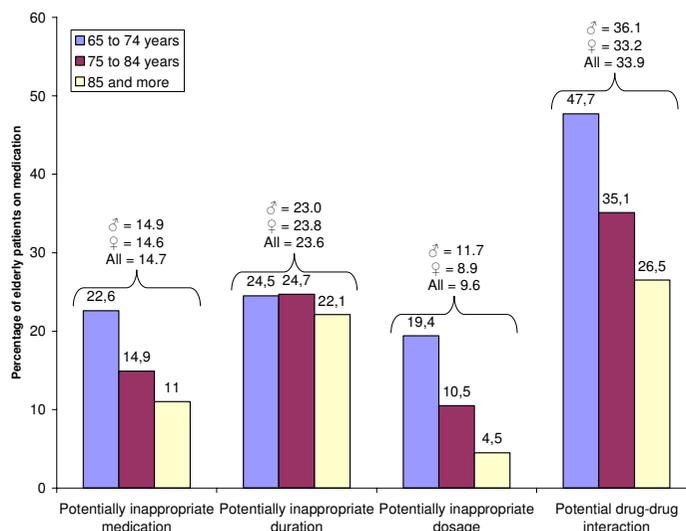
Multivariate analysis indicated that patients with a length of stay 10 years or over were 1.78 times at greater risk of being prescribed a PIP than those with less than 10 years of stay (adjusted odds ratio [OR]: 1.78, 95% confidence interval [CI]: 1.43–2.20) (Table 4). The risk of PIP also increased significantly as the number of drugs prescribed increased (OR: 1.36, CI: 1.32–1.41) whereas it decreased with age. Gender was not a significant predictor of PIP. No

problems of collinearity or overdispersion were observed in the multivariate model.

#### Discussion

The long-term care elderly population evaluated in this study was highly medicated and a majority of patients receiving medication had a PIP. These results indicate that potentially inappropriate prescribing was significant at the time of the study in institutionalized older patients in the Quebec metropolitan area.

A total of 94% of residents in this long-term care population were prescribed at least one drug, compared to 60% in community-dwelling elderly patients in Quebec [25].



**Figure 1**  
Potentially inappropriate prescribing including inappropriate medication, dosage, duration and potential drug-drug interaction among three age-groups of long-term care elderly (N = 2,481) ♂ = male ♀ = female

The mean number of medications was also higher (4.8) than in community-dwelling individuals in Quebec (2.9) [25], but lower than in American long-term care (7.2) [7].

The total prevalence of PIPs among the population under study was high (51.5%). Estimates of PIP prevalence in the literature vary between 4.8% [6] and 45.6% [8] for both institutionalized and community-dwelling older patients. Caution must be used when comparing these results, as the delivery of care may vary from one setting and one region to another [9]. The current lack of consensus when defining lists of criteria and variations with respect to methodologies also contribute to the observed differences [26]. For example, Zhan and colleagues [5] estimated the proportion of potentially inappropriate medication use in the community-dwelling elderly in the United States. Applying criteria on the indication for the use of 33 drugs, they observed a prevalence of 21.3% for 1996. In our study, PIPs were identified using an explicit criteria list that was primarily based on Beers and McLeod criteria [4,13,22] and that was updated and validated by local experts to apply to the long-term care context in Quebec. As we had access to dosage and duration information, we were able to apply a broader set of criteria which can explain the higher prevalence of PIPs we have observed. Explicit criteria lists, such as those developed by

Beers and McLeod, define inappropriate prescription according to the drug overall risk-benefit profile for elderly patients. These lists were previously used in studies examining inappropriate prescribing in elderly populations [3,5,6,11,15,27-30] and undergo a continuous process of revision and updating to reflect the most current clinical information on the risks and benefits of medications [31].

A large number of patients were receiving CNS medication (85%) and the most common PIPs were related to that category of drugs. Thirty-five percent of patients were prescribed antipsychotics and 22.9% had benzodiazepine for potentially inappropriate duration, defined as more than a month [32]. A number of studies have reported the inappropriate use of CNS drugs [5,8,33,34], particularly benzodiazepines [18,19]. Many factors may contribute to the continued use of inappropriate CNS medications, including prescriber attitudes, patient demands and the design of the health care system [34]. A survey of physicians in Quebec reported that the psychological distress of aging patients and the quasi-absence of reported side-effects justified the long-term use of psychotropic medication, which was seen as the most effective way of helping the patient [35]. Moreover, side effects of psychoactive medication are often believed to be a consequence of the

**Table 3: Most common potentially inappropriate prescriptions (PIPs) among older patients receiving medication in long-term care**

Criteria	Number of patients	Proportion of all patients prescribed a medication (%) (N = 2,481)
<b>Potentially inappropriate medication</b>	<b>365</b>	<b>14.7</b>
Long-acting benzodiazepines	138	5.6
Preparations including an antihistaminic	112	4.5
Flurazepam	54	2.2
Doxepin	31	1.3
Amitryptiline	27	1.1
Propranolol	27	1.1
Chloral hydrate	22	0.9
<b>Potentially inappropriate duration</b>	<b>585</b>	<b>23.6</b>
Intermediate and short-acting benzodiazepines at bedtime for more than one month	567	22.9
Oxazepam at bedtime for more than one month	313	12.6
<b>Potentially inappropriate dosage</b>	<b>239</b>	<b>9.6</b>
Haloperidol > 3 mg daily	129	5.2
Thioridazine > 30 mg daily	53	2.1
Lorazepam > 3 mg daily	34	1.4
<b>Potential drug-drug interaction</b>	<b>842</b>	<b>33.9</b>
Repeat* prescription of antipsychotics	409	16.5
Repeat* prescription of benzodiazepine	369	14.9
Clonazepam and other benzodiazepine	46	1.9
Benzodiazepine and hypnotic or sedative	93	3.8
Repeat* prescription of calcium channel blockers	77	3.1
Repeat* prescription of tricyclic antidepressants	37	1.5
Repeat* prescription of angiotensin converting enzyme inhibitors	19	0.8
Repeat* prescription of $\beta$ -blockers	11	0.4
Repeat* prescription of non-steroidal anti-inflammatory drugs (except acetylsalicylic acid)	10	0.4
Repeat* prescription of barbiturate	10	0.4
<b>Total potential inappropriate prescriptions**</b>	<b>1,358</b>	<b>54.7</b>

\*Repeat prescription indicates that two agents of the same drug class are being prescribed

\*\*Numbers do not add up since one prescription may be linked to more than one PIP (e.g., duration and dosage)

aging process [34]. Almost three quarters of potentially inappropriate psychoactive medications can produce a physical dependence [34]. Psychoactive pharmacotherapy increases risk of hip fractures and is advocated for use with caution to prevent falls in elderly populations [36,37]. Anticonvulsants, antidepressants and short- and long-acting benzodiazepines were reported to increase risk of falls in older women [38].

The length of stay was positively associated with PIPs, while the prevalence of PIPs decreased with age. Although the association between length of stay and the likelihood of receiving a PIP in nursing homes was studied in the past [6], to our knowledge, this is the first time it is being shown to be a predictor of PIPs. On the other hand, the risk of receiving a PIP was previously reported to decrease with age in nursing home patients over 65 years [7,12]. Data on clinical status was not considered in these studies and it can be hypothesized that either the oldest residents were less ill or that physicians were more cautious when

prescribing to very old patients. As reported in previous studies [12,26], the number of medications was also a predictor of PIP in older patients. Patients in long-term care frequently have multiple diseases resulting in complex medication regimens, which makes assessment of the risks versus benefits of treatments often difficult. Female gender was previously reported as a predictor of PIP [7,12]. Although we observed gender differences in the prescribed therapeutic classes, female gender was not a predictor of PIPs in our study.

The results presented here should be viewed in light of potential limitations. As in previous studies [15], we did not abstract information on diagnoses from the patients charts and drug prescriptions were considered as surrogates for disease conditions. Thus, the explicit criteria used in this study apply to general circumstances, but may not be applicable to specific cases, since they do not consider clinical information. For example, lipid-lowering drugs may be potentially inappropriate in patients aged 75 and

**Table 4: Predictors of potentially inappropriate prescription among elderly patients in long-term care (N = 2,481)**

Predictor	Proportion of patients with PIP (%)	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)*
Number of prescribed drugs (increments of one drug)	54.7	1.38 (1.33–1.43)	1.36 (1.32–1.41)
Gender			
Women	54.5	1.00	-
Men	55.5	1.04 (0.87–1.25)	-
Age			
65 to 74 years	66.7	1.00	1.00
75 to 84 years	56.4	0.65 (0.51–0.81)	0.74 (0.58–0.96)
85 years or more	47.7	0.46 (0.36–0.57)	0.60 (0.47–0.77)
Length of stay			
<10 years	51.1	1.00	1.00
≥10 years	67.4	1.98 (1.62–2.41)	1.78 (1.43–2.20)

CI: confidence interval; \*Adjusted for number of prescriptions, age, and length of stay

over, but evidence from clinical trials suggests that statins may be of benefit if the patient's life expectancy exceeds two years [39]. Thus, misidentification of potential cases of appropriate or inappropriate prescribing may have occurred, since complex medical conditions can alter the risk-benefit profile of medications. However, due to the frail condition of most patients, it is unlikely that such misidentifications have occurred frequently. Since access to clinical data is often difficult in the nursing home setting, a list of explicit criteria that does not require that type of information may be easier to apply on a larger scale.

This study evaluated prescription patterns rather than the actual consumption of medication. The low prevalence of as-needed medication (14%) and the long-term care setting, in which medication is administered to patients by a health caregiver, suggest that this limitation did not have a significant impact on the results. As-needed prescriptions may have accounted for repeat prescriptions, which may in turn have led to overestimation of the number of drug-drug interactions. However, even after excluding as-needed prescriptions from the analysis, the proportion of residents with a PIP remains high.

Predictors of PIPs were assessed using a multivariate analysis. It allowed us to adjust for potential confounding variables. However, we were not able to adjust for facility variables as those were not available.

This study is the first to describe and qualify prescribing practices in long-term care facilities in urban Quebec. In particular, it highlights the extent of potentially inappropriate prescribing in elderly long-term care patients, which are among the frailest of society [4,21]. Inappropriate prescribing is one component of the major health care problem of suboptimal prescribing that also includes underuse of effective agents, drug-disease interactions and

prescription errors. Substantial morbidity, mortality and cost are attributed to suboptimal prescribing [1,2]. Although a decline in the prevalence of PIPs was reported in community-dwelling older patients in the United States between 1987 and 1996 [40], the continued use of inappropriate medications is a major concern. A growing body of evidence suggests that clinical pharmacy and multidisciplinary team interventions can modify suboptimal prescribing in older patients. Modern data management [15,41] and use of the best clinical evidence could help practitioners improve the management of complex cases [40,42]. Recent studies in long-term care settings showed that physician or pharmacist interventions reduce PIPs [1,12,16,43], while a clinical review program of prescriptions for community-dwelling patients conducted by a team of physicians, pharmacists and nurses did not seem to improve prescribing practices [44].

**Conclusions**

Inappropriate prescribing is highly prevalent in the elderly long-term care population in metropolitan Quebec. The use of a explicit criteria list to identify PIPs is a first step towards identifying most critical issues and implementing strategies to improve quality of care and patient safety. Identifying predictors of PIPs may help to target problems and prioritize interventions that are most needed in the rapidly expanding older population.

**Competing interests**

Carol Rancourt and Jean-Pierre Grégoire were employed by Merck Frosst Canada at the time of the preparation of this article.

**Authors' contributions**

CR, in partial fulfillment for the grade of M.Sc., lead the protocol development, expert panel consultation, data analyses, discussion of results, and manuscript prepara-

tion. JM contributed to all steps of this research project and manuscript preparation. LB contributed to protocol development, presentation and discussion of results and manuscript preparation and participated in the expert panel to define the explicit criteria. RV is the principal investigator for the initial research project which generated the drug prescription data used for this study. He contributed to protocol development, presentation and discussion of results, manuscript preparation and participated in the expert panel to define the explicit criteria. DL was a co-investigator for the initial research project, which generated the drug prescription data used for this study, and contributed to protocol development, data analyses and manuscript preparation. All authors read and approved the final manuscript. JPG contributed to protocol development presentation and discussion of results, manuscript preparation and participated in the expert panel to define the explicit criteria.

### Additional material

#### Additional File 1

Appendix: List of explicit criteria used to assess the quality of prescribing in long-term care for elderly patients provide as additional file

Click here for file

[<http://www.biomedcentral.com/content/supplementary/1471-2318-4-9-S1.xls>]

### Acknowledgements

The authors wish to thank Carmen Vezina MSc for her contribution as a clinical pharmacist to the expert panel. This study was made possible by grants from the Fonds de la Recherche en Santé du Québec (project #940984-104) and the Laval University Chair for Geriatric Research (project #95-14). This article was prepared with the assistance of BioMed-Com Consultants Inc.

### References

- Hanlon JT, Schmadler KE, Ruby CM, Weinberger M: **Suboptimal prescribing in older inpatients and outpatients.** *J Am Geriatr Soc* 2001, **49**:200-209.
- Committee on Quality of Health Care in America: **To err is human: building a safer health system.** Edited by: Kohn LT, Corrigan JM and Donaldson MS. Washington, D.C., National Academy Press; 1999:1-28.
- Liu GG, Christensen DB: **The continuing challenge of inappropriate prescribing in the elderly: an update of the evidence.** *J Am Pharm Assoc (Wash)* 2002, **42**:847-857.
- Beers MH, Ouslander JG, Rollinger I, Reuben DB, Brooks J, Beck JC: **Explicit criteria for determining inappropriate medication use in nursing home residents.** *Arch Intern Med* 1991, **151**:1825-1832.
- Zhan C, Sangl J, Bierman AS, Miller MR, Friedman B, Wickizer SW, Meyer GS: **Potentially inappropriate medication use in the community-dwelling elderly: findings from the 1996 Medical Expenditure Panel Survey.** *JAMA* 2001, **286**:2823-2829.
- Williams B, Betley C: **Inappropriate use of nonpsychotropic medications in nursing homes.** *J Am Geriatr Soc* 1995, **43**:513-519.
- Beers MH, Ouslander JG, Fingold SF, Morgenstern H, Reuben DB, Rogers W, Zeffren MJ, Beck JC: **Inappropriate medication prescribing in skilled-nursing facilities.** *Ann Intern Med* 1992, **117**:684-689.
- Tamblyn RM, McLeod PJ, Abrahamowicz M, Monette J, Gayton DC, Berkson L, Dauphinee WD, Grad RM, Huang AR, Isaac LM: **Questionable prescribing for elderly patients in Quebec.** *CMAJ* 1994, **150**:1801-1809.
- Hogan DB, Eby EM, Fung TS: **Regional variations in use of potentially inappropriate medications by Canadian seniors participating in the Canadian Study of Health and Aging.** *Can J Clin Pharmacol* 1995, **2**:167-174.
- Spore DL, Mor V, Larrat P, Hawes C, Hiris J: **Inappropriate drug prescriptions for elderly residents of board and care facilities.** *American Journal of Public Health* 1997, **87**:404-409.
- Willcox SM, Himmelstein DU, Woolhandler S: **Inappropriate drug prescribing for the community-dwelling elderly.** *JAMA* 1994, **272**:292-296.
- Dhall J, Larrat EP, Lapane KL: **Use of potentially inappropriate drugs in nursing homes.** *Pharmacotherapy* 2002, **22**:88-96.
- McLeod PJ, Huang AR, Tamblyn RM, Gayton DC: **Defining inappropriate practices in prescribing for elderly people: a national consensus panel.** *CMAJ* 1997, **156**:385-391.
- Beers MH, Fingold SF, Ouslander JG, Reuben DB, Morgenstern H, Beck JC: **Characteristics and quality of prescribing by doctors practicing in nursing homes.** *J Am Geriatr Soc* 1993, **41**:802-807.
- Papaioannou A, Bedard M, Campbell G, Dubois S, Ferko N, Heckman G, Flett N: **Development and use of a computer program to detect potentially inappropriate prescribing in older adults residing in Canadian long-term care facilities.** *BMC Geriatr* 2002, **2**:5-12.
- Gill SS, Misiaszek BC, Brymer C: **Improving prescribing in the elderly: a study in the long term care setting.** *Can J Clin Pharmacol* 2001, **8**:78-83.
- Dhalla IA, Anderson GM, Mamdani MM, Bronskill SE, Sykora K, Rochon PA: **Inappropriate prescribing before and after nursing home admission.** *J Am Geriatr Soc* 2002, **50**:995-1000.
- Laurier C, Moride Y, Kennedy WA: **Health survey data on potentially inappropriate geriatric drug use.** *Ann Pharmacother* 2002, **36**:404-409.
- Roberge RF, Genest A, Beauchemin JP, Parent M: **Prescriptions potentiellement inappropriées de benzodiazépines chez les personnes âgées en centre d'accueil.** *Can Fam Physician* 1995, **41**:800-805.
- Bergman H, Beland F, Lebel P, Contandriopoulos AP, Tousignant P, Brunelle Y, Kaufman T, Leibovich E, Rodriguez R, Clarfield M: **Care for Canada's frail elderly population: fragmentation or integration?** *CMAJ* 1997, **157**:1116-1121.
- Régies régionales de la santé et des services sociaux du Québec: **Rapport statistique annuel 1996-1997: centres hospitaliers et centres d'hébergement et de soins de longue durée. Volume AS-478 (rév.: 96-12).** Québec, Gouvernement du Québec, Ministère de la santé et des services sociaux; 1996:1-39.
- Beers MH: **Explicit criteria for determining potentially inappropriate medication use by the elderly: an update.** *Arch Intern Med* 1997, **157**:1531-1536.
- WHO Collaborating Centre for Drug Statistics Methodology: **Anatomical Therapeutic Chemical (ATC) classification index with Defined Daily Doses (DDDs)** Oslo, Norway, WHO Collaborating Centre for Drug Statistics Methodology; 2002:1-88.
- Evans C: **The use of consensus methods and expert panels in pharmacoeconomic studies: practical applications and methodological shortcomings.** *Pharmacoeconomics* 1997, **12**:121-129.
- Régie de l'assurance-maladie du Québec: **Service de l'analyse de la consommation et de la dispensation-médicaments: Rapport du comité d'analyse de la consommation médicamenteuse des personnes âgées.** Québec, Gouvernement du Québec, Ministère de la santé et des services sociaux; 1992:1-181.
- Aparasu RR, Mort JR: **Inappropriate prescribing for the elderly: beers criteria-based review.** *Ann Pharmacother* 2000, **34**:338-346.
- Gupta S, Rappaport HM, Bennett LT: **Inappropriate drug prescribing and related outcomes for elderly Medicaid beneficiaries residing in nursing homes.** *Clin Ther* 1996, **18**:183-196.
- Pitkala KH, Strandberg TE, Tilvis RS: **Inappropriate drug prescribing in home-dwelling, elderly patients: a population-based survey.** *Arch Intern Med* 2002, **162**:1707-1712.
- Straand J, Rokstad KS: **Elderly patients in general practice: diagnoses, drugs and inappropriate prescriptions. A report from**

- the More & Romsdal Prescription Study.** *Family Practice* 1999, **16**:380-388.
30. Stuck AE, Beers MH, Steiner A, Aronow HU, Rubenstein LZ, Beck JC: **Inappropriate medication use in community-residing older persons.** *Arch Intern Med* 1994, **154**:2195-2200.
  31. Fick DM, Cooper JW, Wade WE, Waller JL, Maclean JR, Beers MH: **Updating the Beers criteria for potentially inappropriate medication use in older adults.** *Arch Intern Med* 2003, **163**:2716-2724.
  32. Consensus Conference. Drugs and Insomnia: **The use of medication to promote sleep.** *JAMA* 1984, **251**:2410-2414.
  33. Osborne CA, Hooper R, Li KC, Swift CG, Jackson SH: **An indicator of appropriate neuroleptic prescribing in nursing homes.** *Age Ageing* 2002, **31**:435-439.
  34. Mort JR, Aparasu RR: **Prescribing of psychotropics in the elderly: why is it so often inappropriate?** *CNS Drugs* 2002, **16**:99-109.
  35. Damestoy N, Collin J, Lalonde R: **Prescribing psychotropic medication for elderly patients: some physicians' perspectives.** *CMAJ* 1999, **161**:143-145.
  36. Rothschild JM, Bates DW, Leape LL: **Preventable medical injuries in older patients.** *Ann Intern Med* 2000, **160**:2717-2728.
  37. Wang PS, Bohn RL, Glynn RJ, Mogun H, Avorn J: **Zolpidem use and hip fractures in older people.** *J Am Geriatr Soc* 2001, **49**:1685-1690.
  38. Ensrud KE, Blackwell TL, Mangione CM, Bowman PJ, Whooley MA, Bauer DC, Schwartz AV, Hanlon JT, Nevitt MC: **Central nervous system-active medications and risk for falls in older women.** *J Am Geriatr Soc* 2002, **50**:1629-1637.
  39. Heart Protection Study Collaborative Group: **MRC/BHF Heart Protection Study of cholesterol lowering with simvastatin in 20,536 high-risk individuals: a randomised placebo-controlled trial.** *Lancet* 2002, **360**:7-22.
  40. Avorn J: **Improving drug use in elderly patients: getting to the next level.** *JAMA* 2001, **286**:2866-2868.
  41. Tamblyn R, Huang A, Perreault R, Jacques A, Roy D, Hanley J, McLeod P, Laprise R: **The medical office of the 21st century (MOXXI): effectiveness of computerized decision-making support in reducing inappropriate prescribing in primary care.** *CMAJ* 2003, **169**:549-556.
  42. Webster JR: **How and why we should move our geriatric cheese.** *Ann Intern Med* 2001, **135**:641-642.
  43. Khunti K, Kinsella B: **Effect of systematic review of medication by general practitioner on drug consumption among nursing-home residents.** *Age Ageing* 2000, **29**:451-453.
  44. Allard J, Hebert R, Rioux M, Asselin J, Voyer L: **Efficacy of a clinical medication review on the number of potentially inappropriate prescriptions prescribed for community-dwelling elderly people.** *CMAJ* 2001, **164**:1291-1296.

### Pre-publication history

The pre-publication history for this paper can be accessed here:

<http://www.biomedcentral.com/1471-2318/4/9/prepub>

Publish with **BioMed Central** and every scientist can read your work free of charge

"BioMed Central will be the most significant development for disseminating the results of biomedical research in our lifetime."

Sir Paul Nurse, Cancer Research UK

Your research papers will be:

- available free of charge to the entire biomedical community
- peer reviewed and published immediately upon acceptance
- cited in PubMed and archived on PubMed Central
- yours — you keep the copyright

Submit your manuscript here:  
[http://www.biomedcentral.com/info/publishing\\_adv.asp](http://www.biomedcentral.com/info/publishing_adv.asp)

