DOI: 10.1590/1413-81232020256.26752018

Use of potentially inappropriate medications in institutionalized elderly: prevalence and associated factors

Francisca Sueli Monte Moreira (https://orcid.org/0000-0001-7069-750X) [1]
Javier Jerez-Roig (https://orcid.org/0000-0002-1968-4452) [2]
Lidiane Maria de Brito Macedo Ferreira (https://orcid.org/0000-0002-2191-8641) [3]
Ana Patricia de Queiroz Medeiros Dantas (https://orcid.org/0000-0002-9781-7038) [4]
Kenio Costa Lima (https://orcid.org/0000-0002-5668-4398) [5]
Maria Ângela Fernandes Ferreira (https://orcid.org/0000-0002-6142-948X) [5]

Abstract *This study aimed to verify the prevalence of the use of Potentially Inappropriate Medications (PIM) for elderly living in Long-Term Care Institutions for the Elderly (LTCIE), as well as the types of medications and their associated factors. This is a cross-sectional study carried out in 10 LTCIEs in the city of Natal in the period October-December 2013. Potentially inappropriate medications were classified according to the 2015 American Geriatric Society Beers Criteria for Potentially Inappropriate Medication Use in Older Adults - 2015. Sociodemographic, LTCIE-related and health-related variables were considered. Univariate and multivariate analyses were performed between the primary variable (PIM use) and the independent variables using Poisson regression. The sample consisted of 321 older people, of whom 304 used medications. The prevalence of PIM use was 54.6% (95% CI: 48.9-60.2) and was associated with polypharmacy and dementia in the final model. The most common PIMs were antipsychotics and benzodiazepines. The study revealed a high prevalence of PIM use among the elderly of the LTCIEs, evidencing the need to adopt indicators on the use of these drugs and the implementation of strategies that make drug therapy safer and more adequate for older adults.*

Key words *Elderly, Long-term care institutions for the elderly, Inadequate prescription, List of Potentially Inappropriate Medications*

[1] Departamento de Farmácia, Universidade Federal do Rio Grande do Norte (UFRN). R. General Gustavo Cordeiro de Farias s/n, Petrópolis. 59010-180 Natal RN Brasil. suelimonte@yahoo.com.br
[2] Research Group on Methodology, Methods, Models and Outcomes of Health and Social Sciences (M3O), Faculty of Health Science and Welfare, Centre for Health and Social Care Research (CESS), University of Vic-Central University of Catalonia (UVIC-UCC)
[3] Departamento de Cirurgia, UFRN. Natal RN Brasil.
[4] Departamento de Medicina Clínica, UFRN. Natal RN Brasil.
[5] Programa de Pós-Graduação em Saúde Coletiva, UFRN. Natal RN Brasil.

Introduction

The population aging process is a global phenomenon and is associated with many challenges concerning public health policies[1,2]. While aging is not a synonym for dependence, increased longevity is often associated with an increased number of chronic diseases, physical, cognitive and mental disabilities, as well as drug consumption[3,4]. The greater use of drugs by the elderly increases the risk of adverse health outcomes, such as adverse drug reactions, drug interactions, non-adherence to therapy, functional decline and geriatric syndromes[5-7]. Elderly patients are more susceptible to adverse events due to age-related physiological changes that may influence the pharmacokinetics and pharmacodynamics of medicines, with particular reference to hepatic elimination and renal excretion. Consequently, such changes will affect the choice, dose and frequency of drug administration[4,6,7].

The risk-benefit ratio of each drug should be considered to minimize the occurrence of adverse drug reactions in the elderly. Thus, certain drugs are classified as potentially inappropriate for use in the elderly, when the risk of causing adverse events exceeds the benefit expected for the patient or when a safer, better tolerated or more effective alternative is available[8-10]. Lists of Potentially Inappropriate Medications (PIM) for the elderly have been developed and published to facilitate the adaptation of the drug therapy to the elderly and to help health professionals prescribe drugs more safely. Beers and collaborators pioneered the development of this systematic cataloging of PIMs. Since then, this criterion has been one of the most widely used specific methods for assessing PIM use and was revised in 1997, 2003, 2012, and the most current version was published in 2015 by the American Geriatric Society (AGS) - AGS/Beers 2015[9,10].

Studies indicate that the use of PIMs is associated with an increased risk of falls, fractures, hospitalizations and mortality in the elderly[5,6,8,11]. Due to such adverse events and the adverse effects on quality of life, the use of PIM can be considered a public health problem, also impacting higher health costs[12,13].

Individuals living in Long-Term Care Institutions for the Elderly (LTCIE) have a higher morbidity burden, use more drugs than community-dwelling elderly and are therefore more susceptible to the use of PIMs and adverse drug events[14-16]. A systematic review has estimated that 43% of older adults living in asylum institutions are exposed to PIMs[17] but estimates of PIM prevalence in LTCIEs vary widely because many factors influence PIM use, such as individual variability (morbidity of residents, prescription habits) and the differences in the specific regulations of each region or country (organization and structure of LTCIE, experience and team composition)[18].

Some studies that aimed to measure the prevalence of PIMs were performed in Brazilian South and Southeast regions. However, most of them included only community-dwelling elderly and used pre-2015 versions of the AGS/Beers criteria[19-24]. The investigations conducted at the LTCIE included only non-profit institutions, less than 300 seniors and used the previous version of the 2015 AGS/Beers criteria[25-27].

Based on these findings and the understanding that avoiding PIM is a relevant, simple and effective strategy to improve patient quality and safety[9,28,29], it is essential to determine the size, nature and relevance of the use of PIMs in Brazilian institutions. Given this context, this study aimed to verify the prevalence of PIMs for seniors living in LTCIEs adopting the 2015 AGS/Beers Criteria, the types of medications and to check the associated factors.

Methods

This cross-sectional study was conducted between October and December of 2013 in LTCIEs registered under the health surveillance of the city of Natal, Rio Grande do Norte (RN), Brazil. The study population included all subjects residing in LTCIEs who were 60 years of age or older who agreed to participate in the study. Individuals who were not at the LTCIE at the time of the study due to hospitalization or who were terminally ill were excluded from the investigation. The age of 60 years was adopted, in line with the WHO recommendation that, for developing countries, individuals older than 60 should be considered as elderly[30].

The information was retrieved from the medical records of the elderly and complemented by interviews with the LTCIE health professionals' teams. Elderly caregivers were responsible for answering questions about functional capacity and falls. A structured questionnaire tested before the investigation was used for interviews. The collection was carried out by postgraduate and undergraduate students strictly trained and supervised by the research team. The primary variable of this study was the prescription of one

or more PIMs according to the 2015 AGS/Beers criteria[9]. Initially, each medication was evaluated for inclusion among those in the list of PIMs *that should be avoided by most of the elderly, PIMs that should be avoided by the elderly with specific diseases or clinical syndromes and a list with clinically significant potential drug-drug interactions between drugs without anti-infective activity that should be avoided in the elderly*. The inclusion of the drug in one or more of the above criteria characterizes it as PIM.

Beers' criteria are specific tools, widely used for the identification of PIMs in elderly patients. The American Society of Geriatrics updated the "Beers Criteria for Potentially Inappropriate Medication Use in Older Adults" in 2015 (AGS/Beers 2015)[9]. The update was carried out from an extensive literature review, respecting the principles of evidence-based medicine, and was elaborated by a panel of specialists consisting of physicians, pharmacists and representatives of international organizations[9,10,31]. The independent variables used in the analysis were classified into three groups:

- Sociodemographic: age, gender, level of schooling, number of children and use of private health insurance.

- Related to the institution: type of LTCIE (private for-profit or non-profit), the number of residents per caregiver and length of residence at LTCIE.

- Clinical and health status: occurrence of chronic conditions, number of chronic conditions, depressive symptoms, cognitive status, functional independence and mobility, the occurrence of falls and fractures in the 30 days before data collection, nutritional status, urinary and fecal incontinence, use of medications, polypharmacy and medications used.

Information on chronic diseases was obtained from the medical records of the elderly, considering the following conditions: hypertension, diabetes, CVA, dementias (including Alzheimer's disease), Parkinson's disease, osteoporosis, renal failure, cardiovascular disease, rheumatic disease, mental illness and dyslipidemia. Depressive symptoms were assessed by the Geriatric Depression Scale (GDS-15)[32]. The cognitive state was verified by the Pfeiffer's Short Portable Mental Status Questionnaire, which evaluates short and long-term memory, orientation, information on daily activities and mathematical ability (intact mental function, mild, moderate and severe cognitive impairment)[33]. The Barthel index was used to evaluate the functionality (independence, and mild, moderate, severe and total dependence)[34]. The evaluation of urinary incontinence (UI) or fecal incontinence was performed based on Section H, version 2012, of the Minimum Data Set 3.0 instrument, considering the definition of UI recommended and indicated by the International Continence Society (ICS) in 2002, which defined it as any involuntary loss of urine[35]. For nutritional evaluation, previously trained and calibrated nutritionist researchers performed the Mini Nutritional Assessment (MNA), which facilitates the classification of the elderly into three distinct groups: individuals with adequate nutritional status, at risk of malnutrition and with malnutrition[36]. The drugs recorded and administered daily were characterized as to the therapeutic class. We considered polypharmacy and excessive polypharmacy as the concomitant use of five or more and ten or more drugs, respectively[37].

The descriptive analysis of the data included the calculation of absolute and relative frequencies and the means and standard deviation (SD). The univariate and multivariate analyses were based on the prevalence and respective 95% confidence intervals, estimated by the Poisson Regression model with robust variance. Poisson Regression analysis included any variables with p values less than 0.20 in the univariate analysis. A significance level of $p < 0.05$ was the criterion adopted to identify variables independently associated with the use of PIMs in the multivariate model.

This study is part of the research project "Human aging and health: the reality of institutionalized elderly in the city of Natal (RN)", approved by the Research Ethics Committee of the Federal University of Rio Grande do Norte. The informed consent form was signed by the resident or legal guardian, the caregiver and the LTCIE's director, following the assumptions set out in the Declaration of Helsinki.

Results

Ten (71.4%) of the 14 LTCIEs registered under the health surveillance of the city of Natal (RN) participated in the investigation. Four (28.6%) LTCIEs refused to participate in the study. Of the ten participating LTCIEs, five were philanthropic institutions and five were private for-profit institutions. Of the total residents of participating LTCIEs, eight (2.4%) were excluded from the study; six (1.8%) because they were hospitalized during the collection period, one (0.3%) due to

terminal illness and one was under 60 years of age. The final sample consisted of 321 individuals aged between 60 and 107 years, and most of them were female. A total of 204 (63.8%) elderly individuals resided in non-profit private LTCIEs and 118 (37%) used private health plan. Regarding the health status, most of the elderly, namely, 283 (88.2%), were carriers of some chronic disease. Hypertension, diabetes and dementia were the most prevalent chronic conditions (48.9%, 25.2% and 24.6%, respectively). Table 1 shows the characteristics of the subjects participating in the study.

Of the 321 elderly participants, 94.7% (n = 304) used at least one drug continuously. The mean number of medications used was 4.5 (range 0-14), and 47.0% (n = 143) were exposed to polypharmacy (Table 2). Concerning the group of 304 older adults, 1,440 medications were prescribed, most of them with action on the Central Nervous System (36.8%). Among the drugs, antipsychotics (n = 207) and antidepressants (n = 94) were the most prescribed for the elderly.

Among the elderly patients taking medication, 54.6% (CI 48.9-60.2) used at least one PIM, where 54.6% (166) used a PIM that should be avoided by most of the seniors, 31.3% (52) used at least one PIM that should be avoided by elderly patients with specific clinical diseases or syndromes, and in 9.2% (28) older adults, clinically significant potential drug-drug interactions were observed between drugs without antiinfective activity that should be avoided in the elderly described in the 2015 AGS/Beers criteria. Regarding the therapeutic classes of drugs identified as PIMs, it was observed that antipsychotics, benzodiazepines and sulfonylureas were the most frequent. A total of 225 PIMs that should be avoided by most of the elderly, 79 PIMs for older adults with specific diseases or syndromes due to disease-drug or drug-syndrome interactions and 28 potentially clinically significant drug-drug interactions between drugs without antiinfective activity which should be avoided in the elderly were identified. The data are shown in Table 2.

The use of at least one PIM per elderly was considered for the analysis of associations. The univariate analysis revealed significant associations between PIM use and polypharmacy, dementia, residing in for-profit LTCIE, having private health insurance, and having diabetes (Table 3). The other variables tested (age, children, marital status, elderly/caregiver relationship, hypertension, stroke, Parkinson's disease, osteoporosis, cardiovascular diseases, mental illness, dyslipidemias, cognitive status and MNA) did not show significant associations, and only those with $p < 0.20$ were included in the multivariate analysis. The occurrence of collinearity was verified before the multivariate analysis, and the variables "having a health plan" and "residing in for-profit LTCIE" were collinear. We chose to include only the "Type of LTCIE" variable in the model. The final model of the analysis revealed that PIM use

Table 1. Distribution of the frequencies of sociodemographic and health variables related to institutionalized elderly. Natal, RN, Brazil, 2018.

Variables	Values	
Age, years (m, sd)	81.4	9.0
Female (n,%)	241	75.3
Schooling (n, %)		
Illiterate	73	22,7
Literate/Primary School I	79	24,6
Primary School II	24	7,5
Secondary School	45	14,0
Higher Education	48	15,0
DK/DNR	52	16,2
Children (n, %)	155	49,5
Number of children (m, sd)	1.4	2.1
Use of private health plan (n, %)	118	37.0
Residents per caregiver		
0-8	180	56,1
8.1-21	141	43,9
Elderly in a non-profit private institution (n, %)	204	63.8
Length of institutionalization, months (m, sd)	63.3	62.1
Comorbidities (n,%)	283	88.2
Hypertension	157	48.9
Diabetes	81	25.2
Dementias	79	24.6
Mental disorders	72	22.4
Dyslipidemia	55	17.1
CVA	50	15.5
Osteoporosis	32	10.0
Cardiovascular disease	20	6.3
Parkinson's disease	19	5.9
COPD	16	5.0
Other	64	19.9
Cognitive state (Pfeiffer)		
Intact	76	23.7
Mild cognitive impairment	30	9.30
Moderate cognitive impairment	62	19.3
Severe cognitive impairment	153	47.7
Urinary incontinence	193	60.1

it continues

Ciência & Saúde Coletiva, 25(6):2073-2082, 2020

Table 1. Distribution of the frequencies of sociodemographic and health variables related to institutionalized elderly. Natal, RN, Brazil, 2018.

Variables	Values	
Functional capacity –Barthel		
1. Independence (100)	67	20.9
2. Mild independence (91-99)	23	7.2
3. Moderate independence (61-90)	55	17.1
4. Severe dependence (21-60)	55	17.1
5. Total dependence (0-20)	121	37.7
Falls	21	6.5
Nutritional Assessment (MNA)	72	25.0
Malnutrition	118	41.0
Risk of malnutrition	98	34.0
Eutrophy	98	34.0

m = mean, sd = standard deviation, DK = Does not know, DNR = Did not reply, CVA = cerebral vascular accident, COPD = Chronic obstructive pulmonary disease, MAN: Mini Nutritional Assessment.

Table 2. Frequency of potentially inappropriate medications (PIM) for institutionalized elderly according to the AGS/Beers 2015 Criterion. Natal (RN), Brazil, 2018.

Variables	N	%
Frequency of drug use by elderly		
1–4	161	52.9
5–9	127	41.8
> 10	16	5.3
Polypharmacy (n, %)	143	47,0
Use of at least one PIM (n, %)	166	54,6
Criterion 1 (166 elderly with at least one PIM – 54,6%)		
Antipsychotics ¥	88	39.1
Long-term benzodiazepines ¥	69	30.7
Long-term sulphonylureas ¥	17	7.6
Antidepressants ¥	15	6.7
Barbiturates ¥	14	6.2
Other (amiodarone, ticlopidine) ¥	12	5.3
Anticholinergics ¥	10	4.4
Criterion 2 (52 elderly with at least one PIM - 31,3%)		
Antipsychotics ¥	53	67.1
Benzodiazepines and agonists ¥	20	25.3
TCA and SSRI ¥	4	5.1
Anticholinergics ¥	2	2.5
Criterion 3 (28 elderly with at least one PIM - 9,2%)		
Antipsychotics + > 2 medications action CNS *¥	52	54.2
Benzodiazepines + > 2 medications action CNS *¥	23	24.0
Antidepressants + > 2 medications action CNS *¥	18	18.7
Lithium + ACEI **	2	2.1
Opioid + > 2 medications action CNS *¥	1	1.0

Criterion 1: Use of PIM that should be avoided for most of the elderly, according to the 2015 AGS/Beers Criterion. Criterion 2: Use of PIM by the elderly due to drug-disease or drug-syndrome interactions that may exacerbate the disease or syndrome, according to 2015 AGS/Beers Criterion. Criterion 3: The 2015 AGS/Beers Criterion for clinically relevant potential drug-drug interactions between drugs with no anti-infective activity that should be avoided in the elderly. *Action in the Central Nervous System (CNS): TCA – Tricyclic Antidepressants; SSRI – Serotonin Reuptake Inhibitors. **ACEI: Angiotensin-Converting Enzyme Inhibitor. ¥ For these variables, N corresponds to the number of PIMs (pharmacological group) identified in each criterion.

was significantly associated with polypharmacy and dementia (Table 3).

Discussion

The prevalence of PIMs use was high in the LTCIEs investigated in this study, evidencing a positive association with polypharmacy and dementia. The therapeutic classes that determined the high prevalence of PIMs were antipsychotics, benzodiazepines and sulfonylureas, in agreement with previous studies.

Brazilian studies have a wide variety of PIM-related prevalence levels, ranging from 24.6% to 82.6%[19-27]. These studies collected data in different contexts, such as domiciles[20, 22,23,38], basic care services[21,24], and they vary in sample size, which justifies this wide prevalence variation. Similarly, Brazilian studies conducted specifically in LTCIEs also show a wide discrepancy among prevalence levels (29.2 to 82.6%)[25-27,39]. In these cases, the reduced sample size[26,27,39] and the implementation of the study in only one institution[26,39] decreased the generalization potential. However, in addition to these factors, we considered the adoption of different versions and the partial use of the Beers Criteria lists as the primary source of bias for studies of this nature.

Table 3. Univariate and multivariate analysis of the association between sociodemographic characteristics, health conditions and use of potentially inappropriate medications in institutionalized elderly. Natal (RN), Brazil, 2018.

Variable	N	p	PR (95% CI)	p (adj.)**	PR(adj.) (95% CI)***
Gender					
Male	33	0.138	1		
Female	134		1.227(0.937-1.607)		
Schooling					
Primary School II, Secondary School, Higher Education	69	0.131	1		
Illiterate, Primary School I	71		0.844(0.677-1.052)		
Health Plan					
No	91	0.013	1		
Yes	74		1.293(1.057-1.581)		
Type LTCIE					
Non-profit	94	0.009	1		
For-profit	73		1.304(1.067-1.593)		
Comorbidity					
No	11	0.102	1		
Yes	156		1.521(0.920-2.514)		
Diabetes					
No	119	0.042	1	0.226	1
Yes	48		1.242(1.008-1.530)		1.135(0.924-1394)
Dementias					
No	108	<0.001	1	< 0.001	1
Yes	59		1,669(1,39-2,004)		1,582(1,315-1,904)
Depression (GDS)¥					
No	30	0.198	1		
Yes (6-15 points)	31		1.257(0.887-1.781)		
Functional capacity*					
Independence or mild independence	52	0.124	1		
Moderate to total independence	115		1.205(0.950-1.527)		
Polypharmacy					
No	73	<0.001	1	<0.001	1
Yes	94		1.664(1.344-2.059)		1.524(1.230-1.887)

Note: contains variables with value < 0.20. LTCIE: Long-Term Care Institution for the Elderly. ¥GDS: Geriatric Depression Scale. * Barthel Index. ** Poisson Regression significant when p<0.05. ***Prevalence ration (95% CI) estimated by the adjusted Poisson Regression.

Many changes are implemented as a result of the updates between the versions of the Beers criteria, such as the inclusion, removal or reclassification of medicines in the various lists. Thus, the same population may have different prevalence levels depending on the version used. The tool is built with specific criteria that may not be used in full to characterize the use of PIMs. Varallo et al.[39] and Nascimento et al.[26] used the Beers-Fick criterion published in 2003, whereas the studies conducted by Vieira Lima et al.[25] and Alves-Conceição et al.[27] used the Criteria de Beers published in 2012 and considered for the assessment of the PIMs all the three lists of the document (*PIMs that should be avoided by most of the elderly, PIMs due to drug-disease or drug-syndrome interactions that may deteriorate the disease or syndrome and medicines that should be used with caution*).

Our research adopted the 2015 AGS/Beers criteria, which is the most updated version and one of the tools most used by health professionals[10,40]. This version has been revised from the principles of evidence-based medicine with extensive literature review; it includes the analysis

of drug interactions and evidence of new drugs and conditions not available at the time of the 2012 version. Also, it is more specific and is organized by medical specialty and pathology, facilitating a quick and practical use[9,10,31,38].

In our study, we chose to carry out a comprehensive evaluation and to apply three lists of the 2015 AGS/Beers criterion, since we had data that are generally not available in other works and are essential for PIM assessment, such as functional capacity, nutritional status, occurrence of falls, urinary incontinence and cognitive status[20,23,26]. Thus, our prevalence of 54.6% was obtained through the broader and more detailed use of the 2015 AGS/Beers criteria. It is important to note that in a systematic review involving 26 American and European studies (227,534 elderly), we estimated a PIM prevalence in LTCIEs of 43% (95% CI: 37.3-49.1)[17].

Thus, we also call attention to the consideration of drug interactions as a PIM criterion, which in our study aimed to widely disseminate medications and interactions cited in the 2015 AGS/Beers criterion, thus making this essential educational tool known by professionals, managers and health services, so that they can be considered in the evaluation of the elderly who require medicines[41]. As a result, we chose to show the result with the drug interactions that were included in the 2015 update.

In our investigation, most of the elderly residing in private for-profit LTCIEs (88.8%) used health insurance plans, whereas the non-profit LTCIE elderly residents essentially used the SUS network. The univariate analysis showed that these two variables have a statistically significant association between them, to the point of being considered collinear. Therefore, only one of them was included in the multivariate analysis of the association with PIM use. No difference was observed between the LTCIE's administrative profile (for-profit/non-profit) regarding the use of PIMs following the multivariate analysis.

Regarding the factors associated with the use of PIMs, polypharmacy stands out and has been identified as the most frequently associated factor to increase the probability of receiving PIMs. Our result is consistent with other studies that found the same association[18,25,26,42,43]. One of the possible explanations for such a finding is that polypharmacy is triggered by the so-called prescription cascade, and several classes of drugs associated with the phenomenon of the prescription cascade include agents that are often considered PIMs, such as psychotropics[43]. In the literature, polypharmacy has been associated with an increased risk of adverse events, as it entails a greater complexity of drug therapy and favors the occurrence of medication errors[26,27].

Contrary to several studies that suggested that cognitive impairment and dementia were associated with a lower probability of receiving PIMs[17,44,45], our investigation found that PIMs were more likely to occur among seniors with dementia. Most patients who have dementia show behavioral and psychological symptoms, many of which are particularly detrimental to the patient and their caregivers, such as agitation, aggression, oppositional behavior, delusions or hallucinations. Antipsychotics are commonly used for the treatment of psychotic symptoms and aggressiveness, and together with benzodiazepines were the most prescribed PIMs in the study, although there is only modest evidence of its efficacy and lack of regulatory approval for use in dementia[46]. The use of antipsychotics is strongly associated with adverse outcomes such as mortality and stroke, especially among individuals with dementia[46,47]. Because of this, many regulatory agencies have published, as of 2004, alerts on the risks of using antipsychotics by older adults with dementia[46], and this may be a justification by which, in international studies, no association was found between PIM use and dementia. Dementia is a non-modifiable factor but serves as a warning about the need for a continuous drug therapy review in this type of patient and greater precaution in the prescription of new drugs, to minimize the inclusion of PIMs and polypharmacy whenever possible.

Another class of PIMs much prescribed in our study, that of benzodiazepines has been reported in the literature as the most commonly identified as PIM. This finding is of concern, since benzodiazepines, especially long-acting ones, are more likely to cause residual sedative effects and increased risk of falls, cognitive impairment, dependence, and delirium[48]. Such occurrences become more noticeable due to age-related physiological changes that modify pharmacokinetics and pharmacodynamics, prolonging the half-lives of benzodiazepines and increasing the risk of adverse events[6,13,48]. The use of benzodiazepines in the elderly is only recommended if safer alternatives are not available[9,48].

In order to reduce the inappropriate use of psychotropic drugs in LTCIEs, international studies recommend that institutions provide the elderly[28,49] with behavioral therapy programs, meaningful activities and physical activity pro-

grams. The use of psychotropics and the occurrence of polypharmacy are suggested as indicators of the quality of care in LTCIEs[50,51].

The systematic review of drug therapy has been suggested as a standard practice in LTCIEs, with the implementation of deprescription programs and the use of quality indicators to monitor actions[50,51].

The results of this study should be interpreted taking into account some limitations. First, we highlight the cross-sectional design that may have underestimated the PIM estimate by not allowing the evaluation of some drugs that are considered PIMs when used for an extended period, such as proton pump inhibitors, which are considered inappropriate when used for more than eight weeks.

Another limitation that may have led to the lower prevalence estimate was the unavailability of some clinical information of the elderly. Such information is necessary for a more accurate evaluation of the drug-disease interaction and, therefore, of the assessment of the use as potentially inappropriate by the 2015 AGS/Beers criteria (e.g., the absence of creatinine clearance). Finally, the Pfeiffer test is not yet validated in Brazil, but it is less demanding than other instruments such as Mini-Mental State Examination, which could have caused a "ground" effect due to the high overall sample weakness[15].

The main strengths of the study are the sample size, which included 71.4% of all LTCIEs in Natal (RN) and the inclusion of for-profit and non-profit institutions, reducing selection bias. The use of the 2015 AGS/Beers Criteria[9] is also a strength because it has been developed according to updated scientific evidence.

Conclusion

The study has shown that the use of PIMs is high among residents of LTCIEs, mainly of long-acting antipsychotics, benzodiazepines and sulfonylureas. Polypharmacy and dementia were the characteristics most associated with the use of PIMs, regardless of the type of institution (for-profit or non-profit). The prevalence of PIMs of this magnitude reveals the need to improve the quality of the drug therapy of the elderly living in LTCIEs and requires the actions of professionals and managers.

Collaborations

FSM Moreira, J Jerez-Roig, LMBM Ferreira, APQM Dantas, KC Lima and MAF Ferreira contributed to the conception, design, analysis and interpretation of data, the writing of the article and the revision of the version to be published.

References

1. Menezes RL, Bachion MM, Souza JT, Nakatani AYK. Estudo longitudinal dos aspectos multidimensionais da saúde de idosos institucionalizados. *Rev Bras Geriat Gerontol* 2011; 14(3):485-496.
2. Veras R. Envelhecimento populacional contemporâneo: demandas, desafios e inovações. *Rev Saude Publica* 2009; 43(3):548-554.
3. Marengoni A, Angleman S, Melis R, Mangialasche F, Karp A, Garmen A, Meinaw B, Fratiglioni L. Aging with multimorbidity: A systematic review of the literature. *Ageing Res Rev* 2011; 10(4):430-439.
4. Shi S, Morike K, Klotz U. The clinical implications of ageing for rational drug therapy. *Eur J Clin Pharmacol* 2008; 64(2):183-199.
5. Lohman MC, Cotton BP, Zagaria AB, Bao Y, Greenberg RL, Fortuna KL, Bruce ML. Hospitalizarion Risk and Potentially Inappropriate Medications among Medicare Home Health Nursing Patients. *J Gen Intern Med* 2017; 32(12):1301-1308.
6. Davies EA, O'Mahony MS. Adverse drug reactions in special populations – the elderly. *Br J Clin Pharmacol* 2015; 80(4):796-807.
7. Shah BM, Hajjar ER. Polypharmacy, adverse drug reactions, and geriatric syndromes. *Clin Geriatr Med* 2012; 28(2):173-186.
8. Sichieri K, Rodrigues ARB, Takahashis J, Secoli SR, Nobre MRC, Martinez MA, Fernández JG . Mortality Associated with the use of Inappropiate Drugs According Beers Criteria: a Systematic Review. *Adv Pharmacol Pharm* 2013; 1(2):74-84.
9. The American Geriatrics Society 2015 Beers Criteria Update Expert Panel. American Geriatrics Society 2015 Update Beers Criteria for Potentially Inappropriate Medication Use in Older Adults. *J Am Geriatr Soc* 2015; 63(11):2227-2246.
10. Desnoyer A, Guignard B, Lang PO, Desmeules J, Vogt-Ferrier N, Bonnabry P. Potentially inappropriate medications in geriatrics: Which tools to detect them? *Presse Med* 2016; 45(11):957-970.
11. Nascimento MMG, Mambrini JVM, Lima-Costa MF, Firmo JOA, Peixoto SWV, Loyola-Filho AI. Potentially inappropriate medications: predictor for mortality in a cohort of community-dwelling older adults. *Eur J Clin Pharmacol* 2017; 73(5):615-621.
12. Hyttinen V, Jyrkka J, Valtonen H. A systematic review of the impact of potentially inappropriate medication on health care utilization and costs among older adults. *Med Care*. 2016; 54(10):950-964.
13. Harrison SL, O'Donnell LK, Milte R, Dyer SM, Gnanamanickam ES, Bradley C, Liu E, Hilmer SN, Crotty M. Cost of potentially inappropriate medication use in residential aged care facilities. *BMC Geriatri* 2018; 18(1):9.
14. Castella JI, Karnikowski MG, Vianna LG, Nóbrega OT. Estudo da farmacoterapia prescrita a idosos em Instituição Brasileira de Longa Permanência. *Acta Med Port* 2007; 20:97-105.
15. Jerez-Roig J, Santos MM, Souza DLB, Amaral FLJS, Lima KC. Prevalence of Urinary Incontinence and Associated Factorsin Nursing Home Residents. *Neurourol Urodyn* 2016; 35(1):102-107.
16. Chiu Y, Bero L, Hessol NA, Lexchin J, Harrigton C. A literature review of clinical outcomes associated with antipsychotic medication use in North American nursing home residentes. *Health Policy* 2015; 119(6):802-813.
17. Morin L, Laroche ML, Texier G, Johnell K. Prevalence of Potentially Inappropriate Medication Use in Older Adults Living in Nursing Homes: A Systematic Review. *J Am Med Dir Assoc* 2016; 17(9):862.e1-9.
18. Storms HS, Marqueta,K , Aertgeertsc B, Claes N. Prevalence of inappropriate medication use in residential long-term care facilities for the elderly: A systematic review. *Eur J Gen Pract* 2017; 23(1):69-77.
19. Lopes LM, Figueiredo TP, Costa SC, Reis AMM. Utilização de medicamentos potencialmente inapropriados por idosos em domicílio. *Cien Saude Colet* 2016; 21(11):3429-3438.
20. Nascimento MMG, Lima-Costa MF, Loyola-Filho AI. Potentially Inappropriate Medication Use Among Brazilian Elderly: A Population-Based Pharmacoepidemiological Study. *Lat Am J Pharm* 2016; 35(4):659-666.
21. Oliveira MG, Amorim WW, Jesus SR, Rodrigues VA, Passo LC. Factors associated with potentially inappropriate medication use by the elderly in the Brazilian primary care setting. *Int J Clin Pharm* 2012; 34(4):626-632.
22. Lutz BH, Miranda VIA, Bertoldi AD. Potentially inappropriate medications among older adults in Pelotas, Southern Brazil. *Rev Saude Publica* 2017; 51:52.
23. Cassoni TCJ, Corona LP, Romano-Lieber NS, Secoli SR, Duarte YAO, Lebrão ML. Uso de medicamentos potencialmente inapropriados por idosos do Município de São Paulo, Brasil: Estudo SABE. *Cad Saude Publica* 2014; 30(8):1708-1720.
24. Gorzoni ML, Fabbri RMA, Pires SL. Potentially inappropriate medications in elderly. *Rev Assoc Med Bras* 2012; 58(4):442-446.
25. Vieira de Lima TJ, Garbin CAS, Garbin AJ, Sumida DH, Saliba O. Potentially inappropriate medications used by the elderly: prevalence and risk factors in Brazilian care homes. *BMC Geriatri* 2013; 13:52.
26. Nascimento MMG, Ribeiro AQ, Pereira ML, Soares AC, Loyola-Filho AI, Dias-Júnior CAC. Identification of inappropriate prescribing in a Brasilian nursing home using STOPP/START screening tools and Beers' Criteria. *Braz J Pharm Sci* 2014; 50(4):912-918.
27. Alves-Conceição V, Silva DTS, Santana VL, Santos EG, Santos LMC, Lyra Junior DP. Evaluation of pharmacotherapy complexity in residents of long-term care facilities: a cross-sectional descriptive study. *BMC Pharmacol Toxicol* 2017; 18:59.
28. Patterson SM, Cadogan CA, Kerse N, Cardwell CR, Bradley MC, Ryan C, Hughes C. Interventions to improve the appropriate use of polypharmacy for older people. *Cochrane Database Syst Rev* 2014; 7(10):CD008165.
29. Instituto para Práticas Seguras no Uso de Medicamentos (ISMP Brasil). Medicamentos Potencialmente Inadequados para idosos. *Boletim ISMP Brasil* 2017 [citado em 2018 Maio 05]; 7(3):1-8. Disponível em: http://www.ismp-brasil.org/site/wp-content/uploads/2017/09/IS_0006_17A_Boletim_Agosto_ISMP_210x276mm_V2.pdf.

30. World Health Organization (WHO). *The uses of epidemiology in the study of the elderly : report of a WHO Scientific Group on the Epidemiology of Aging*. Geneva: WHO; 1984.
31. Salbu RL, Feuer J. A closer look at the 2015 Beers Criteria. *J Pharm Pract* 2017; 30(4):419-424.
32. Almeida OP, Almeida SA. Confiabilidade da versão brasileira da Escala de Depressão Geriátrica (GDS) versão reduzida. *Arq Neuropsiquiatr* 1999; 10(2):421-426.
33. Pfeiffer EA. Short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. *J Am Geriatr Soc* 1975; 23(10):433-441.
34. Minosso JSM, Amendola F, Alvarenga MRM, Oliveira MAC. Validação, no Brasil, do Índice de Barthel em idosos atendidos em ambulatórios. *Acta Paul Enferm* 2010; 23(2):218-223.
35. Klusch L. The MDS 3.0 and its impact on bladder and bowel care. *Provider* 2012; 38:33-37.
36. Guigoz Y, Vellas BJ, Garry PJ. Mini Nutritional assessment: a pratical assessment tool for grading the nutritional state of elderly patients. *Facts and Research in Gerontology* 1994; 4:15-59.
37. Gnjidic D, Hilmer SN, Blyth FM, Naganathan V, Waite L, Seibel MJ, McLachan AJ, Cumming RG, Handelsman DJ, Le Couteur D. Polypharmacy cutoff and outcomes: feve or more medicines were used to identify community-dwelling older men at risk of diffferent adverse outcomes. *J Clin Epidemiology* 2012; 65(9):989-995.
38. Santos TRA, Lima DM, Nakatan AYK, Pereira LV, Leal GS, Amaral RG. Consumo de medicamentos por idosos, Goiânia, Brasil. *Rev Saude Publica* 2013; 47(1):94-100.
39. Varallo FR, Ambiel ISS, Nanci OL, Galduroz JCF, Mastroianni PC. Assessment of pharmacotherapeutic safety of medical prescriptions for elderly residents in a long term care facility. *Braz J Pharm Sci* 2012; 48(3):477-485.
40. Andrew MK, Pircell CA, Marshall EG, Varatharasan N, Clarke B, Bowles SK. Polypharmacy and use of potentially inappropriate medications in long-term care facilities: does coordinated primary care make a difference? *Int J Pharm Pract* 2018; 26(4):318-324.
41. Steinman MA, Beizer JL, DuBeau CE, Laird RD, Lundebjerg NE, Mulhausen P. How to Use the American Geriatrics Society 2015 Beers Criteria-A Guide for Patients, Clinicians, Health Systems, and Payors. *J Am Geriatr Soc*. 2015; 63(12):e1-e7.
42. Herr M, Sirven N, Grondin H, Pichetti S, Sermet C. Frailty, polypharmacy, and potentially inappropriate medications in old people: findings in a representative sample of the French population. *Eur J Clin Pharmacol* 2017; 73(9):1165-1172.
43. Komiya H, Umegati H, Asa A, Kanda S, Maeda K, Shimojima T, Nomura H, Kuzuka M. Factors associated with polypharmacy in elderly home-care patients. *Geriatr Gerontol Int* 2018; 18(1):33-41.
44. Kristensen RU, Nøgaard A, Jenses-Dahm C, Gasse C, Wimberley T, Gunhild W. Polypharmacy and Potentially Inappropriate Medication in People with Dementia: A Nationwide Study. *J Alzheimers Dis* 2018; 63(1):383-394.
45. Cool C, Cestac P, Laborde C, Lebaudy C, Rouch L, Lepage B, Vellas B, Barreto OS, Rolland Y, Lapeyre-Mestre M. Potentially Inappropriate Drug Prescribing and Associated Factors in Nursing Homes. *J Am Med Dir Assoc* 2014; 15(11):850e1-850e8.
46. Gallini A, Andrieu S, Donohue JM, Oumouhou N, Lapyere-Mestre M, Garbette V. Trends in use of antipsychotics in elderly patients with dementia: Impact of national safety warnings. *Eur Neuropsychopharmacol* 2014; 24(1):95-104.
47. Gill SS, Bronskill SE, Normand SLT, Anderson GM, Sykora K, Lam K, Bell CM, Lee PE, Fisher HD, Hermann N, Gurwitz JH, Rochon PA. Antipsychotic drug use and mortality in older adults with dementia. *Ann Intern Med* 2007; 146(11):775-786.
48. Picton JD, Marino AB, Nealy KL. Benzodiazepine use and cognitive decline in the elderly. *Am J Health Syst Pharm* 2018; 75(1):e6-e12.
49. Morley JE. Inappropriate Drug Prescribing and Polypharmacy Are Major Causes of Poor Outcomes in Long-Term Care. *J Am Med Dir Assoc* 2014; 15(11):780-782.
50. Frijters DHM, Roest HG, Carpener IG, Finne-Soveri H, Henrard JC, Chetrit A, Gindin J, Bernabei R. The calculation of quality indicators for long term care facilities in 8 countries (SHELTER project). *BMC Health Serv Res* 2013; 13:183.
51. Medeiros PA, Fortunato AR, Viscardi AAF, Sperandio AAF, Mazo GZ. Instrumentos desenvolvidos para o gerenciamento e cuidado de idosos em instituições de longa permanência: uma revisão sistemática. *Cien Saude Colet* 2016; 21(11):3597-3610.

Article submitted 12/06/2018
Approved 26/10/2018
Final version submitted 28/10/2018

This is an Open Access article distributed under the terms of the Creative Commons Attribution License