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Medication regimen complexity in institutionalized elderly people in an aging society

Ana Margarida Advinha · Sofia de Oliveira-Martins ·
Vanessa Mateus · Sara Grou Pajote ·
Manuel José Lopes

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Abstract *Background* Complex medication regimens may adversely affect compliance and treatment outcomes. Complexity can be assessed with the medication regimen complexity index (MRCI), which has proved to be a valid, reliable tool, with potential uses in both practice and research. *Objective* To use the MRCI to assess medication regimen complexity in institutionalized elderly people. *Setting* Five nursing homes in mainland Portugal. *Methods* A descriptive, cross-sectional study of institutionalized elderly people (n = 415) was performed from March to June 2009, including all inpatients aged 65 and over taking at least one medication per day. *Main outcome measure* Medication regimen complexity index. *Results* The mean age of the sample was 83.9 years (± 6.6 years), and 60.2 % were women. The elderly patients were taking a large number of drugs, with 76.6 % taking more than five medications per day. The average medication regimen complexity was 18.2 (\pm SD = 9.6), and was higher in the females ($p < 0.001$). The most decisive factors contributing to the complexity were the number of drugs and dosage frequency. In regimens with the same number of medications, schedule was the most relevant factor in the final

score ($r = 0.922$), followed by pharmaceutical forms ($r = 0.768$) and additional instructions ($r = 0.742$). *Conclusion* Medication regimen complexity proved to be high. There is certainly potential for the pharmacist's intervention to reduce it as part as the medication review routine in all the patients.

Keywords Drug therapy complexity · Elderly · MRCI · Nursing homes · Portugal

Impact of findings on practice statements

- Regimen complexity assessment by clinicians and pharmacists should be a high priority in the management of institutionalized elderly patients.
- Nursing homes should consider conducting medication reviews in order to reduce the complexity of older patients' drug regimens.
- Educational sessions for managers, pharmacists, clinicians and patient attendants working at nursing homes would be of great value.
- MRCI could be an important tool in monitoring drug therapy complexity at nursing homes in Portugal and identifying the potential ways of reducing it.

A. M. Advinha (✉) · S. de Oliveira-Martins
iMed.UL - Instituto de Investigação do Medicamento, Faculty of
Pharmacy of the University of Lisbon, Avenida Professor Gama
Pinto, 1649-003 Lisbon, Portugal
e-mail: ana.advinha@gmail.com

V. Mateus
Lisbon School of Health Technology, Polytechnic Institute of
Lisbon, Avenida D. João II, Lote 4.69.01, 1990-096 Lisbon,
Portugal

S. G. Pajote · M. J. Lopes
College of Nursing S. João de Deus, University of Évora, Largo
do Senhor da Pobreza, 7000-811 Évora, Portugal

Introduction

Demographic aging is a global phenomenon. The United Nations estimates that elderly people currently account for 11 % of the total population (about 800 million), and an exponential increase is expected up to 2050 (about 2 billion) [1].

Portugal is among the most aging countries. According to the United Nations (which considers everyone aged 60 or over to be elderly), 24 % of the Portuguese population was elderly in 2011. The 2011 National Census data (Statistics Portugal [2]) showed that there were about 129 elderly (≥ 65 years) per 100 young people (< 15 years), representing 19 % of the total population [1–3].

The social transition that follows this phenomenon, at least in more developed countries, often conditions the possibility of aging in the family environment. Institutionalization of the elderly is frequently driven by a lack of domestic and social support and the admission in a care home is often the only way to have access to care and services, especially health, that they would otherwise not receive [4–6].

In most cases, aging is also synonymous with chronic diseases and consequently polypharmacy. Old people are the age group with highest consumption of medications. Polypharmacy is associated with adverse reactions, greater risk of hospitalization, poor adherence and unnecessary costs for the patient [7–10].

A large number of medications and complicated schedules or additional instructions can also contribute to the patient's increased difficulty or loss of interest in following treatment recommendations and therefore poor clinical outcomes [11]. The results of several studies have shown that adherence declines as medication regimen complexity increases and this complexity is one of the main root causes of patients' non-compliance. It may also result in medication errors—the more complex the regimen is to follow, the easier it is for the patient to get it wrong. Poor adherence and medication errors are a serious concern for health practitioners. They often lead to higher use of resources, owing to a reduction in effectiveness and increased risk of therapeutic failure [12–14].

Medication regimen complexity is therefore a major concern for patients with chronic diseases and their caregivers. The complexity of a person's medication regimen depends on the characteristics of the pharmacotherapy, such as the number of drugs consumed, their pharmaceutical forms, schedules and doses and additional instructions given by the physician. It can be measured with the medication regimen complexity index (MRCI), originally validated in English by George [15] and adapted to Portuguese by Melchior [16]. The MRCI has proved to be a valid, reliable tool for quantifying medication regimen complexity. It is, fast (5–10 min) with potential use in both practice and research [15].

The MRCI is divided into three different sections, which contribute to the final score based on the weight of the tasks in the medication regimen. Section A covers pharmaceutical forms, Section B frequencies and Section C additional instructions. Each section has its own score and the final complexity score is the sum of the section subtotals [15].

Older people in residential aged-care facilities have many of the difficulties experienced by those in the community, but also encounter problems specific to that environment. In nursing homes medication regimen complexity and its problems arise not just from the medication taken but also other factors, such as lack of training of staff administering the medication, no pharmacovigilance and no medication follow-up or reviews [15–17].

Stange [18] and Elliott [19] identified dosing frequency as the simplification with the highest potential, especially in inpatients, followed by the number of dose units and the time of administration—Sections B and C of the MRCI.

Higher MRCI scores were associated with increased risk of emergency department visits and hospitalization, even after controlling for number of medications and case-mix (demographics, comorbidity and clinical and functional status) [20].

Simplification and greater attention to managing complexity are potentially remedial factors for poor adherence and medication errors, not only in community dwelling elders, but also in institutionalized patients. However, before remedial action can be taken, patients with complex management regimens must be identified.

Aim of the study

The aim of this study was to assess the medication regimen complexity of institutionalized elderly people, using the MRCI to identify the type of action with the highest potential for reducing complexity (according to the three MRCI sections) and contribute to rational use of medication in this frailer population.

Method

This descriptive, cross-sectional study was conducted in five nursing homes in mainland Portugal (Lisbon and Alentejo health regions) from March to June of 2009, and included all inpatients aged 65 and over and taking at least one medication a day (recorded in their medication schedule). Selection of the nursing homes was based on the following criteria: existence of written individual medication records, nursing and medical support and participation agreement in the study.

Data collection was based on the MRCI, but also included social, demographic and medication data.

The following factors were considered when scoring complexity: the number of medications in the regimen; their pharmaceutical forms (each different form represents a unit); the number of doses per day (each dose represents a unit); additional instructions (i.e. take with meals or break

the tablet) (each instruction represents a unit). Additional instructions also include some mechanical means needed to administer medications, such as eye drops, inhalers or injections.

The MRCI is an open-ended index, so there is no limit to the total number of medications that can be included in it. The minimum MRCI score for someone on medication is 1.5, which represents a single tablet or capsule taken once a day as needed, while there is no established maximum as the score increases with the number of medications.

Data were collected from the nursing home pharmacies and the form was filled out in two stages. The first was a transcription of each elderly patient's medication profile (approximately five minutes per individual) and the second was use of the MRCI scale to evaluate medication regimen complexity (approximately 10 min per individual profile). Polypharmacy was considered six or more drugs [21].

Statistical analysis was performed with the SPSS (v19). We considered a significance level of $p < 0.05$ and a confidence interval of 95 %. All study variables, including baseline and outcome measures, were analyzed. For continuous measures, p values represented an overall F test of the means. For categorical variables, a Chi square test was performed to assess statistical significance.

In accordance with the Helsinki Declaration, informed consent was obtained for collecting and processing information and data confidentiality was ensured. Ethical approval of the research was obtained from the institutions involved. The results of the performed assessment were left to the health professionals in charge of the medication management of the involved Institutions, in order to allow the implementation of interventions, aiming to reduce the regimen complexity, when applicable.

Results

Patient profiles

Data was collected from 415 elderly patients. The sample's mean age was 83.9 years (± 6.6 years), and 60.2 % were women. Mean age by gender was 84.3 years (± 6.2 years) for women and 83.4 years (± 7.1 years) for men (Table 1).

Medication profile

The sample ($n = 415$) took a total of 3,410 medications and average consumption was 8.2 (± 3.6) drugs per individual per day, with a minimum of 1 and a maximum of 20. Mean daily consumption was higher in females (8.9 ± 3.4 drugs) than in males at 7.2 drugs (± 3.6) per day ($p < 0.001$). The majority of the sample (85.5 %) was under polypharmacy.

Table 1 Socio demographic characterization of the sample

Variables	Frequency (N = 415) %
Gender	
Female	60.2
Male	39.8
Age group	
65–74 years	9.6
75–84 years	40.5
≥ 85 years	49.9

Table 2 Medication profile

Variables	Frequency %
<i>Daily consumption of drugs</i>	(n = 415)
(01–05 drugs)	23.4
(06–10 drugs)	51.8
(11–15 drugs)	21.2
(16–20 drugs)	3.6
<i>Dosage forms</i>	(n = 3,410)
Tablets and capsules	84.5
Oral solutions	3.1
Powders and granules	2.9
Topicals (excl. Patches)	2.6
Patches	1.5
Eye drops and creams/ear drops	1.5
Nasal spray	0.2
Inhalers	2.6
Injections	0.9
Enemas and suppositories	0.2
<i>Pharmacotherapeutic groups</i>	(n = 3,410)
Cardiovascular system	30.8
Nervous system	27.7
Metabolism and alimentary tract	16.4
Blood	7.8
Respiratory system	4.3
Others	13.0

Table 2 shows the sample's drug consumption, pharmaceutical forms and therapeutic groups.

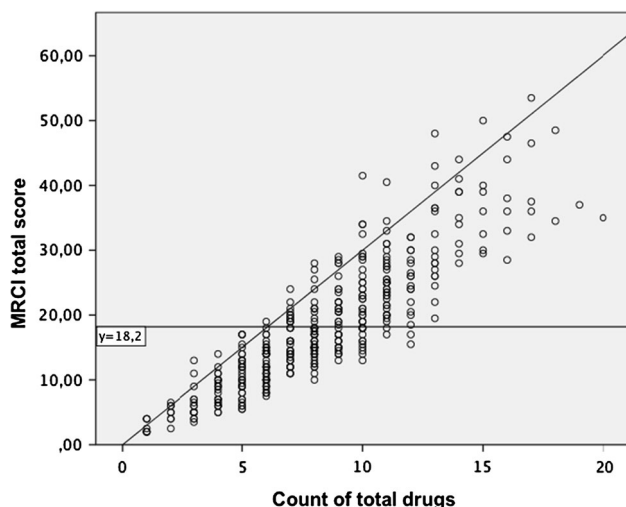
Cardiovascular system (30.8 %), nervous system (27.7 %) and metabolism and alimentary tract (16.4 %) were the most common groups.

In the sample, 88.2 % (366/415) of the elderly were taking at least one cardiovascular drug, 83.4 % (346/415) at least one drug for the nervous system and 70.1 % (291/415) at least one drug for the metabolism and alimentary tract.

The top five active substances were low-dosage aspirin—31.8 % (132/415), simvastatin—28.2 % (117/415),

Table 3 Medication regimen complexity index by sections (mean scores)

MRCI profile			
MRCI total score	Mean (SD)	Minimum	Maximum
MRCI section A score	3.6 (3.1)	1.0	20.0
MRCI section B score	11.2 (5.4)	0.5	28.0
MRCI section C score	3.4 (3.0)	0	15.0
MRCI total score	18.2 (9.6)	2.0	53.5

**Fig. 1** Scatterplot of medication regimen complexity index scores according to the number of consumed drugs

furosemide—22.9 % (95/415), omeprazole—17.1 % (71/415) and acetaminophen, 16.1 % (67/415).

Medication regimen complexity

The MRCI in the sample showed a mean of 18.2 (± 9.6), ranging from 2.0 to 53.5. The index was higher in the women, with a mean of 19.6 (± 9.1), and 16.1 (± 9.9) in men ($p < 0.001$). Table 3 shows the sections of the medication complexity index and mean values.

MRCI was higher as the number of drugs increased ($r = 0.879$, CI 99 %, $p < 0.001$). This was not a rule for every single case, however, as some individuals had high scores that were not related to a large number of drugs, but rather to more complex tasks to be performed. There was considerable variation in MRCI scores within regimens with the same number of drugs (Fig. 1).

Of the factors that contributed to complexity, schedule was the most relevant to the final score ($r = 0.922$), followed by pharmaceutical form ($r = 0.768$), and additional instructions ($r = 0.742$) (CI 99 % ($p < 0.001$)).

In the elderly people receiving from 1 to 5 different drugs, the total MRCI score was 6.6 (± 2.9) while in those receiving from 6 to 20 was 20.2 (± 8.9) (CI 99 % ($p < 0.001$)).

Most of the medications (84.5 %) were taken in only one form (tablet/capsule). About 99.3 % of the patients were taking at least one tablet or capsule. The most common dosing frequency was one medication twice daily (31.8 %).

Where additional instructions were concerned, 22.7 % of the patients followed at least one, 22.2 % at least two and 40 % three or more. The most frequent instructions were to break or crush the tablets (27 %) and take or use the medications at a specific time. The mean scores are shown in Table 4.

Discussion

An aging population with a lack of family support leads to more institutionalized elderly people [22]. Medication management was found to rarely include in this population a critical analysis or review of regimens and is usually restricted to distribution.

The elderly population (living at home or in an institution) is particularly vulnerable to adverse drug reactions, drug interactions and low compliance to chronic medication and it is essential to characterize drug therapy complexity in order to do something to simplify it [23].

Validated tools can assess medication regimen complexity. We chose the MRCI for this study, because it is a comprehensive instrument that includes 65 items related not only to prescription data (number of medications, dosage forms), but also to dose frequency and instructions on how to take the medication (e.g. break tablet) [15, 16].

The MRCI has been adapted to Portuguese for Brazil by George [15] and Melchioris [16], but not for Portugal. From the point of view of the authors this is not a limitation because even if the language is slightly different, the tool is to be used by health care professionals, not by patients, and no problems related with the use of the instrument have been reported during the study.

Medication profile

Mean consumption in the sample was 8.2 drugs per individual per day. This high consumption is similar to results found in other studies of elderly peoples' pharmacotherapy [24]. The polypharmacy observed in this study was also similar to that found in the majority of studies performed in this age group. Kaufman [25] in the USA found that 57 % of women aged 65 and over took five or more drugs and 12 % took ten or more. In a study conducted in eight

Table 4 Medication regimen complexity index by item (mean scores)

Section A dosage forms	Mean	Section B Dosing frequency	Weight	Mean
<i>Oral</i>		Once daily	1	5.2
Capsules/tablets	1	Once daily prn	0.5	0
Gargles/mouthwashes	0	Twice daily	2	3.4
Gums/lozenges	0	Twice daily prn	1	0.1
Liquids	0.4	Three times daily	3	1.5
Powders/granules	0.5	Three times daily prn	1.5	0
Sublingual sprays/tabs	0	Four times daily	4	0.2
<i>Topical</i>		Four times daily prn	2	0
Creams/gels/ointments	0.3	q 12 h	2.5	0.1
Dressings	0	q 12 h prn	1.5	0
Paints/solutions	0	q 8 h	3.5	0
Pastes	0	q 8 h prn	2	0
Patches	0.2	q 6 h	4.5	0
Sprays	0	q 6 h prn	2.5	0
<i>Ear, eye and nose</i>		q 4 h	6.5	0
Ear drops/creams/ointments	0	q 4 h prn	3.5	0
Eye drops	0.3	q 2 h	12.5	0
Eye gels/ointments	0	q 2 h prn	6.5	0
Nasal drops/cream/ointment	0	prn/sos	0.5	0.2
Nasal spray	0	On alternate days or less frequently	2	0.5
<i>Inhalation</i>		Oxygen prn	1	0
		Oxygen < 15 h	2	0
Accuhalers	0.1	Oxygen > 15 h	3	0
Aerolizers	0.1	<i>Total for Section B</i>	11.2	
Metered dose inhalers	0.2	<i>Section C</i>	Weight	Mean
Nebuliser	0.1	Additional directions		
Oxygen/concentrator	0.1			
Turbuhalers	0.1			
Other DPIs	0	Break or crush tablet	1	0.7
<i>Others</i>		Dissolve tablet/powder	1	0.2
Dialysate	0	Multiple units at one time (e.g. 2 tabs, 2 puffs)	1	0.3
Enemas	0			
Injections		Variable dose	1	0
Prefilled	0.1	(e.g. 1–2 caps, 2–3 puffs)		
Ampoules/vials	0.1	Take/use at specified time/s (e.g. mane, nocte, 8 AM)	1	1
Pessaries	0	Relation to food (e.g. pc, ac, with food)	1	0.3
Patient controlled analgesia	0	Take with specific fluid	1	0
Suppositories	0	Take/use as directed	2	0.4
Vaginal creams	0	Tapering/increasing dose	2	0
<i>Total for Section A</i>	3.6	Alternating dose (e.g. one mane and two nocte, one/two on alternate days)	2	0.5
		<i>Total for Section C</i>	3.4	
<i>Medication complexity index (Section A + Section B + Section C)</i>				
18.2				

European countries, Fialová [26] observed that 51 % of elderly people were taking six or more drugs a day. Sicras-Mainar [27] found higher consumption of oral forms (84.5 %).

Castellar [17] obtained similar results for medication profiles. By therapeutic groups, he found that the medications taken most were for the cardiovascular system (27.3 %), followed by the nervous system (21.6 %) and the alimentary tract and metabolism (14.1 %) [17].

Similar results were also obtained by Muir [28], in which the active substance that individually appeared most often in medication record was, acetylsalicylic acid 100 and 150 mg, found in 31.8 % of cases.

Medication regimen complexity

Older people, especially women, are more prone to polypharmacy due to multiple chronic conditions that they usually suffer and their greater propensity for taking medications. In the current study, however, only gender contributed significantly to the complexity of therapeutic schemes [15].

The average complexity index of the sample was 18.2. This figure is different from the results found in other published studies that used the same instrument: Oosthuizen [29] obtained a figure of 19.3 in an age range of 60–69 years, and Correr [30] found an average complexity of 15.5 in individuals older than 30. In our study, the older population taking a large number of medications may explain the average complexity index figure. However, a greater number of medications does not always mean a higher complexity index. This confirms the index's ability to emphasize the different complexity of regimens with the same number of drugs, and demonstrates that the MRCI goes beyond the mere quantification of drugs [15, 28].

The correlation between the complexity index's total ratio and its three sections (A, B and C) in particular shows direct proportionality. In other words, a higher complexity index is the direct result of individual growth in each section [15].

As the MRCI is an open-ended index, with no maximum value, no articles or authors were found who tried to establish a cut-off, a figure related to negative health outcomes and the need to intervene. However, several studies have investigated the positive impact of intervention aimed at reducing the complexity of medication regimens whenever possible [18, 31].

Like Stange [18], the most relevant factors found for complexity were schedule (section B of the MRCI-frequency of doses), followed by pharmaceutical forms and additional instructions. Here, specialized intervention by a healthcare professional, particularly a pharmacist, may be more effective in reducing it in a medication review [18].

Khalil [32] demonstrated the importance of the doctor-pharmacist collaboration in the management of residents' medications in aged care facilities from the point of view of the patient safety.

The assessment of regimen complexity using the MRCI may be an effective tool for professionals managing the medication of the elderly in order to promote rational use of drugs. In a study on the effect of medication reviews in institutionalized elderly, Zermansky [33] demonstrated its advantages, when performed by specialized professionals, not only in terms of patient health outcomes, but also of costs. However, the additional time, effort, and professional training needed to calculate it may decrease its use and popularity [13]. In 2013 McDonald et al. [11] developed a tool that for automating calculation of the MRCI score and accelerating evaluation of its potential.

Conclusion

The literature highlights medication complexity as a factor likely to impact negatively on patient compliance and ultimately treatment efficacy and safety, and should therefore be considered as a particularly important aspect in the elderly population.

This study evaluated medication complexity in institutionalized male and female patients taking different medications and patients with different underlying conditions.

Medication complexity evaluated by the MRCI index was found to be high (average of 18.2), and higher in females, suggesting the need for further intervention. It was mainly related to the number of medications taken chronically, and also to dose frequency.

Of the factors that contributed to complexity, schedule was the most relevant to the final score, followed by pharmaceutical forms and additional instructions, in which a medication review by a healthcare professional may be more effective in reducing it.

The MRCI showed good evidence of classifying regimen complexity better than a simple medication count, in the studied population. It proved to have potential in the routine to help reduce medication regimen complexity by identifying factors that contribute to this complexity in elderly care institutions, thereby promoting compliance and avoiding medication errors.

Given the large body of evidence that regimen complexity is an important predictor of treatment burden, medication adherence and outcomes, more attention should be devoted to this aspect.

Health care professionals and particularly pharmacists should be trained to use the MRCI, in order to assess the complexity of medication regimen of their older patients, and try to find solutions to reduce it, whenever possible.

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Conflicts of interest None.

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