

New lists and new technological tools on potentially inappropriate drugs for the elderly: an integrative review

Novas listas e novas ferramentas tecnológicas sobre medicamentos potencialmente inapropriados para idosos: uma revisão integrativa

Nuevas listas y nuevas herramientas tecnológicas sobre medicamentos potencialmente inapropiados para ancianos: una revisión integradora

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Objective: to identify new lists and new technological tools on Potentially Inappropriate Medicines for the Elderly existing in scientific productions. **Methods:** an integrative review was carried out in 2020, considering the period from 2010 to 2019, in the following databases: Scientific Electronic Library on-line, National Library of Medicine and National Institutes of Health, Latin American and Caribbean Health Sciences Literature, Spanish Bibliographic Index of Health Sciences, Cochrane Library, Network of Scientific Journals of Latin America, the Caribbean, Spain and Portugal, *Fundación Index Database – España*. The languages Portuguese, English and Spanish were listed and the selected articles were categorized by thematic similarities. **Results:** 42 productions were considered, most of them published in English and produced in the United States of America, Canada, Spain, Germany, Belgium and Ireland. Two thematic categories were constructed: “*Lists on potentially inappropriate medicines for the elderly*” (with 22 publications); and, “*New Technological Tools on potentially inappropriate medicines for the elderly*” (with 20 publications). As main findings, the following stood out: the relevance of having lists on these drugs adapted to specific countries and/or populations; as well as the fact that new technological tools follow a trend of development and improvement, although the usability and user coverage requirements can be improved. **Conclusion:** this review identified that the use of potentially inappropriate medicines for the elderly represents a challenge for health care, as well as the growing initiatives to expand access to information, such as the construction of large databases and repository with simplified access. **Descriptors:** Potentially Inappropriate Medication List; Drug utilization; Inappropriate prescribing; Biomedical technology; Aged.

Objetivo: identificar novas listas e novas ferramentas tecnológicas sobre Medicamentos Potencialmente Inapropriados para Idosos existentes em produções científicas. **Método:** revisão integrativa realizada em 2020, considerando o período de 2010 a 2019, nas bases de dados: *Scientific Electronic Library on-line, National Library of Medicine and National Institutes of Health, Literatura Latino-Americana e do Caribe em Ciências da Saúde, Índice Bibliográfico Espanhol de Ciências de Saúde, Cochrane Library, Rede de Revistas Científicas da América Latina e Caribe, Espanha e Portugal, Base de dados da Fundación Index – España*. Elencou-se os idiomas português, inglês e espanhol e os artigos selecionados foram categorizados por similaridades temáticas. **Resultados:** foram consideradas 42 produções, em sua maioria publicadas em língua inglesa e produzidas nos Estados Unidos da América, Canadá, Espanha, Alemanha, Bélgica e Irlanda. Duas categorias temáticas foram construídas: “*Listas sobre medicamentos potencialmente inapropriados para idosos*” (com 22 publicações); e “*Novas Ferramentas Tecnológicas sobre medicamentos potencialmente inapropriados para idosos*” (com 20 publicações). Como principais achados, destacou-se: a relevância de que listas sobre esses medicamentos sejam adaptadas a países e/ou populações específicas; bem como ao fato de que novas ferramentas tecnológicas seguem uma tendência de desenvolvimento e aprimoramento, embora os quesitos usabilidade e abrangência de usuários possam ser melhorados. **Conclusão:** esta revisão identificou que o uso de medicamentos potencialmente inapropriados para idosos representa um desafio para a assistência à saúde, bem como as crescentes iniciativas para expandir o acesso às informações, como a construção de grandes bancos de dados e repositório com acesso simplificado. **Descritores:** Lista de Medicamentos Potencialmente Inapropriados; Uso de medicamentos; Prescrição Inadequada; Tecnologia biomédica; Idoso.

Objetivo: identificar nuevas listas y nuevas herramientas tecnológicas sobre Medicamentos Potencialmente Inapropiados para Ancianos existentes en las producciones científicas. **Método:** revisión integradora realizada en el año 2020, considerando el periodo de 2010 a 2019, en las bases de datos: *Scientific Electronic Library online, National Library of Medicine and National Institutes of Health, Literatura Latinoamericana y del Caribe en Ciencias de la Salud, Índice Bibliográfico Español de Ciencias de la Salud, Cochrane Library, Red de Revistas Científicas de América Latina y el Caribe, España y Portugal, Base de datos de la Fundación Index - España*. Se seleccionaron los idiomas portugués, inglés y español y los artículos seleccionados se clasificaron por similitudes temáticas. **Resultados:** Se consideraron 42 producciones, en su mayoría publicadas en inglés y producidas en Estados Unidos de América, Canadá, España, Alemania, Bélgica e Irlanda. Se construyeron dos categorías temáticas: “*Listas sobre medicamentos potencialmente inapropiados para ancianos*” (con 22 publicaciones); y “*Nuevas herramientas tecnológicas sobre medicamentos potencialmente inapropiados para ancianos*” (con 20 publicaciones). Como principales resultados destacan: la relevancia de que las listas sobre estos medicamentos se adapten a países y/o poblaciones específicas; así como, el hecho de que las nuevas herramientas tecnológicas sigan una tendencia de desarrollo y mejora, mientras que las cuestiones de usabilidad y amplitud de usuarios pueden ser mejoradas. **Conclusión:** esta revisión identificó que el uso de medicamentos potencialmente inapropiados para ancianos representa un desafío para la asistencia a la salud, así como las crecientes iniciativas para expandir el acceso a informaciones, como la construcción de grandes bancos de datos y repositorios con acceso simplificado.

Descritores: Lista de Medicamentos Potencialmente Inapropiados; Uso de medicamentos; Prescripción Inadecuada; Tecnología biomédica; Anciano.

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INTRODUCTION

The aging of populations represents a relevant epidemiological transition, showing a growing increase in the demand for health care. It is a worldwide phenomenon and, in the case of Brazil, the number of elderly people (over 60 years old) is expected to almost double in the next 35 years, as well as the number of people over 70 years old, which will triple by 2050, reaching 13.2% of the population¹. In Brazil, with the 2010 census, the projections for the population were revised: the number of elderly people should double in twenty years and the number of people over 70 years old will reach 16.2% of the population in 2050².

In this context, the elderly are considered a special therapeutic group, due to factors such as the increasing prevalence of non-communicable chronic diseases and the consequent use of medication³. Associated with this, it is important to consider that there is interference of the physiological changes of the aging process in the pharmacokinetics and pharmacodynamics, increasing the risk of toxicity caused by the drugs⁴.

Among the particularities of drug therapy for this group, potentially inappropriate medicines for the elderly (PIM) stand out, defined as those whose risk of use is greater than the clinical benefits provided, when safer and more effective alternatives are available⁵ and, due to the high potential to generate negative outcomes, such as falls and increased health costs, its prescription should be avoided⁶.

The evaluation of prescriptions containing PIM can be supported by implicit or explicit methods. The former are based on clinical judgment according to patient information (health profile, presence of health problems or relevant clinical peculiarities), and propose a more in-depth pharmacotherapeutic analysis. Therefore, they require more time and depend on the professional's experience, but they provide an individualized analysis compatible with the reality of health services and the clinical variability of the geriatric population, and can be incorporated with relative ease in the therapeutic decision process, multidisciplinary clinical discussion and in pharmacotherapeutic follow-up processes. The most established implicit method is the Medication Appropriateness Index (MAI)⁷⁻⁸.

Explicit methods are based on more rigidly established criteria, usually developed through reviews, expert opinions, and consensus techniques. They focus on the drug and do not take into account the clinical suitability of each patient. As they are based on less flexible criteria, they are good instruments to carry out more punctual and simpler geriatric prescription reviews. The Beers Criterion is considered one of the most important explicit

methods, listing classes and specificities of drugs and in categories, such as those potentially inappropriate⁷⁻⁸.

Considering that the use of PIM has a high prevalence in several countries, ranging from 25.5% to 98.2%⁹⁻¹⁰, knowing the updates of lists on PIM, as well as new technological tools applied to them, becomes of great importance. value to the field of practices. Thus, this study aims to identify new lists and new technological tools on Potentially Inappropriate Medicines for the Elderly existing in scientific productions.

METHODS

This is an integrative review, defined as the method that brings together the synthesis of knowledge from the relevant scientific production on a given topic, offering quick and synthesized access to the scientific results of greatest relevance to the area studied¹¹.

The guiding question listed was: *What is the state of the art, in scientific productions, between 2010 and 2019, about new lists and new technological tools on Potentially Inappropriate Medicines for the Elderly?*

The search was carried out in 2020 and the databases considered were: SciELO (Scientific Electronic Library on-line); PubMed/Medline (National Library of Medicine and National Institutes of Health), LILACS (Latin American and Caribbean Health Sciences Literature); IBECs (Spanish Bibliographic Index of Health Sciences); Cochrane; Redalyc (Network of Scientific Journals of Latin. America, the Caribbean, Spain and Portugal); and Cuiden (Fundación Index database – España).

The primary search in the databases consisted of the following strategy: (“Potentially Inappropriate Medication List” [All Fields] OR “*Lista de Medicamentos Potencialmente Inapropiados*” OR “*Lista de Medicamentos Potencialmente Inapropiados*” AND “aged” [All Fields]] OR “elderly” [All Fields] OR “elder people” [All Fields] OR “*anciano*” [All Fields] OR “*idoso*” [All Fields]).

However, for two databases it was necessary to reformulate the search strategy; in the case of PubMed it consisted of: 'Potentially Inappropriate Medication List aged'; and for SciELO: 'Potentially Inappropriate Medication List'.

For the composition of the corpus, the articles obeyed the following criteria:

- **Inclusion criteria:** complete research articles, in Portuguese, English and Spanish, published in scientific journals from 2010 to 2019. Regarding the theme, articles dealing with: Lists/Updates of Lists on PIM were included; Consensus; Derived Lists about PIM; Construction Studies and/or Validation of New Technological Tools applied to the theme.

• **Exclusion criteria:** observational, case-control and cohort studies; editorials; reviews; reports of experiences and theoretical reflections; dissertations; theses and monographs; abstracts published in annals of events, repeated articles, and those that had no direct relationship with the topic.

The analysis of the articles was based on Evidence-Based Practice (EBP), which is defined as an approach that associates the best scientific evidence with clinical experience and patient choice¹². The EBP is important to support professional practice, as it describes that its implementation is essential to achieve effectiveness, reliability and safety in health practices¹³.

All publications were initially filtered by reading title and abstract, thus identifying the articles that apparently addressed the topic and answered the research question. In a second phase, the articles considered were read in full and categorized by thematic similarities.

The articles were presented in tables that focus on the *reference* (identification of the title, author and year), *language and country*, *objective*, *proposal of the study* (which summarizes in a critical rereading the direction of the article - method; without the intention of copying the statements of the authors). authors of the production, therefore critical re-reading; also seeking to interpret the contributions, novelties, results and defended aspects) and, level of scientific evidence. The latter followed the classification proposed by Melnyk and Fineout-Overholt¹⁴: Level I – evidence from a systematic review or meta-analysis of relevant randomized controlled trials (RCTs) or from clinical guidelines based on systematic reviews of controlled RCTs; Level II – evidence obtained from at least one well-designed controlled RCT; Level III – evidence obtained from well-designed clinical trials without randomization; Level IV – evidence from well-designed cohort and case-control studies; Level V – evidence from a systematic review of descriptive and qualitative studies; Level VI – evidence from a single descriptive or qualitative study; Level VII – evidence from the opinion of authorities and/or the report of expert committees.

From the categories obtained, the articles were discussed in the light of the analytical process, with emphasis on Nóbrega and Karnikowski¹⁵, directing the discussion to the state of the art, the main specific lines of research and gaps, dialoguing with the critical analysis of scientific evidence and the main contributions.

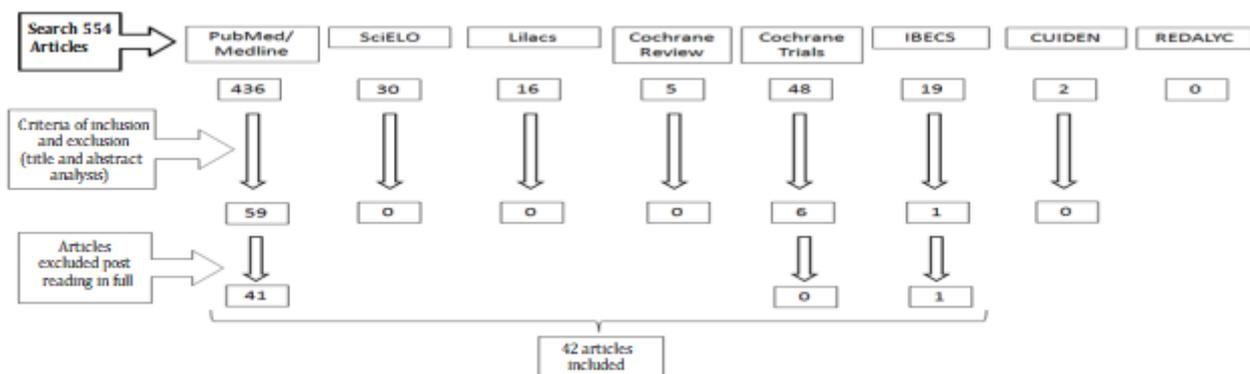
The journals involved in the publications were identified, including their scope of circulation (national/international). The countries and languages were presented in their abbreviated forms, aiming at the best configuration of the data. The countries presented the following correspondences: Germany (DEU); Argentina (ARG); Australia (AUS); Austria (AUT); Belgium (BEL); Brazil (BRA); Canada (CAN); Korea (KOR); Spain (ESP); United States of

America (USA); Ireland (IRL); Italy (ITA); Japan (JPN); Norway (NOR); Netherlands (NLD); United Kingdom (GBR); Sweden (SWE); Switzerland (CHE); Taiwan (TWN). The publication languages were represented by the abbreviations: English (en) and Spanish (sp).

RESULTS

A total of 554 references were identified and 42 of them were included for analysis. The detail is presented in the flow diagram (Figure 1).

Figure 1: Flow diagram of articles filtered, evaluated for eligibility, included and excluded. Uberaba, MG, 2021.



In the first filter step, 46 articles were excluded for being duplicates, and another 442 articles for not meeting the study typology eligibility criteria. In the second stage of the filter, 23 articles were excluded for deviating from the theme, and one for incompleteness of methodological information and results.

The 42 productions analyzed were published in 25 journals of international circulation, the most frequent being the Journal of the American Geriatrics Society, in which there were six articles, followed by the European Journal of Clinical Pharmacology, with four articles, and three articles each in the journals Geriatrics & Gerontology International and BMC Geriatrics.

The main language used by the publications was English, observed in 39 of the publications, which does not necessarily imply that all of them are from English-speaking countries, but only that the adoption of English as the main language of dissemination has been required by journals from different countries. Spanish appears as the language of the other three remaining articles, with no articles written only in Portuguese.

Most of the articles identified came from studies carried out in the United States of America (8 articles – 1 of them in partnership with Italy); Canada and Spain (five articles each); Germany, Belgium and Ireland (three articles each); Norway, Switzerland and Taiwan (two

articles each); Argentina, Australia, Austria, Brazil, Korea, Japan, Netherlands, United Kingdom and Sweden (one article each).

By production similarities, two categories were constructed, namely: “*Lists on potentially inappropriate medicines for the elderly*” and “*New Technological Tools on potentially inappropriate medicines for the elderly*”, being Categories 1 and 2, respectively.

Category 1. *Lists on potentially inappropriate medicines for the elderly*

This category with 22 studies brings new lists on PIM, including translations and adaptations of pre-existing lists for specific localities and contexts.

Of the 22 publications analyzed in this category, most of them (14) presented level of scientific evidence I, due to the basis on systematic reviews; the other eight studies mentioned reviews, followed by expert consensus (Delphi Method), but did not indicate the performance or basis of systematic reviews.

Some of these new lists, in addition to expert reviews and opinions, were also guided by pre-existing PIM criteria, namely: Beers^{18,23,30-32,35-36}, Screening Tool to Alert doctors to the Right Treatment (START)^{21,23,25-26,32,34}, Screening Tool of Older Person's Prescriptions (STOPP)^{18,21,23,25-26,28,32,34-35}, The Norwegian General Practice (NORGEP)^{23,31-32,35}, lista Laroche criteria^{23,32,35}, PRISCUS^{23,32}, Winit-Watjana criteria^{32,35}, Korean and Austrian Criteria²³, McLeod criteria^{32,35}, The European Union (EU)(7)-PIM list¹⁸, Rancourt criteria³⁵, Basger Criteria³².

Of the total number of publications^{16-17,19-20,22,24,27,29,33,37} did not mention pre-existing criteria.

Chart 1. Articles considered on PIM Lists from 2010 to 2019. Uberaba, 2021.

References	Language /Country	Type of Study	Objective	Proposal	Level of Evidence
01 - American Geriatrics Society 2019 Updated AGS Beers Criteria® for Potentially Inappropriate Medication Use in Older Adults. Griebing TL et al. – 2019 ¹⁶	en/USA	Validation by Delphi Method	Update the Beers Criteria and classify the evidence on drug-related problems (DRP) and adverse events in the elderly.	Update by a Panel of 13 Experts, incorporating new evidence to the 2015 version. Clinical guideline based on systematic reviews, generating the addition of 46 new criteria, including individual and specific. The authors reinforce the importance of non-pharmacological approaches, with emphasis on patients with dementia and delirium.	I
02 - Spanish list of potentially inappropriate drugs in the elderly (ES-PIA project). Harmand MGC et al. – 2019 ¹⁷	sp/ESP	Validation by Delphi Method	Develop and validate a Spanish PIM list.	Elaboration of the Spanish PIM list, by 25 specialists from different areas of geriatrics and gerontology, with questionnaires in two rounds. Of the 160 items initially proposed, 138 made up the final version, all with a strong level of agreement. It represents an important advance as it is adapted to the Spanish pharmacopoeia and prescribing habits.	VII
03 - Pain and Inflammation Management in Older Adults: A Brazilian Consensus of Potentially Inappropriate Medication and Their Alternative Therapies. Motter FR et al. – 201 ¹⁸	en/BRA	Validation by Delphi Method	Develop and validate a list of PIM and alternative therapies for the treatment of pain and inflammation in the elderly adapted to the Brazilian context.	Adaptation of three international lists to the Brazilian context, by a Panel of 9 Specialists in geriatric pharmacotherapy, with validation of 144 PIM at the end of the Consensus. It represents the update of the 1 st List on Brazilian PIM, published in 2016. For two drugs, phenylbutazone and tizanidine, there was no consensus among experts even after the second round of the Delphi method.	VII
04 - Development of an Anticholinergic Burden Scale specific for Korean older adults. Jun K et al. – 2019 ¹⁹	en/KOR	Validation by Delphi Method	Develop the Korean anticholinergic load scale.	Clinical guideline based on a systematic review for the development of an anticholinergic scale, applied to drugs available in Korea. From 10 pre-existing tools, 655 drugs were initially analyzed, generating a final version with 56 drugs classified as strong, 23 moderate and 59 weak. Drugs with	I

				anticholinergic action are associated with negative health outcomes, requiring more careful medical prescriptions.	
05 - Potentially Inappropriate Prescribing to Older Patients: Criteria, Prevalence and an Intervention to Reduce It: The Prescription Peer Academic Detailing (Rx-PAD) Study - A Cluster-Randomized, Educational Intervention in Norwegian General Practice. Rognstad S et al. – 2018 ²⁰	en/NOR	Validation by Delphi Method and large randomized cluster educational intervention	Develop the Norwegian criterion (NorGeP) on PIM and apply it in an educational intervention	Elaboration of the NorGeP, explicit criteria composed of 36 PIM, and subsequent 1-year educational intervention involving 454 general practitioners. The use of this criterion showed a prevalence rate of 24.7 MPI per 100 patients ≥70 years per year. Older physicians were the ones who most generated PIM prescriptions in the pre-study period, and were the ones who best accepted the educational intervention. Highlight for drugs with anticholinergic and antipsychotic action, and interactions resulting from combinations with warfarin and those with Non-Steroidal Anti-Inflammatory Drugs (NSAIDs).	VII
06 - Uso potencialmente inapropiado de fármacos en cuidados paliativos: versión en castellano de los criterios STOPP-Frail (STOPP-Pal). Delgado-Silveira E, et al. – 2018 ²¹	sp/ESP	Translation/A daptation by Delphi Method	Present an adapted and translated version of the STOPP-Frail list into Spanish	The list adapted to Spanish through Consensus by 17 experts, called STOPP-Pal, was developed for decision-making on medications in elderly people undergoing palliative care, further clarifying the semantic confusion between frailty and palliative care. There was final consensus for 27 criteria. This translated list can contribute to improving the quality of care provided to palliative care patients in different health systems in Spain and Latin America.	VII
07 - Adequate, questionable, and inadequate drug prescribing for older adults at the end of life: a European expert consensus. Morin L, et al. – 2018 ²²	en/SWE	Systematic Review and Validation by Delphi Method	Identify drugs and drug classes that are most often appropriate, questionable, or inappropriate for late-life seniors.	Clinical guideline based on a systematic review for the characterization of drugs and drug classes, by forty experts from ten different countries, at three levels of adequacy (adequate, questionable and inadequate). Among the questionable drugs, an important proportion of them is represented by anticoagulants. Forty-nine drug classes were submitted to consensus, with the final inclusion of 75% of the items presented. The work reinforces the importance of studies such as RCTs for high-quality evidence, but states that the present criteria can support important clinical decisions.	I
08 - Ingredientes Farmacéuticos Activos Potencialmente Inapropiados en Adultos Mayores: Lista IFAsPIAM: Panel de Consenso Argentino. Marzi MM, et al. – 2018 ²³	en/ARG	Validation by Delphi Method	Develop/Adapt a list on PIM (Potentially Inappropriate Active Pharmaceutica l Ingredients in	Clinical guideline based on a systematic review for the elaboration/adaptation of foreign lists to the Argentine context, by a Panel of 10 Experts, generating the 1 st Latin American List on PIM, with validation of 128 PIM at the end of the Consensus. Medications for the Nervous System represented the largest proportion of PIM (47%), followed by the Cardiovascular and Musculoskeletal groups. The IFAsPIAM	I

			Adults Major - IFAsPIAM List) adapted to the local Argentine context.	List can contribute to the rational use of medicines in the elderly, constituting a valuable tool in Argentine public health.	
09 - Development and Application of the GheOP3S-Tool Addendum on Potentially Inappropriate Prescribing (PIP) of Renally Excreted Active Drugs (READs) in Older Adults with Polypharmacy. Wazzan AAA, et al. – 2018 ²⁴	en/BEL	Validation by Delphi Method / Retrospective cross-sectional study	Expand the Ghent Older People's Prescription community Pharmacy Screening (GheOP3 S-) tool with the first addendum for PIM screening of frequently used renally excreted active drugs (DAER) and perform a cross-sectional analysis using the addendum and history of medication of a group of elderly people with polypharmacy.	Construction/Application of the GheOP3S clinical tool, through a Panel of Experts, with 61 substances included as DAER and considered inappropriate for use in elderly people with renal failure. This tool can contribute to the reduction of inappropriate prescriptions for this group of patients, with emphasis on cases of polypharmacy (concurrent use of ≥ 5 medications). For glomerular filtration rate ≤ 60 mL/min, the following DAERs were considered PIM: perindopril, spironolactone, metformin, allopurinol, digoxin, indapamide, hydrochlorothiazide and potassium-sparing agents and others.	VII
10 - STOPPFrail (Screening Tool of Older Persons Prescriptions in Frail adults with limited life expectancy): consensus validation. Lavan AH, et al. – 2017 ²⁵	en/IRL	Validation by Delphi Method	Validate the Screening Tool of Older Persons Prescriptions in Frail adults	Elaboration of the STOPPFrail list, a list of explicit criteria for the use of PIM in frail older adults with limited life expectancy (LLE), by means of a Consensus by 17 experts. Initial proposal of 30 criteria; final version with 27 criteria. This list can help physicians prescribe medication to patients with LLE.	VII

			with limited life expectancy list (STOPPRail)	This list avoided generating a generalized statement about controversial treatments, as in the case of antihypertensives, thus focusing on drugs not usually used as 1st line.	
11 - Screening Tool of Older Person's Prescriptions/Screening Tools to Alert Doctors to Right Treatment Medication Criteria Modified for U.S. Nursing Home Setting. Khodyakov D, et al. – 2017 ²⁶	en/USA	Validation by Delphi Method	Develop a set of measurable prescribing indicators, adapted from the START-STOPP criteria and underused drugs for the USA, with a focus on nursing homes.	Clinical guideline based on a systematic review for the adaptation of the START-STOPP criteria to the USA, by a panel of 17 experts. Of the 114 criteria reviewed, 53 were considered compatible with the nursing homes in the USA, 48 of them considered valid and 24 of great clinical relevance. In the end, 22 measures of medicines were obtained related to PIM and 2 related to underused medicines. One of the highlights of this modified list is the inclusion of criteria on important clinical care for initiating annual influenza vaccinations and pneumococcal vaccination at least once if you are 65 years of age or older. These are the first explicit criteria for assessing prescribing quality in US nursing homes.	I
12 - [Criteria for defining consensus achievement in Delphi studies that assess potentially inappropriate medications in the elderly]. Marzi MM et al. – 2016 ²⁷	en/ESP	Validation by Delphi Method	Develop criteria to define the reach of consensus in Delphi studies carried out to assess PIM in the elderly.	Construction and Validation of an index (Yq) to analyze the agreement of pairs of evaluators on MPI. Pilot study with 12 drugs evaluated by Likert scale. According to the study, three criteria guarantee the achievement of a consensus: a) Number of evaluators $\geq 60\%$ of the panel members, b) $Yq \geq 0.800$; c) frequency of statistical mode $\geq 60\%$. The index considers the real distances between the Likert scale categories and the developed criteria constitute a simple tool for the analysis of the Delphi questionnaires in the evaluation of the use of PIM in the elderly.	VII
13 - Intervention to Improve Appropriate Prescribing and Reduce Polypharmacy in Elderly Patients Admitted to an Internal Medicine Unit. Urfer M, et al. – 2016 ²⁸	en/AUS	Intervention Study	Test the effectiveness of an easy checklist to support clinicians' therapeutic reasoning to reduce inappropriate prescribing	Efficacy and safety assessment of a 5-point checklist applied by ward physicians of internal medicine, comparing the proportion of PIM prescription (based on START/STOPP criteria) and polypharmacy before and after application of the checklist in 450 patients. Reduced risk of PIM prescription by 22% and actual reduction of observed polypharmacy less than 20%. The reduction of deaths in the first 30 days after hospital discharge was one of the confirmed effects of this checklist, due to the significant reduction in the risk of PIM prescriptions at hospital discharge.	VII

			and polypharmacy		
14 - Screening Tool for Older Persons' Appropriate Prescriptions for Japanese: Report of the Japan Geriatrics Society Working Group on "Guidelines for medical treatment and its safety in the elderly". Kojima T, et al. – 2016 ²⁹	en/JPN	Validation by Delphi Method	Update and Revise the Japanese Guidelines (2005 version), and add a comprehensive list on PIM	Clinical guideline based on systematic review for the update/revision of Japan's "Guidelines for medical treatment and its safety in the elderly 2005", including a Section on PIM, adapted to the Japanese context. Among the drugs to be carefully prescribed, the classes 'antipsychotics', 'muscarinic receptor antagonists' and NSAIDs deserve to be highlighted due to the high proportion of items mentioned. This list differs from other explicit criteria (eg, Beers and STOPP) in that it is based on a systematic review.	I
15 - 2015 updated AGS Beers Criteria offer guide for safer medication use among older adults. Counsell SR– 2015 ³⁰	en/USA	Validation by Delphi Method	Update the Beers Criteria (2015) and classify the evidence on DRP and adverse events in the elderly	Updated by an Expert Panel, incorporating new evidence into the 2012 version. Review of over 6,700 clinical trials and research studies. Organization of recommendations into an expanded set of five lists, in addition to non-drug recommendations for nursing care. Inclusion of two additional lists: one specific to "drug-drug" interactions, and the other a summary of drugs that should be avoided or administered differently in people with kidney failure.	I
16 - The Norwegian General Practice--Nursing Home criteria (NORGE-P-NH) for potentially inappropriate medication use: A web-based Delphi study. Nyborg G, et al. – 2015 ³¹	en/NOR	Validation by Delphi Method	Develop a set of explicit criteria for the use of PIM in nursing homes.	Development of the Norwegian General Practice – Nursing Home (NORGE-P-NH) list (based on the NORGE-P List), a list of 34 explicit criteria for PIM use in Norwegian nursing homes, by a Panel of 49 Experts. The NORGE-P-NH list can serve as a tool in the prescribing process and drug list review and can also be used for quality assessment and research purposes. Emphasis is given to the recommendation that the term 'deprescription' be adopted internationally, and to the risk of drug combinations with NSAIDs and the combination of bisphosphonates and statins, by elderly people with EVL.	VII
17 - The development of the PROMPT (Prescribing Optimally in Middle-aged People's Treatments) criteria. Cooper AJ et al. – 2014 ³²	en/GBR	Validation by Delphi Method	Develop a specific prescription instrument for the middle-aged population, containing criteria	Instrument called 'Prescribing Optimally in Middle-aged People's Treatments' (PROMPT) and developed by a panel of 17 experts in internet-based consensus. Comprised of 22 recommendations, the PROMPT addresses drugs commonly used in the UK and Ireland, and aims to explore PIM burden and associated factors, identifying prescribing patterns and predictors for potentially inappropriate drug use in this age group (45-59 years).). It represents the first criteria for this age group and needs future tests to assess its effectiveness. A	VII

			relevant to this age group	limitation of the study was the non-inclusion of drugs suitable for use under specialized care.	
18 - The St Vincent's potentially inappropriate medicines study: development of a disease-specific consensus list and its evaluation in ambulatory heart failure care. Birmingham M, et al. – 2014 ³³	en/IRL	Validation by Delphi Method	Develop a list of PIM for Heart Failure (HF), the PIMHF list; to evaluate the relationship between the prescription of these PIMHF items and the clinical outcome in an outpatient HF population	Development of the PIMHF by an expert panel of 35 cardiologists, two general practitioners; four specialized nurses; and six specialist pharmacists. The final version counts 11 MPI; the medication profile of 350 patients was analyzed, and one or more Consensus PIMs were prescribed to 14.6% of these patients. The PIMHF list provides the first HF-specific drug review tool and reinforces the importance of specific MPI lists for certain clinical conditions. Of the drugs on this new list, the most prescribed to the elderly in the study were: non-dihydropyridine calcium channel blockers (n = 15, 26.3%), followed by oral corticosteroids and metformin in patients with renal dysfunction.	VII
19 - Mejorando la prescripción de medicamentos en las personas mayores: una nueva edición de los criterios STOPP-START [Improving drug prescribing in the elderly: a new edition of STOPP/START criteria]. Silveira ED et al. – 2014 ³⁴	sp/ESP	Revision/Translation by Delphi Method	Translate a list about PIM into Spanish	Translation of the START-STOPP List (2014 version) into Spanish, through a panel of experts with geriatricians and specialized pharmacists. The translated version maintains the 87 STOPP and 34 START recommendations of the English version, and represents an advance in the quality of detection of PIM use by Hispanic-speaking professionals. The authors also reinforce that they can avoid frequent omissions (START) due to the lack of prescription drugs for cardiovascular diseases, diabetes and vitamin D calcium supplements.	VII
20 - Using published criteria to develop a list of potentially inappropriate medications for elderly patients in Taiwan. Chang CB, et al. – 2012 ³⁵	en/TWN	Validation by Delphi Method	Describe a process for developing explicit country-specific PIM criteria	Elaboration of a list of explicit criteria on PIM based on at least three pre-existing criteria, through a Consensus by 21 experts, applied to the Taiwanese context. The final version has 24 PIM to be avoided by any elderly person (explicit criteria), in addition to 12 comorbidities associated with 6 PIM classes. Long-acting benzodiazepines and drugs with anticholinergic action received clear definitions. More prospective studies are needed to validate its use in clinical and research settings.	VII
21 - Using explicit criteria to evaluate the quality of prescribing in elderly Italian	en/USA-ITA	Validation by Delphi Method/	Establish explicit criteria for prescribing	Update of the 2002 Beers Criteria with adaptation to the Italian prescription standard, through a Consensus with nine experts, with subsequent application in the elderly at a Local Health Unit in Parma, Italy, through a retrospective cohort study. The	VII

outpatients: a cohort study. Maio V, et al. – 2012 ³⁶		Retrospective cohort study.	PIM and assess the prevalence and factors associated with PIM, according to the criteria developed.	final version had 23 MPI, allocated into three categories, and the cohort study involved 91,741 elderly people aged ≥ 65 years, and at least one prescribed medication. 25.8% of the elderly analyzed were prescribed at least one PIM, based on these adapted criteria. As an example of the consensus results, fluoxetine, due to its long half-life and its active metabolites, was considered PIM, with its use limited to cases of failure of other therapeutic agents. The study corroborates that PIM use among outpatient elderly people is a substantial problem in this Italian locality.	
22 - Potentially inappropriate medication in geriatric patients: the Austrian consensus panel list. Mann E et al. – 2011 ³⁷	en/AUT	Validation by Delphi Method	Develop the Austrian criterion on PIM	Elaboration of the Austrian list on PIM, by a Panel of 8 Experts in geriatric medicine, composed of 73 PIM, in addition to suggestions of therapeutic alternatives, and pharmacokinetic and pharmacological information of the listed drugs. This list can be a useful tool for clinicians to improve the quality of prescribing for the elderly, and its validity needs to be proven in validation studies.	VII

Category 2. New Technological Tools on potentially inappropriate medicines for the elderly

This category with 20 articles presents new technological tools on PIM, including studies aimed at the development/application/presentation of technological tools applied to the identification and support of decision-making on PIM.

Of the 20 publications analyzed, most of them (10) presented level of scientific evidence VI, as the data generated, despite the initial interventionist approach, are characterized as descriptive. Evidence levels II and VII had four publications each; level II was assigned because it was data obtained from at least one RCT and the attribution of level VII was justified by the fact that the publications presented methodological studies based on expert opinions.

Two studies were classified as level VI^{43,54} because they were qualitative research, initiated by the construction of a technological tool, but with an outcome focused on the perceptions and attitudes of the interviewees.

Most of these publications (18) mentioned that their tools were based on pre-existing IPM criteria. The use of criteria in the construction of these technological tools has the following distribution: Beers (5)^{39,44,50,53-54}; Beers and STOPP (4)^{40,47,49,57}; Beers, STOPP-START and EU(7)-PIM(1)⁴⁶; Beers, ACOVE, BEDNURS (1)⁵⁶; STOP (1)⁴⁵; START-STOPP (3)^{38,41,48}; EU(7)-PIM(2)^{43,55}; EU(7)PIM, FORTA, PRISCUS (1)⁴². Two studies⁵¹⁻⁵² did not mention pre-existing PIM criteria.

The tools described in this review, which have an intervention rather than a consultation nature, are based on two main lines of action: generation of Computerized Alerts (CA) or provision of reports to support clinical decisions. Most of the tools listed (9)^{39-40,45,49,51,53-54,56-57} work in this first line, generating CA and, therefore, evidencing the presence of PIM in therapies for the elderly. The second line is used by eight studies^{38,41,43-44,47,50,52,55}, generating reports with the presence of PIM or the recommendation to include certain drugs in the therapy, and allowing a comprehensive review of the case.

Three publications do not fit into the generation of CA or reports, namely: building a database⁴², building a repository⁴⁶ and testing the applicability of an PIM algorithm to a database⁴⁸.

In some cases, these technological tools are addressed to specific groups or professionals, such as: physicians (3)^{38,41,43}; assistant physicians in nursing homes (1)⁵⁶; physicians and patients (3)^{42,47,54}; medical residents in training (3)⁵²⁻⁵⁴; doctors and pharmacists (4)^{40,49,53,57}. Of the 20 publications, six are not directed by the authors to any specific group^{39,45-46,48,50-51}.

Three publications^{41,44,55} present the tools and projections for when they are applied, but do not represent studies applying them and, therefore, do not address the results achieved.

Chart 2. Articles considered on New Technological Tools on MPI from 2010 to 2019. Uberaba, 2021.

References	Language /Country	Type of Study	Objective	Proposal	Level of Evidence
01 - 'Optimising Pharmacotherapy In the multimorbid elderly in primary CARE' (OPTICA) to improve medication appropriateness: study protocol of a cluster randomised controlled trial. Jungo KT, et al. - 2019 ³⁸	en/CHE	Clustered ECR	Test whether the use of a systematic software-assisted drug review intervention leads to more appropriate drug use than a sham usual care intervention	Systematized review of multimorbid and polypharmacy therapy for elderly patients supported by the 'Systematic Tool to Reduce Inappropriate Prescribing'-Assistant' (STRIPA) software and underutilization assessment, involving 40 primary care units. This type of software-based review has been shown to improve decision making about appropriate therapy in multimorbid patients.	II
02 - Utilization of computerized clinical decision support for potentially inappropriate medications. Alagiakrishnan K, et al. - 2019 ³⁹	en/CAN	Retrospective methodological/observational study	To assess the frequency of clinical interaction of medical record computerized alerts (CA) and associated prescribing behaviors in outpatient settings.	Study in two outpatient clinics for an observation period of 30 months. The performance of CA was 17.2% in both clinics, not showing clinical significance in the detection of PIM (Beers). The authors point to the phenomenon of 'alert fatigue' as the cause of the lack of clinical impact of these tools. The potential for low-cost impact points to the relevance of further studies	VI
03 - A pharmacist-physician intervention model using a computerized alert system to reduce high-risk medication use in primary care.	en/CAN	Intervention Study	To assess the applicability of an interdisciplinary pharmacist-physician intervention model to reduce the use of high-risk drugs and the clinical relevance of CA.	Knowledge translation strategy, implemented by a family health team including a medical-pharmaceutical intervention model based on CA. One or more alerts were clinically significant for 42% of patients. This intervention proved to be efficient in reducing the use of high-risk drugs in hospitalized elderly patients.	VI

Cossette B, et al. – 2019 ⁴⁰					
04 - The effect of SENATOR (Software ENgine for the Assessment and optimisation of drug and non-drug Therapy in Older persons) on incident adverse drug reactions (ADRs) in an older hospital cohort - Trial Protocol. Lavan AH, et al. – 2019 ⁴¹	en/IRL	RCT (multinational, pragmatic, parallel-arm, prospective, open, blind endpoint)	To evaluate the effect of the Software ENgine for the Assessment and optimization of drug and non-drug Therapy in Older persons (SENATOR) in adverse drug reactions (ADRs) in elderly, multimorbid and hospitalized patients	Software evaluation that produces reports that optimize prescriptions for elderly patients, highlighting drug-drug and drug-disease interactions and providing non-pharmacological recommendations aimed at reducing the risk of incident delirium. This is the first clinical trial to examine the effectiveness of a software intervention on ADR incidents and associated health care costs during hospitalization in older adults with multimorbidity and polypharmacy. This publication presents the study's projections, but does not disclose results yet.	II
05 - Data-Driven Assessment of Potentially Inappropriate Medication in the Elderly. Friedrichs M, et al. – 2018 ⁴²	en/DEU	Methodological Study	Develop database on PIM (PIMBase)	Development tool that integrates well-known PIM lists and unifies their rating scales. The benefits of this combination of lists are supported by pharmacovigilance data. PIMBase allows identification of PIM and is based on the address: https://pimbase.kalis-amts.de .	VII
06 - Reduction of inappropriate medication in older populations by electronic decision support (the PRIMA-eDS study): a qualitative study of practical implementation	en/DEU	Validation/Qualitative Study	Explore the use of the 'Polypharmacy in chronic diseases-Reduction of Inappropriate Medication and Adverse drug events in older populations' (PRIMA) tool for	Conducting interviews with 21 physicians using the PRIMA-eDS tool. This tool seeks to reduce the use of PIM in elderly patients with polypharmacy. After entering prescription-relevant patient data into an electronic case report form, the physician receives a comprehensive medication review with recommendations on missing indications, laboratory tests needed, evidence base of current medication, dose adjustments for dysfunction impairment, potentially harmful drug interactions, contraindications, and possible adverse drug events. The present qualitative validation concludes that the use of this tool in the future is unfeasible due to the delay in entering patient data in the form.	VI

in primary care. Rieckert A, et al. – 2018 ⁴³			evidence-based electronic decision support (eDS), analyzing attitudes and perceptions physicians, to optimize the tool and prepare it for future implementation.		
07 - A Cloud Based Potentially Inappropriate Medication Management System Using Patient Owned Personal Health Records. Lee HÁ, et al. – 2018 ⁴⁴	en/TWN	Methodological Study	Design a cloud-based personal health management platform (“My Health Bank”).	Development of a platform that allows the analysis and storage of information in two databases, one for the health insurance medication table and the other for the PIM. The authors believe that this tool will increase medication safety and improve the self-reliance management of the elderly. This publication presents the study's projections, but does not disclose results yet.	VI
08 - Polimedication: applicability of a computer tool to reduce polypharmacy in nursing homes. García-Caballero TM, et al. – 2018 ⁴⁵	en/ESP	Methodological Study / Observational Retrospective	Assess the effect of therapeutic alerts on PIM detection	Processing of medical prescriptions from 115 institutionalized elderly people in a nursing home to assess the generation of therapeutic alerts about PIM in order to minimize analysis time. Of the total number of alerts (average: 10.04 alerts/patient), 12.12% were considered relevant, with a time spent of 6.26min/patient and savings of €32.77 per resident/year on medications. The use of this tool provided significant savings in pharmaceutical expenses, in addition to reducing medication review time.	VI
09 - European repository of explicit criteria of potentially inappropriate medications in old age. Ivanova I, et al. – 2018 ⁴⁶	en/BEL	Methodological Study	Build a European repository of explicit PIM criteria suitable for electronic assessment	Construction of a repository contemplating the description of the PIM, drug information, clinical information and the level of evidence. It was possible to insert most of the original criteria from three selected PIM lists in the repository. The authors hope that in the future, developers of new PIM lists will take semantic interoperability into account and consider the suitability of the criteria for electronic use.	VI

10 - Effect of the Tool to Reduce Inappropriate Medications on Medication Communication and Deprescribing. Fried TR, et al. - 2017 ⁴⁷	en/USA	RCT	To examine the effects of the Tool to Reduce Inappropriate Medication (TRIM) in reducing PIM use and shared decision making.	Evaluation of a web tool that connects an electronic medical record to a clinical decision support system, with an emphasis on communication and medication prescription. These automated algorithms identify discrepancies in medication reconciliation, PIM, and potentially inappropriate regimens. The authors point out that the association of this tool with electronic medical records improved shared decision-making and reduced medication reconciliation errors, but did not change the prescription.	II
11 - Application of the STOPP/START criteria to a medical record database. Nauta KJ, et al. - 2017 ⁴⁸	en/NLD	Intervention Study	Test computer algorithms to apply PIM criteria to a medical records database.	Application of computer algorithms based on the STOPP/START criteria and defined by the Anatomical-Therapeutic-Chemical codes, to a Dutch primary care database, with patients aged ≥ 65 years using ≥ 5 chronic drugs and coded diagnoses International Classification Codes for Primary Care (ICPC). In total, 65% of the criteria could be converted into a computer algorithm. The inapplicability of the other criteria resulted from the lack of information on the severity of a condition and the insufficient coverage of ICPC codes.	VI
12 - Reduction in targeted potentially inappropriate medication use in elderly inpatients: a pragmatic randomized controlled trial. Cossette B, et al. - 2017 ⁴⁹	en/CAN	RCT	To assess change in MPI use with an AC-based pharmacist-physician intervention model compared to usual clinical care.	Single-site RCT through CA based on two PIM criteria. The primary endpoint was cessation of PIM or dose reduction. A significantly higher number (absolute difference of 30% 48h after use of alerts) of interruption and reduction of PIM dosage was observed in the intervention group.	II
13 - Quality of Provider Practices for Older Adults in the Emergency Department (EQUIPPED).	en/USA	Intervention Study	Assess the effectiveness and sustainability of the Enhancing Quality of Provider Practices for Older Adults in the Emergency	Educational intervention (didactic lectures) and clinical decision support (with PIM criteria) based on informatics, with drug order sets embedded in electronic medical records, dose adjustments for renal failure, PIM prescribing guidance and links to content synthesized geriatric. The proportion of PIM use dropped from 11.9% to 5.1% (pre and post intervention). The authors classified the intervention as sustainable and stated that a multicomponent program has an influence	VII

Stevens M, et al. – 2017 ⁵⁰			Department initiative (EQUIPPED) to reduce MPI usage	on the generation of safer prescriptions for elderly people who are discharged from the emergency room.	
14 - Evaluating the Impact of Medication Safety Alerts on Prescribing of Potentially Inappropriate Medications for Older Veterans in an Ambulatory Care Setting. Vanderman AJ, et al. – 2017 ⁵¹	en/USA	Intervention Study	Assess changes in PIM prescribing in pre-implementation and post-implementation of CA.	AC-based intervention to reduce PIM prescription, with 1539 pre-alert patients and 1490 post-alert patients; 1952 and 1897 PIM prescribed, respectively. There was no significant difference in the rate of new pre-alert and post-alert PIMs overall, but there was a significant reduction in the rate of the 10 most common newly prescribed PIMs, from 9.0% to 8.3% (P = 0.016). The study concludes that CA use may decrease the incidence of more frequently prescribed PIM in older adults who receive care in an outpatient setting.	VI
15 - PIM-Check: development of an international prescription-screening checklist designed by a Delphi method for internal medicine patients. Desnoyer A, et al. – 2017 ⁵²	en/CHE	Validation by Delphi Method	Develop an electronic prescription screening checklist	Development of an electronic tool, based on literature review, semi-structured interviews and consensus by 40 physicians and 25 clinical pharmacists. The final checklist includes 160 statements; 17 medical domains; 56 pathologies; algorithm of approximately 31,000 lines was developed. PIM-Check is the first electronic prescription screening checklist designed to detect PIM in internal medicine.	VII
16 - Knowledge Translation Strategy to Reduce the Use of Potentially Inappropriate Medications in Hospitalized Elderly Adults.	en/CAN	Intervention Study	To evaluate the effect of a knowledge translation (kt) strategy to reduce PIM use in hospitalized elderly.	Intervention based on the distribution of educational materials, presentations by geriatricians, medical-pharmaceutical interventions by CA and comprehensive geriatric assessments. A 3.5% (P<0.001) absolute decrease in patient-days with at least one PIM was observed immediately after the intervention. The authors point out that this strategy resulted in a decrease in the use of PIM in elderly adults in the hospital.	VII

Cossette B, et al. – 2016 ⁵³					
17 - Physicians' use of computerized clinical decision supports to improve medication management in the elderly - the Seniors Medication Alert and Review Technology intervention. Alagiakrishnan K, et al. – 2016 ⁵⁴	en/CAN	Intervention Study	Create an AC of physician-acceptable medications and deploy them into an outpatient Electronic Medical Record (EMR); and figure out how to deploy this tool with the least disruption to the workflow and the most attention from the clinician.	Pre-production, development and post-production optimization of an electronic medical clinical decision support tool embedded in electronic medical records (with criteria on PIM) and Cockcroft-Gault formula to estimate glomerular filtration rates (GFR). The "Seniors Medication Alert and Review Technologies" (SMART) intervention generates chart messages and order entry alerts, exposing MPI, decreased GFR, and the possible need for medication adjustments. About 36% of eligible cases triggered at least one SMART alert, with a GFR alert, with ~25% of alerts ignored and ~15% generating evidence verification. This tool has proven acceptable to specialist and primary care physicians, with no significant negative impacts on workflow.	VII
18 - Polypharmacy in chronic diseases-Reduction of Inappropriate Medication and Adverse drug events in older populations by electronic Decision Support (PRIMA-eDS): study protocol for a randomized controlled trial. Sönnichsen A, et al. – 2016 ⁵⁵	en/DEU	Methodological study/RCT	Develop the PRIMA-eDS tool to help clinicians reduce inappropriate prescribing and test its effectiveness in a large-scale RCT.	Construction and effectiveness testing of the PRIMA-eDS tool that comprises an indication check and recommendations for polypharmacy and PIM reduction based on systematic reviews and guidelines on PIM, SFINX interactions database, PHARAO database on adverse effects and RENBASE database on renal dosage. The tool was built, and the RCT designed (3500 patients and 325 general practitioners involved). The main hypothesis is that reduced polypharmacy and inappropriate prescribing can reduce hospitalizations or deaths. This publication presents the study's projections, but does not disclose results yet.	II
19 - Quality of prescribing in Belgian nursing	en/BEL	Methodological/cross-sectional	Develop a computerized assessment tool to	Development of an electronic tool for the detection of PIM use and underused medications by elderly residents in nursing homes by combining three PIM criteria and a list of drug interactions. Most PIMs	VI

homes: an electronic assessment of the medication chart. Elsevier MM, et al. – 2014 ⁵⁶		observational study	monitor the quality of prescribing in Belgian nursing homes.	were detected by the ACOVE criteria for underutilization with 58% of patients having at least one PIM. Using the BEDNURS and Beers criteria, at least one PIM was observed in 56% and 27% of patients, respectively. The study concludes that the development of a combined assessment tool and the implementation of a computerized PIM monitoring system is highly recommended to improve care in nursing homes.	
20 - Electronic surveillance and pharmacist intervention for vulnerable older inpatients on high-risk medication regimens. Peterson JF, et al. – 2014 ⁵⁷	en/USA	Intervention study (pilot)	Develop and evaluate an electronic tool to assist clinical pharmacists in reviewing PIM in hospitalized older adults	Development and application of computerized panel on PIM. There was signaling of subjects with at least one administered PIM or a high calculated anticholinergic score. The panel also displayed the cumulative administration of narcotics and benzodiazepines over 48 hours. Intervention applied to elderly people (≥65 years) admitted to general medicine, orthopedics and urology services for 3 weeks in 2011. After the intervention, 22% of patients had signs of using at least one PIM and physicians approved 78% of the recommendations subsequent pharmaceuticals. This tool allowed clinical pharmacists to quickly review the medication regimens of hospitalized older adults and provide a timely point-of-care intervention when indicated.	VII

DISCUSSION

The use of medicines by the elderly is increasingly attracting the interest of scientific investigations, which is easy to understand – one of the main therapeutic resources today and the age group with the highest growth rate. In turn, there is irrational use, with consequent risks. This scenario shows the need for more information and more tools to be made available, in order for the elderly to benefit from their drug therapies with the highest possible level of safety.

The search for updating through a comprehensive analysis of scientific publications is shown to be one of the most acceptable and promising ways, allowing to know successful initiatives that can be reproduced, and others that are not so successful, but which, even so, become data and point out what not to do.

The classification of findings into two thematic categories allowed a clearer analysis of two important aspects on the PIM theme; the first, presenting the state of the art regarding the new lists of drugs that pose risks to the elderly, in addition to adaptations for local contexts, for subgroups or for specific clinical conditions. The second category presents scientific efforts for new tools to reach the field of practice, promoting the integration of health care for the elderly, safe drug therapy and ways to educate professionals and patients.

There were efforts by several countries to develop or adapt PIM criteria for their contexts. One of the reasons for these local initiatives is that many drugs on important international lists may be unavailable in certain countries. This scenario was observed in Brazil, where only 60% of the drugs mentioned in the Beers criterion are marketed in the country, based on the National List of Essential Medicines (2013), creating a bias in the results of several Brazilian studies⁵⁸.

In addition to the search for specific lists for the elderly in each country or region, the elaboration of a list for subgroups was observed. This is the case of the Norwegian list NORGEP NH31, adapted from the national list (NORGEP²⁰) on PIM, and aimed at institutionalized elderly people. This initiative was motivated after a Norwegian study pointed out the high prevalence of PIM use (31% of the analyzed population) in nursing homes⁵⁹. A similar adaptation involved the START-STOPP criteria for institutionalized North American elderly people²⁶, which explains the existence of subgroups within special age groups, such as the elderly.

In the relevance of special subgroups contained in the large group of elderly, three other subgroups should be highlighted: elderly in palliative care²¹, elderly with HF³³ and elderly with renal failure²⁴. The elaboration of lists on specific PIM such as these demonstrate the scope of

the theme and the need for continuous innovations so that various developments can be studied.

As for studies that showed clinical convergence, two publications^{22,25} agreed to discontinue anticoagulants in elderly people with limited life expectancy, as the risk of bleeding and the cost of treatment outweighed the potential benefits for patients, but recommended the analysis of specific cases, as the risk of stroke.

One of the publications³⁰ addresses the relevance of geriatric nursing care in patients with 'behavioral problems', avoiding the use of antipsychotics, except in cases of inefficiency of non-pharmacological measures, or risks to the patient or others. Although nursing has a fundamental role in the provision of care and in detecting the use of PIM, only one study³³, aimed at the elderly with HF, had specialized nurses in the composition of its panel of experts, which signals the need for greater appreciation of the inter and transdisciplinary work.

Regarding Category 2, in general terms, all the technological tools listed aim at some aspect related to the use or detection of PIM in the elderly, characterized as individuals aged ≥ 65 years. Only one study³² addressed an age group transitioning to senescence, that of middle-aged individuals (defined as age between 45 and 64 years), indicating the existence of evidence⁶⁰ that multimorbidity is also prevalent in this group, but so far, studies related to PIM have been little considered for these individuals.

In this category, there was a case of cumulative scientific contribution related to the PRIMA-eDS tool, aimed at reducing PIM prescriptions. The first publication⁵⁵ presents the construction of this tool and designs an ECR; the second publication⁴³ is a qualitative study on the attitudes and perceptions of assistant physicians who used the tool in their clinical practices. Although the tool is considered capable of generating clinical reports and recommendations of great scope and quality, the qualitative validation this study showed that the physicians interviewed found it unfeasible to apply the tool in question in their practices, due to the delay in entering patient data in the form⁴³.

Cumulative contributions such as this one reinforce the importance of new investigative findings in the construction of knowledge and overcoming gaps and, although a tool can be discarded after the judgment of practical infeasibility, a lot of knowledge is generated by its development and tests, contributing to future successes.

The analysis of the technological tools of this review reveals another important data; although there are at least three professional groups that work directly with drug therapies in clinical practice, only two of these groups had tools aimed at the best performance of their

work: physicians, including medical residents, and pharmacists, with no mention of nurses in any of the publications.

The construction of tools that signal the risks of drug therapy for the elderly also for nurses can represent a big step towards greater safety and rational use of medicines in this public. Analyzing the profile and purpose, it is evident, as in the case of the STRIPA³⁸, SENATOR⁴¹, PRIMA-eDS⁴³ and TRIM⁴⁷ tools, an important power of detection and decision support for physicians and pharmacists about PIM prescription. However, none of these tools was able to reach the role of nursing in the reception of elderly patients, aiming at the detection of PIM in the first stage of the care itinerary.

It is worth noting the insignificant participation of Latin American countries in international publications on the PIM theme, with emphasis on Brazil, with only one study found focused on Category 1. This finding is consistent with the report Science and Engineering Indicators 2020⁶¹, by the National Science Foundation (USA), and presented by Pesquisa FAPESP magazine, which shows that Brazil, despite having advanced six positions between 2000 and 2018, occupies the 11th position in the ranking of countries that produce the most international scientific publications, in a list led by China, followed by the USA and India.

This review highlights the importance of continually drawing up new lists on PIM, ensuring compatibility with specific contexts and the availability of medications in each location, in addition to showing that the technological tools applied to the safety of medication use in the elderly can be improved, with emphasis on usability and inclusion of a larger audience of users, including nurses.

Two possible knowledge gaps were also found; the first one is the lack of a list on PIM applied to obese elderly people, justified by the possibility of body deposits of certain active principles, it is worth noting that aging, analyzed separately, causes a reduction of 20 to 30% in muscle mass (sarcopenia) and bone mass (osteopenia/osteoporosis)⁶², and a 20 to 30% increase in total body fat (2 to 5%/decade, after age 40)⁶³.

The second gap refers to technological tools that allow the outpatient evaluation of signs and symptoms in elderly patients, and that establish a possible causal relationship with the use of PIM. A tool of this nature can contribute to quick assessments in medical, nursing and pharmaceutical consultations in Primary Health Care, minimizing aggravations resulting from the non-detection of PIM use.

CONCLUSION

This study identified that there is an important national and international movement focused on the elaboration and adaptation of lists on PIM applied to specific countries, populations and subgroups. New technological tools for detecting and evaluating PIM follow a trend of development and improvement, and make evident the need for these efforts to continue.

This review also identified initiatives to expand access to PIM information, such as building large databases and repository with simplified access for professionals and patients.

The sum of these initiatives builds, gradually and cumulatively, a scenario of greater safety for the elderly in their drug therapies, whether in primary health care environments or hospitals with greater technological density, in addition to adding important educational value by allowing, in many cases, the possibility of updating for future health professionals.

As limitations, there was the non-use of databases such as the Web of Science and CINAHL, the latter specific to nursing, and the non-inclusion of languages other than Portuguese, English and Spanish. In turn, the present study brings evidence and new contributions on the PIM theme, through the analysis of publications with varied methodological designs, in addition to covering works published around the world.

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Rodrigo Rodrigues Silva contributed to the design, collection and analysis of data, writing and revision. **Luan Augusto Alves Garcia** collaborated in the writing and revision. **Ana Luisa Zanardo Buso, Daiane Silva Marques** and **Fabiana Fernandes Silva de Paula** acted in the revision. **Álvaro da Silva Santos** supported the design, writing and revision.

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