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ORIGINAL REPORT

Application of the STOPP/START criteria to a medical record database

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Abstract

Purpose: The STOPP/START criteria are increasingly used to assess prescribing quality in elderly patients at practice level. Our aim was to test computerized algorithms for applying these criteria to a medical record database.

Methods: STOPP/START criteria-based computerized algorithms were defined using Anatomical-Therapeutic-Chemical (ATC) codes for medication and International Classification of Primary Care (ICPC) codes for diagnoses. The algorithms were applied to a Dutch primary care database, including patients aged ≥65 years using ≥5 chronic drugs. We tested for associations with patient characteristics that have previously shown a relationship with the original STOPP/START criteria, using multivariate logistic regression models.

Results: Included were 1187 patients with a median age of 75 years. In total, 39 of the 62 STOPP and 18 of the 26 START criteria could be converted to a computerized algorithm. The main reasons for inapplicability were lack of information on the severity of a condition and insufficient covering of ICPC-codes. We confirmed a positive association between the occurrence of both the STOPP and the START criteria and the number of chronic drugs (adjusted OR ranging from 1.37, 95% CI 1.04-1.82 to 3.19, 95% CI 2.33-4.36) as well as the patient's age (adjusted OR for STOPP 1.30, 95% CI 1.01-1.67; for START 1.73, 95% CI 1.35-2.21), and also between female gender and the occurrence of STOPP criteria (adjusted OR 1.41, 95% CI 1.09-1.82).

Conclusion: Sixty-five percent of the STOPP/START criteria could be applied with computerized algorithms to a medical record database with ATC-coded medication and ICPC-coded diagnoses.

KEYWORDS

aged, algorithms, inappropriate prescribing, pharmacoepidemiology, polypharmacy, potentially inappropriate medication list

1 | INTRODUCTION

High-risk prescribing and drug-related problems are common in elderly patients,[1,2] and are associated with negative health-outcomes and hospital admissions.[3-5] It is therefore important to monitor and optimize drug prescribing in this population.[6] Several screening tools have been developed to identify suboptimal prescribing in the elderly.[7] In 2008, the Screening Tool of Older Persons' Prescriptions (STOPP) and the Screening Tool to Alert doctors to Right Treatment (START) criteria were introduced.[8] These criteria are now widely used to identify potentially inappropriate prescribing (PIP) and potential prescribing omissions (PPO).[9-12] PIP and PPO rates are related to the number of hospital admissions.[13] The PIP rate is also related to the number of adverse drug events.[14]

Various adaptations of the original STOPP/START criteria have been made for different countries and settings.[9] In The Netherlands, the STOPP/START criteria have been incorporated as screening tool in the national guideline on polypharmacy in the elderly.[15] Although developed as a screening tool to identify problems at individual patient level, the criteria are increasingly used to assess prescribing quality at practitioner or practice level. In order to calculate PIP and PPO rates from electronic medical records or administrative databases, the

criteria need further specification. Such specification depends on the type and the level of detail of the information available in the medical record database. Most databases in Europe use the International Classification of Primary Care (ICPC), International Classification of Diseases (ICD9/ICD10) or Read system to code diagnoses,[16] and the Anatomical-Therapeutic-Chemical (ATC) system to classify medication.[17] Previously, the STOPP/START criteria have been specified into ICPC, ICD9, and ATC-codes.[18] For 7 STOPP and 3 START criteria problems were encountered with imperfect or lacking corresponding codes.[18] The potential to apply the criteria to electronic medical record databases, which are now increasingly used for evaluation and feedback purposes in primary care, needs further investigation. In particular, the impact of incomplete information on disease severity or diagnostic measurements requires attention.

The present study aims to test the feasibility of using computerized algorithms to apply the STOPP/START criteria to a primary care database, and to test the construct validity of these algorithms by assessing their association with patient characteristics that have shown a relationship with the original STOPP/START criteria.

KEY POINTS

- Two-thirds of the STOPP/START criteria were converted in algorithms that are applicable to medical record database.
- Lack of codes for disease severity constrains computerized application of several criteria.
- In agreement with the original criteria, the algorithm-based STOPP/START alerts are also associated with high age, female gender, and number of drugs.

2 | METHODS

2.1 | Study population and data

We used the Registration Network Groningen (RNG) primary care database. This is a longitudinal database with anonymous data from medical records on prescriptions and diagnoses from 3 large general practices in the northern part of the Netherlands.[19] Prescription data include start date, expected end date, number of prescribed medication units (total and per day), and ATC-code. Diagnosis data include ICPC-codes for symptoms, conditions and diseases,[20] and a date of recording. Outcomes from laboratory or other clinical measurements were not available.

We applied the algorithms in patients who are commonly screened for medication reviews following the guideline on polypharmacy in the elderly.[15] We thus included patients aged ≥65 years with polypharmacy at the beginning of 2012 and complete follow-up in 2012. Polypharmacy was defined as chronic use (ie, prescribed for ≥90 days) of 5 or more drugs at pharmacological subgroup level (ie, third ATC-level) in 2012. Prescriptions for eye, nose, and ear-drops (ATC-codes S), dermatological medication (ATC-codes D, M02), infections (ATC-codes J, G01A), and vitamins were excluded, because they are often intended for intermittent or non-chronic use. Drugs with invalid ATC-codes were also excluded (5% of prescriptions).

2.2 | STOPP/START criteria-based algorithms

The original criteria have previously been translated and adjusted to fit treatment recommendations of Dutch guidelines.[21] In this process 3 STOPP criteria were converted to START criteria (Appendix A, START GI2, GI3, and O1), and 1 START criterion was added (Appendix A, START CV6). We aimed to create algorithms for the resulting 62 STOPP and 26 START criteria using ATC-codes for medication and ICPC-codes for diagnoses following the coding proposed by de Groot et al.[18] Several criteria required further specification with respect to the time window or duration of the condition or the prescribed medication. For non-chronic conditions, we considered a criterion to be satisfied when a drug was prescribed within 30 days after the condition was recorded. For chronic conditions, including cardiovascular, respiratory, musculoskeletal diseases, and malignancies, no time restriction was applied for medication prescribed within the same year. Criteria specifying a longer duration of a non-chronic condition, for example "chronic constipation", were considered satisfied when a patient had at least 2 episodes or records for that condition exceeding the specified duration (>3 months for "chronic"). The duration of prescriptions was calculated by dividing the total number of prescribed medication units by the number of prescribed units per day, or—when data on units per day were missing—by subtracting the expected end date as provided in the database by the start date. Criteria specifying concurrent use of medication were considered satisfied when the prescriptions overlapped for a period of at least 7 days.

2.3 | Applicability of criteria and validation of algorithms

Before applying the criteria, all prescriptions for fixed drug combinations were split in their separate components. Criteria were rated feasible to apply when valid and reliable data were available in the database.[22] For criteria that could not be applied, deficiencies were recorded. Because there is no gold standard to assess inappropriate prescribing, it was not possible to establish the concurrent validity of our algorithms. Instead, we tested the construct validity by looking at known associations of the criteria with patient-level factors, including high age, female gender, and number of prescribed drugs.[9] We determined whether the occurrence of our criteria was associated with the patients' age (2 categories: 65–75 or ≥75 years), gender, and number of chronic drugs (3 categories: 5–6, 7–8, ≥9 drugs).

2.4 | Statistical analyses

The population characteristics were summarized with descriptive statistics. The STOPP and START criteria were assessed per patient and calculated as proportion of the eligible patients per criterion with 95% confidence intervals. Multivariate logistic regression models were built to assess the association between patient-level characteristics, including age, gender, number of chronic drugs, and the occurrence of the combined STOPP, respectively, START criteria. Odds ratio's

(OR) with a 95% confidence interval (95% CI) are presented. In addition, associations were assessed for the 10 most commonly occurring STOPP criteria with age and gender, adjusted for the number of chronic drugs prescribed.[23] Statistical analyses were performed using SPSS statistics version 20.0.0.2.

3 | RESULTS

One-thirds of the 3341 patients aged 65 years or older were being prescribed at least 5 drugs for chronic use, resulting in 1187 patients who met the inclusion criteria. The median age of these patients was 75 years (range 65-97; 612 patients ≥75 years), and 683 were female (57.4%). The median number of chronic drugs was seven (range 5-17; 369 patients with 7-8 drugs, 270 with ≥9 drugs). Morbidity was high, including 780 (65.7%) patients with a history of coronary, cerebral or peripheral vascular disease, 488 (41.1%) with type 2 diabetes, 218 (18.4%) with osteoporosis, 131 (11.0%) with gout, and 91 (7.7%) with chronic constipation.

3.1 | Applicability of criteria

In total, 39 of the 62 STOPP criteria (63%) and 18 of the 26 START (69%) could be converted to algorithms applicable to the data available in the medical record database (Appendix A). A STOPP algorithm defines the medication that generates an alert for the condition where this medication is potentially unfavorable. For example, when loop diuretics (ie, prescription for ATC codes C03CA or C03CB) are prescribed in patients with ankle oedema (ie, ICPC code K07) without clinical signs of heart failure (ie, ICPC code K77) (STOPP criterion 2, Appendix). A START algorithm defines the condition when certain medication is potentially indicated. It generates an alert when the recommended medication is lacking in patients with this condition. For example, when a bisphosphonate (ie, prescription for ATC codes M05BA or M05BB) is lacking in patients taking maintenance oral corticosteroid therapy (ie, ATC codes H02A or H02B prescribed for >3 months) (START criterion 21, Appendix).

The set of applied algorithms covered 8 of the 10 STOPP domains and 6 of the 7 START domains. Not being able to define the severity of a condition, such as severity of hypertension or asthma/COPD, was the reason that 8 STOPP and 5 START criteria could not be applied. For example, systemic corticosteroids instead of inhaled corticosteroids for maintenance therapy in moderate-severe COPD (STOPP criterion 35, Appendix). In 5 cases, this could have been solved when data on blood pressure or forced expiratory volume would have been available (START criteria 5 and 12, Appendix). Lack of an adequate ICPC or other code was the reason for not being able to apply another 10 STOPP and 2 START criteria. For example, NSAIDS with chronic renal failure (STOPP criterion 39, Appendix). In 5 cases, this could have been solved with laboratory data on blood oxygen, albuminuria, kidney function, or sodium levels (STOPP criteria 1, 27, and 39, START criteria 2 and 13, Appendix). In the other cases, coding was lacking for bleeding disorder, catheter, intact uterus, or prone to falls (STOPP criteria 15, 49, 54 to 58). Lack of information on side effects or contraindications was the reason that 3 STOPP and 1 START criteria could not be applied (STOPP criteria 26, 41, and 42, START criterion 8). Finally, the classification and information about medication were not sufficient to calculate 2 STOPP criteria (STOPP criteria 32 and 62, Appendix A). Domains no longer included for the STOPP criteria concerned the long-term use of opiates (2 criteria) and the use of duplicate drugs (1 criterion). For the START criteria, the respiratory system (3 criteria) could not be covered.

The 39 STOPP criteria generated at least 1 alert in 33.8% of the patients, whereas the 18 START criteria generated at least 1 alert in 65.9% of patients. The top 10 of most common STOPP and START criteria were related to the cardiovascular system, central nervous system, and endocrine system (Table 1).

3.2 | Construct validity

A higher number of drugs prescribed for chronic use was associated with the occurrence of both STOPP and START criteria in the multivariate logistic regression model (Table 2). The association was stronger for patients with STOPP alerts compared with patients with START alerts. Higher age was also associated with the occurrence of both STOPP criteria (OR 1.30; 95% CI 1.01-1.67) and START criteria (OR 1.73; 95% CI 1.35-2.21). Female gender was associated with the occurrence of STOPP criteria (OR 1.41; 95% 1.09-1.82). The STOPP criteria for NSAIDs with heart failure and for psychotropic drugs were more likely to occur in females (Table 2). This NSAID STOPP criterion was also more likely to occur in patients over 75 years of age, as was the STOPP criterion for unwanted loop diuretics. Other STOPP criteria showed no significant associations with gender or age (Table 2).

4 | DISCUSSION

Around two-thirds of the original list of STOPP (63%) and START (69%) criteria were converted to algorithms that could be applied to a medical record database. The main reasons for inapplicability were lack of information about the severity of a condition and insufficient covering of ICPC-codes. We confirmed a positive association between the number of prescribed drugs as well as the patient's age and the occurrence of both STOPP and START criteria, and between female gender and the occurrence of STOPP criteria.

4.1 | Comparison with existing literature

The percentages of applicable criteria in our study were higher than the 40% STOPP criteria and 45% START criteria reported in a study by Galvin et al, who made use of a dataset with information on medication and diagnoses.[24] Their lower application rates were mainly caused by lack of information on treatment duration.[24] The percentage of applicable STOPP criteria in our study was also higher than the percentage of 46% reported by Cahir et al, who used a prescription claims database.[4] By linking these claims data to medical records, the percentage of applicable STOPP criteria increased to 77%.[14] Similar to our study, criteria were excluded in these previous studies because of insufficient information on the severity of diseases. In 10 out of 25 cases in our study, this problem could have been addressed by using

TABLE 1 Top 10 of most common STOPP and START criteria in primary care patients aged ≥65 years with polypharmacy

Description	Number of patients with criterion	Percentage of population (*n* = 1187)
STOPP criteria[a]		
Acetylsalicylic acid or carbasalate calcium without coronary, cerebral, or peripheral vascular disease [CV10]	60	5.0
Dipyridamole as monotherapy for secondary prevention [CV12]	57	4.8
NSAIDs with heart failure [M2]	43	3.6
Thiazide diuretic with gout [CV4]	40	3.4
Long-term use of long-acting benzodiazepines [CN7]	39	3.3
Loop diuretic for ankle oedema without clinical signs of heart failure [CV2]	38	3.2
Tricyclic antidepressants with opiate or calcium channel blocker [CN6]	35	2.9
Long-term use of neuroleptics [CN9]	27	2.3
Classical antihistamines use >1 week [CN13]	25	2.1
Calcium channel blockers with chronic constipation [CV8]	22	1.9
START criteria[a]		
Statin therapy with coronary, cerebral, or peripheral vascular disease [CV4]	207	17.4
Laxatives with use of opiates [O1]	183	15.4
Metformin with type 2 diabetes [E1]	163	13.7
Acetylsalicylic acid or carbasalate calcium and/or clopidogrel with coronary, cerebral, or peripheral vascular disease [CV9]	162	13.6
Beta blocker with chronic stable angina, myocardial infarction, or chronic heart failure [CV7]	150	12.6
Statin with diabetes [E3]	106	8.9
Antiplatelet agent with diabetes and cardiovascular disease [E2]	93	7.8
Calcium and vitamin D with known osteoporosis [M3]	86	7.2
Angiotensin converting enzyme inhibitor or angiotensin II receptor blocker with chronic heart failure [CV1]	61	5.1
Angiotensin converting enzyme inhibitor or angiotensin II receptor blocker with myocardial infarction [CV3]	57	4.8

[a]For specifications, see Appendix A where [codes] refer to the criteria.

TABLE 2 Associations of patient level factors with the occurrence of STOPP and START criteria

	Number of drugs 7–8 and ≥9 vs 5–6 odds ratio (95% CI)	Gender female vs male odds ratio (95% CI)	Age ≥ 75 vs 65–74 years odds ratio (95% CI)
STOPP criteria	2.12[a] (1.58-2.83) 3.19[a] (2.33-4.36)	1.41[a] (1.09-1.82)	1.30[a] (1.01-1.67)
START criteria	1.37[a] (1.04-1.82) 1.66[a] (1.20-2.29)	1.15 (0.90-1.48)	1.73[a] (1.35-2.21)
Individual STOPP criteria		**Gender female** vs **male**	Age **≥ 75** vs **70–74 years**
Acetylsalicylic acid or carbasalate calcium without coronary, cerebral, or peripheral vascular disease [CV10]		1.54 (0.88-2.70)	1.46 (0.85-2.51)
Dipyridamole as monotherapy [CV12]		0.85 (0.50-1.47)	1.50 (0.86-2.61)
Thiazide diuretic with gout [CV4]		0.63 (0.33-1.19)	0.53 (0.28-1.03)
Calcium channel blocker with chronic constipation [CV8]		0.65 (0.28-1.53)	1.85 (0.74-4.63)
Loop diuretics for ankle oedema without clinical signs of heart failure [CV2]		1.87 (0.89-3.91)	2.75[a] (1.28-5.89)
NSAIDs with heart failure [M2]		2.14[a] (1.03-4.42)	2.68[a] (1.30-5.53)
Long-term use of long-acting benzodiazepines [CN7]		3.48[a] (1.52-7.99)	1.19 (0.62-2.30)
Tricyclic antidepressants with opiate or with calcium channel blocker [CN6]		2.13 (0.98-4.64)	0.63 (0.32-1.26)
Long-term use of neuroleptics [CN9]		2.35 (0.93-5.93)	0.92 (0.42-2.01)
Classical antihistamines use >1 week [CN13]		2.27 (0.89-5.79)	1.13 (0.50-2.56)

[a]Significant association in multivariate logistic regression model including age, gender, number of chronic drugs; 95% CI, 95% confidence interval.

clinical measurement or laboratory data, which were not available in our database.

Using the applicable algorithms, we found that STOPP criteria occurred in 34% of the patients and START criteria in 66%. A higher occurrence of START criteria compared with STOPP criteria is in line with previous studies.[24-26] Most common domains for START alerts included medication for cardiovascular diseases and diabetes, similar as observed in a study in Irish primary care.[10] Domains for the most commonly occurring STOPP criteria were diverse and included high-risk medication, such as salicylates, NSAIDs, diuretics, and

psychotropics. Furthermore, in line with previous studies, the occurrence of STOPP criteria concerning long duration of treatment was common.[10,14]

One should realize that the percentages observed using computerized STOPP and START criteria are likely to overestimate the actual number of patients in whom treatment should be stopped or started, because the criteria do not account for individual patient characteristics, such as intolerances. One may question whether some of the START criteria should be restricted on age, because restrictions on life expectancy or frailty are difficult to capture with electronic medical record data. Biased outcomes may also occur due to incomplete or not fully correct or consistent coding of diagnoses.[18] Therefore, results obtained with the algorithms are not intended for summative benchmarking purposes. Instead, they are meant to support health care practitioners and provide feedback on their prescribing.

Because of differences in the number of applicable STOPP/START criteria and differences in study population, one should be cautious when comparing the results of our study with those of other studies. Ryan et al concluded that the application of STOPP/START criteria to medication data without clinical information resulted in an overestimation of PIPs and underestimation of PPOs.[25] In our study, the percentage of patients with at least 1 START alert—indicating PPOs—was much higher than observed in other primary care studies,[24,25] which used limited data sources for diagnoses. The percentage of patients with STOPP alerts—indicating PIPs—was within the range observed in other primary care populations.[4,10,14,23,24,27] The higher likelihood of STOPP and START criteria occurring in older aged patients and using more chronic drugs confirms findings of previous studies.[9] The higher likelihood of STOPP criteria occurring in female patients is also in line with results of previous studies.[9] This confirmation of expected associations supports the construct validity of the STOPP/START algorithms applied in our study.

4.2 | Strengths and limitations

Our study is one of the few that provide detailed specifications to facilitate computerized application of the STOPP/START criteria to datasets that include medication with ATC-codes and diagnoses with ICPC-codes (Appendix A). These coding specifications may require adaptations before applying them in other countries or studies, for example, to include new or country specific criteria. We used the Dutch version of the first STOPP/START criteria. Although a second version of the STOPP/START criteria has been published,[28] this was not incorporated in the national guideline on polypharmacy in the elderly.[15] Our algorithms were based on the consensus panel study of de Groot et al translating the Dutch STOPP/START criteria into explicit measures.[18] We adapted some specifications because the ICPC-1 lower-level codes that they applied for some criteria are not used by all health care practitioners. This lower level is also not included in second edition of the ICPC-codes, which is maintained by the World Organization of Family Doctors International Classification Committee.[29] Our algorithms are therefore delineating the core concepts of the STOPP/START criteria, which can be used as starting point for future studies in other settings. For validation, we included elderly patients with polypharmacy. Further validation may include larger samples as well as comparison with expert chart review.

4.3 | Implications for research and practice

Computerized application of the STOPP/START criteria to electronic medical record data can support routine assessment of prescribing for elderly patients for evaluation and feedback purposes. This study showed that two-thirds of the STOPP/START criteria can be applied by means of algorithms to a medical record database with ATC-coded medication and ICPC-coded diagnoses, covering 8 of the 10 STOPP domains and 6 of the 7 START domains. Particularly, the application of criteria that need differentiation on disease severity, a feature not provided by the ICPC-coding system, was problematic. This problem may in part be addressed by using a database that contains additional information on clinical and laboratory measurements, but for several criteria additional coding on conditions such as "prone to falls" would be needed. At present, one can question whether this can be accurately coded in practice. This implies that some clinically relevant criteria can get lost when using computerized screening tools.

ETHICS STATEMENT

According to the code of conduct for the use of data in health research, no ethics committee approval is needed for research using data from anonymous medical records in the Netherlands.

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CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

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SUPPORTING INFORMATION

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