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RESEARCH PAPER

Improving usability of the STOPP/START version 3 criteria: development of a practice tool for clinicians, students and researchers

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Key summary points

Aim The present study aimed at contributing to STOPP/START.v3 by highlighting the new content of the criteria and by providing clinicians, students and researchers with a user-friendly presentation to facilitate medication review.

Findings More than half of STOPP/START.v3 criteria are new or significantly modified showing important update of this version. To improve the usability of the list, a practice tool (i.e. a single-entry table) is presented.

Message The adoption in clinical practice of the extended list of STOPP/START.v3 criteria could be improved by this user-friendly presentation.

Abstract

Background The STOPP/START criteria are aimed to be used by clinicians to perform medication review to optimize pharmacotherapy in older adults. The STOPP/START.version 3 (SS.v3) published in *European Geriatric Medicine* in 2023 updated and significantly extended the previous version. SS.v3 is more open to criticism for its poor usability in daily clinical practice. The present study aimed at contributing to SS.v3 by highlighting the new content of its criteria and by providing clinicians, students and researchers with a user-friendly presentation to facilitate medication review.

Methods The SS.v3 criteria were reviewed by seven geriatricians and clinical pharmacists with expertise in pharmacotherapy in older adults. The 190 SS.v3 criteria were carefully compared to the 115 SS.v2 criteria in order to identify the new ones and those with clinically significant modifications. A single-entry table was developed for the medications (STOPP.v3) and the medical conditions (START.v3).

Results Among the 133 STOPP.v3 criteria, we identified 54 new (41%) and 25 modified (19%) ones. The 57 START.v3 criteria include 24 new (42%) and 17 modified (30%) ones. The single-entry table is a comprehensive presentation of SSv3 in 3 pages. It is systematically organized and upfront presents the medication for the STOPP criteria and the condition for the START criteria, enhancing its usability.

Conclusion This work highlights many new and modified SS.v3 criteria that clinicians, students and researchers should be aware of. The single-entry table for STOPP medications and START clinical conditions may facilitate medication review for older adults in daily clinical practice.

Keywords Potentially inappropriate medication list · Practice patterns · Medication review · Older people · STOPP/START criteria

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Introduction

The eagerly anticipated STOPP/START (Screening Tool of Older Persons' Prescriptions/Screening Tool to Alert to Right Treatment) version 3 (SS.v3) was developed by European experts in geriatric pharmacotherapy and published in the August 2023 issue of *European Geriatric Medicine*. The article provides a list of 190 explicit criteria to detect potentially inappropriate medications (PIM) and potential prescribing omissions (PPO) in older adults [1].

Several teams from various countries have since commented on the revised version and have critically evaluated its strengths and weaknesses [2–7]. A significant concern pertains to its usability. Firstly, the SS.v3 does not distinguish between the new, the modified and the unchanged criteria, as pointed out by Canadian colleagues [2]. This lack of distinction complicates the transition for users familiar with the previous version, making it challenging to implement the changes introduced in the new version. Secondly, the expanded list of 190 criteria poses a considerable challenge when conducting a medication review for older adults [5, 6]. Lastly, while the system-based approach of the STOPP/START lists is logically sound and beneficial for research, it proves to be less user-friendly in daily clinical practice for the clinician (physician or pharmacist) facing an older adult using a medication belonging to different sections. To find out whether a medication is potentially inappropriate indeed requires examining many sections. This is particularly the case for several frequently prescribed medications in older adults such as benzodiazepines (D8-10, G4 and K1), non-steroidal anti-inflammatory drugs (NSAIDs; B17, B19, C10, E4, H1, H2, H3, H6, H7) and corticosteroids (B19, F5, H4-5, G2) [5]. Given that reliable software applications are not widely accessible to most clinicians and their operationalisation remains challenging [6, 8], navigating through an extensive list of criteria to determine the potential inappropriateness of a medication continues to be a daunting task for clinicians.

Furthermore, the applicability of the tool, which is the extent to which the users can implement a recommendation into practice, based on internal qualities such as clearly defined eligible patients [9, 10], is under scrutiny. Notably, a recent Swedish evaluation indicated a diminishing trend in the applicability of the STOPP/START across observational studies with each successive version [11].

For these reasons, a user-friendly presentation is necessary. Indeed, when developing clinical practice tools such as STOPP/START, the emphasis is frequently placed on the development and validation of content, while the optimization of the design is often overlooked. It's important to note that design characteristics, such as usability, play a crucial role in successful implementation and can also affect the likelihood of non-adoption [12]. The latest American Geriatrics Society Beers criteria® highlight their consideration for the formatting of the recommendation to enhance usability [13]. User-centered design stands as one of the most recognized strategies that can enhance the usability of clinical tools [12].

As geriatricians and clinical pharmacists using STOPP/START criteria since a decade in daily clinical care, academic teaching, and clinical research [8, 14–22] and more recently in the OPERAM trial [23], we intend to contribute to the usability of SSv3 by.

a) Highlighting modifications and additions made in the SS.v3 as compared to version two (v2), and.
b) Developing a more user-friendly presentation to facilitate medication review in clinical practice and teaching. We had already conducted this work for the French version 2 [24], which is widely utilized by a substantial number of clinicians and students in Belgium. Given the significant expansion in the number of criteria, we believed there was an opportunity to carry out similar work and make it available to a larger, English-speaking audience.

Methods

This study is a contribution to the SS.v3 criteria by seven clinicians (three geriatricians and four hospital clinical pharmacists) experts in pharmacotherapy at the Université catholique de Louvain (UCLouvain), Belgium.

Identification of the new and the modified criteria

First, two senior investigators (BB and OD) compared the lists of SS.v3 criteria [1] between the supplementary file 1 (the 190 criteria) and the supplementary file 2 (the 190 criteria and their 472 references). Discrepancies were found for 49 STOPP.v3 criteria, among which 17 with potential impact on the application of the criteria (e.g. A1: « without a clinical indication» instead of "without an evidence-based indication"; C5: removal of « without a clear indication for anticoagulation therapy» at the end of the criterion; C9: « longer than 12 months» instead of longer than 6 months). No discrepancy was observed between files 1 and 2 regarding the START criteria. The research team opted to further proceed with file 1.

Second, the two investigators carefully compared the SS.v3 criteria to the SS.v2 ones in order to identify the new ones and those with clinically significant modifications (i.e. criteria may change the prescribing practice). They independently categorized the 190 SS.v3 criteria from file 1 in three

categories, i.e. the new, the modified and the unchanged criteria. Subdivision of criteria, or addition of examples were considered as unchanged criteria.

Design of a user-friendly version of the criteria as a single-entry table

For user-friendliness, the scattering of a medication in various sections of the STOPP list [1] was solved by classifying the medication of each of the 133 STOPP criteria in its pharmacological class which was placed in its pharmacological section. A medication single-entry table was created, showing the code of each criterion to allow the clinicians to easily identify it and read its full text in the original article [1]. The single entry table gathers all the criteria applicable to each medication into a single row. This means each medication is represented once in the table, and all relevant criteria related to this medication are grouped together. Similarly, to provide a single entry, the medical condition or a concomitant treatment triggering each START criterion was classified under its main system. The START criteria were reordered to begin with the medical condition and then proceed to the medication, reflecting clinical practice where clinicians start from the patient's medical condition to identify potentially prescribing omissions (PPOs). The thirteen STOPP sections (A to M) and twelve START sections (A to L) were ordered by decreasing prevalence of PIMs and PPOs in geriatric patients [14–16, 23, 25, 26].

Results

STOPP.v3 criteria

New, modified and unchanged STOPP criteria

The 133 STOPP.v3 criteria, compared to the 81 STOPP.v2 ones, were categorized into new (n = 54, 41%), modified (n = 25, 19%), and unchanged (n = 54, 41%) ones (Fig. 1a and Appendix 1a).

The 54 new STOPP criteria concern ten of the thirteen sections (Fig. 1a), with a majority (33/54) classified in four sections, namely the cardiovascular, coagulation, central nervous systems and fall-risk inducing drugs. New cardiovascular criteria (section B) include medications frequently prescribed in older adults, such as a beta-blocker as monotherapy for uncomplicated hypertension (B5), medications prolonging the QTc interval in patients with QTc prolongation (B15), a statin for primary cardiovascular prevention in patients ≥ 85 years with frailty and < 3 years of life expectancy (B16), and digoxin as first line treatment for long term (≥ 3 months) ventricular rate control in atrial fibrillation (B21). Of note, B14 and B17-19 (phosphodiesterase type-5 inhibitors, NSAIDS, antipsychotics, and corticosteroids) are not cardiovascular medications. Among the new coagulation STOPP criteria are vitamin K antagonist as first line anticoagulant for atrial fibrillation (C11) and P-glycoprotein (P-gp) drug efflux pump inhibitors making a direct oral anticoagulant (DOAC) potentially inappropriate (C14). Selective Serotonin Reuptake Inhibitor (SSRIs; C12) are included in the coagulation section due to their antiplatelet effect, reminded in D7. Oestrogens (C15) belong to the new criteria but are not coagulation medications. The new central nervous system criteria include a serotonin and norepinephrine reuptake inhibitors (SNRI) when severe hypertension (D3), a SSRI when significant bleeding (D7), a benzodiazepine (D10) and a Z-drug (D11) during ≥ 2 weeks for sleep problems. Six new criteria belong to the fall risk inducing drugs (FRIDs), involving anti-epileptic, first generation antihistamine, opioid, anti-depressant, alpha-blocker, centrally-acting antihypertensive and anticholinergic drugs (K5-12). The renal section presents four new drugs/classes which belong to the endocrine (E7), urogenital (E8) and musculoskeletal (E9-10) systems. The endocrine section now points to sodium/glucose cotransporter 2 (SGLT2) inhibitors when symptomatic hypotension coexists (J4) and to levothyroxine for subclinical hypothyroidism (J9). Potentially inappropriate analgesic medications now include lidocaine patch for chronic osteoarthritis pain (L4) and gabapentinoids for non-neuropathic pain (L5).

The 25 STOPP.v3 criteria with modifications are identified in Appendix 2a (Δ symbols). Importantly, the first criterion (A1) is modified with « clinical indication» replacing « evidence-based indication». On the cardiovascular side, some situations are no longer potentially inappropriate in heart failure, e.g. verapamil/diltiazem in New York Heart Association NYHA III-IV Heart failure with preserved ejection fraction (HFpEF) (B2), a loop diuretic for arterial hypertension with concurrent heart failure (HF, B7) and NSAIDS unless the patient requires loop diuretic therapy (B19). Digoxin is now potentially inappropriate (E1) when at 125 µg/day or more when long-term (> 90 days) in patients with severe renal failure, i.e. estimated glomerular filtration rate (eGFR) < 30 ml/min/1.73 m^2). As far as coagulation is concerned, two significant modifications are related to antiplatelet agents. The maximal dosage of long-term aspirin is reduced from 160 to 100 mg/day (C1). An antiplatelet agent is no longer potentially inappropriate in combination with an anticoagulant agent (C4) in patients with coronary artery disease (stent or > 50% stenosis) and atrial fibrillation. Regarding the central nervous system section, STOPP.v3 presents several modifications about tricyclic antidepressants (D1-2), antipsychotics (D4-5,15,21), and medications having potent anticholinergic effects (D14). In the urogenital section, silodosin is noted as not being potentially inappropriate when orthostatic hypotension is present. (I5). The

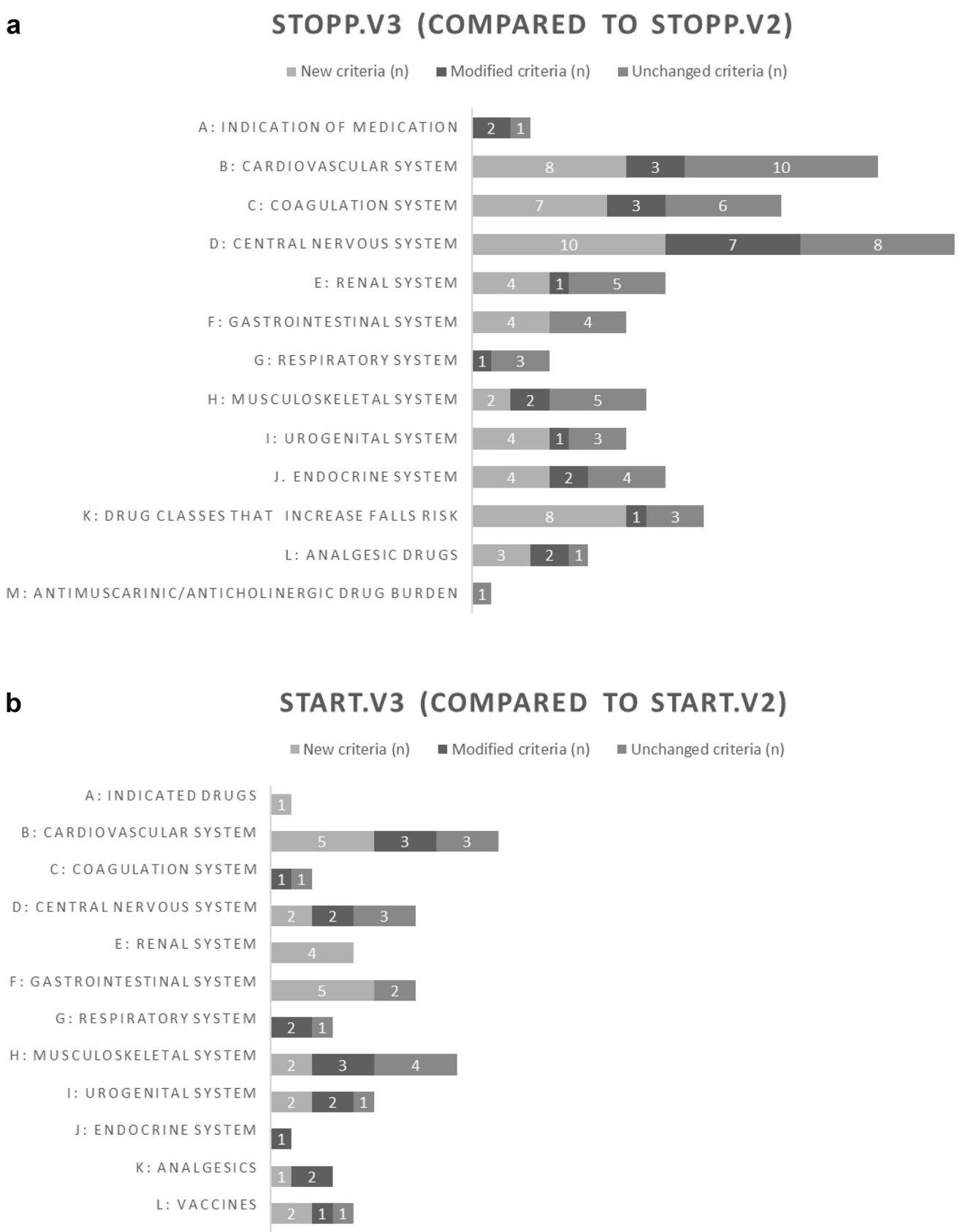

Fig. 1 **a** New (n = 54), modified (n = 54) and unchanged (n = 54) STOPP criteria in SSv3 compared to SSv2. **b** New (n = 24) modified (n = 17) and unchanged START (n = 16) criteria in SSV3 compared to SSv2

modification in the analgesic section extends to moderate the level of break-through pain where long-acting opioid is prescribed in the absence of short-acting opioid (L3). This latter criterion might also belong to the START list. We similarly recommend converting two additional STOPP criteria into START criteria: the STOPP criterion F5 which points corticosteroids with history of peptic ulcer in the absence of proton pump inhibitor (PPI) and the STOPP criterion L2 which refers to opioids without laxatives. The STOPP criterion in version 2 on NSAID with PPI (C2) has logically become a START one in version 3 (F3).

Single-entry STOPP table

The medication single-entry table (Table 1) presents 11 STOPP sections, with central nervous and coagulation PIMs listed first as they are the most prevalent ones in older people. Medications mentioned in several sections of SS.v3 are presented together. Table 1 presents several cases of single-entry medications found in various sections, e.g. benzodiazepine (D8-10; G4; K1), Z-drug (D11; K4), oral anticoagulants (C2; F6) and DOACs (C13-14; E2-3), SSRIs (D6-7; C12; K8), beta-blockers (B3-5; J3), digoxin (B1,4,21; E1) and NSAIDs (B17,19; C10; E4; H1-3,6,7). The medications of the renal section are distributed in the section concerned by their pharmacological action (e.g. digoxin in the cardiovascular system). The STOPP tool presents the 133 STOPP.v3 criteria in 58 single-entry medications in two pages (Table 1).

START.v3 criteria

New, modified and unchanged START criteria

Three new START sections are present, namely sections A (indicated medications), C (coagulation) and E (renal). The STOPP and START system sections (B-J) are now presented in parallel. The 57 START.v3 criteria, when compared to the 34 START.v2 ones, were categorized in three groups, namely the new (n = 24, 42%), modified (n = 17, 30%) and unchanged (n = 16, 28%) criteria (Fig. 1b and Appendix 1b, Fig. 1b). All sections except for the coagulation (which is new but does not contain new criteria), the endocrine and the respiratory ones are concerned by new START criteria.

Most of the new START criteria (14/24) belong to the cardiovascular (B), renal (E) and gastro-intestinal (F) systems. Among the new cardiovascular criteria are three evidence-based medications for heart failure, i.e. spironolactone when eGFR > 30 ml/min (B7), SGLT2 when symptomatic (B8), and sacubitril/valsartan when there is persisting failure in the presence of reduced ejection fraction (B9, with angiotensin-converting-enzyme inhibitors (ACEI) withdrawal). The new coagulation section lists the two main medication classes (which belonged in SS.v2 to the cardiovascular section), i.e. the anticoagulant therapy for atrial fibrillation (C1) and the antiplatelet therapy for atherosclerotic disease (C2). The new renal section lists three cases of PPOs in severe renal failure, i.e. calcitriol, phosphate binder and erythropoietin analogue (E1-3).

The Appendix 2b lists the 17 START.v3 criteria with modifications (Δ symbols). Moderate to severe frailty has now to be taken into account in two START criteria i.e. antihypertensive therapy (initiation or intensification) when systolic blood pressure is above 140 mmHg (B1) and statin therapy for secondary cardiovascular prevention (B2). Regarding the respiratory system, the long-acting bronchodilators, muscarinic antagonists and beta-2 agonists, are now present (G1). The severity of chronic obstructive pulmonary disease and of chronic asthma is introduced (G1 *vs* G2). In the musculoskeletal system, calcium is no longer present in the drug therapy of osteoporosis (H3), except with long-term systemic corticosteroid therapy (H2). A confirmation of vitamin D deficiency is now required in the vitamin D criterion for patients who are housebound, experiencing falls and/or presenting osteopenia (H5). The endocrine section has a single and modified criterion, an ACEI (or Angiotensin II Receptor Blockers if intolerance) when proteinuria is present in a patient with diabetes (J1). This medication however belongs to the cardiovascular system.

Single-entry START table

The ten START sections present musculoskeletal and cardiovascular placed first (Table 2). The START tool presents the 57 START.v3 criteria in 48 single-entry medical conditions in one page.

Discussion

This contribution to the STOPP/START version.3 identifies 78 new criteria as well as 42 criteria with significant modifications (Appendices 1 and 2). It provides the clinicians with a user-friendly tool designed to facilitate medication review in daily practice (Tables 1 and 2).

In the updated SS.v3 [1], the structure of the STOPP sections remains unchanged, while START sections have been expanded. The STOPP and START system sections (B-J) are now presented in parallel. The STOPP/START.v3 lists include numerous new criteria, mainly in medications classes frequently encountered in older patients. The addition of some criteria aligns with recent guidelines updates and significant advancements in clinical practice (e.g. SGLT2 inhibitors, the distinction between heart failure with

Table 1 Single-entry STOPP.v3 criteria

	STOPP.v3 medication	Potentially Inappropriate Medication (PIM) : consider deprescribing	code
ANY	No clinical indication		A1
	Beyond recommended duration	in any circumstances	A2
	Duplicate class		A3
CENTRAL NERVOUS SYSTEM	Benzodiazepine	for any reason > 4 weeks	D8
		for insomnia > 2 weeks	D10
		for agitation (dementia)	D9
		with respiratory failure (pO_2<8.0 kPa ± pCO_2>6.5 kPa ; pO_2<60 mmHg ± pCO_2>49 mmHg	G4
		with recurrent falls	K1
	Hypnotic Z-drug	for insomnia > 2 weeks	D11
		with recurrent falls	K4
	Antipsychotic	with coronary, cerebral or peripheral vascular disease, long term use	B18
		with prostatism / urinary retention, if moderated-marked anticholinergic effect*	D4
		with parkinsonism or Lewy body dementia (except quetiapine or clozapine)	D12
		with dysphagia	F7
		with recurrent falls	K2
		for BPSD > 12 weeks, unless severe	D15
		for BPSD > 3 months at unchanged dose without medication review	D5
		for sleep disorder (unless due to psychosis or BPSD)	D16
	Phenothiazine	for psychosis or dementia, first line	D21
	Anticholinergic drug	for extrapyramidal side effects of antipsychotics	D13
	Antidepressant	with falls	K8
	Tricyclic antidepressant	with dementia, narrow angle glaucoma, cardiac conduction abnormalities, prostatism, constipation, recent falls, orthostatic hypotension	D1
		for major depression, in first-line	D2
	SSRI	with Na^+ < 130 mmol/l, current or recent	D6
		with significant bleeding, current or recent	D7
		with OAC and history of major bleeding	C12
	SNRI (venlafaxine, duloxetine)	with severe hypertension (> 180 / 105 mmHg)	D3
	Acetylcholinesterase inhibitor	with bradycardia (< 60bpm), heart block, unexplained syncopes	D17
		with drug reducing heart rate (β-blocker, diltiazem, verapamil, digoxin)	D18
	Memantine	with seizure disorder	D19
	Nootropic†	for dementia	D20
	Anti-epileptic drug	with recurrent falls	K5
	Levodopa / dopamine agonist	for benign essential tremor	D22
		for extrapyramidal side effects of antipsychotics	D23
	Anti-histamine 1st generation	for allergy/pruritus	D24
		for insomnia	D25
		with recurrent falls	K6
COAGULATION	Antiplatelet	with bleeding risk (uncontrolled severe hypertension, bleeding diathesis, recent bleeding, GAVE)	C2, F6
		with OAC in AF, unless concurrent stent in the previous 12 months or > 50% coronary stenosis	C4
		with OAC in stable atherosclerotic disease (coronary, cerebral, peripheral)	C5
		instead of OAC for stroke prevention in AF	C7
	Aspirin	> 100 mg per day, long term	C1
		plus clopidogrel for secondary stroke prevention > 4weeks, unless ACS, coronary stent <12months, carotid stenosis	C3
		for primary CV prevention	C16
	Ticlopidine	in any circumstance	C6
	Oral anticoagulant	with bleeding risk (uncontrolled severe hypertension, bleeding diathesis, recent bleeding, GAVE)	C2, F6
		for first DVT > 6 months, if no continuing risk factor	C8
		for first PE > 12 months, if no continuing risk factor	C9
	Vitamin K antagonist	for AF, first line, unless eGFR < 15ml/min, metallic heart valve, mitral stenosis	C11
	DOAC	with P-gp drug efflux pump inhibitor‡	C14
	Dabigatran	with ditiazem / verapamil	C13
		with eGFR < 30 ml/min	E2
	Factor Xa inhibitor§	with eGFR < 15 ml/min	E3
CARDIOVASCULAR	Ventricular rate limiting	with bradycardia (< 50/min), type II heart block, complete heart block	B4
	Digoxin	for HFpEF	B1
		for rate control in AF, 1st line and > 3 months	B21
		≥ 125 µg/day for ≥ 3 months and with eGFR < 30ml/min	E1
	Verapamil / diltiazem	with HfrEF NYHA class III – IV	B2
		with chronic constipation	F3
	β-blocker	with verapamil or diltiazem	B3
		for uncomplicated hypertension, monotherapy	B5
	non-selective	with diabetes mellitus and frequent hypoglycemic episodes	J3
	Amiodarone	for supraventricular tachyarrhythmias, first-line	B6
	QTc prolonging drug**	with long QTc (450 msec in males, 470 msec in females)	B15
	Thiazide diuretic	with K^+< 3,0mmol/L ; Na^+ < 130mmol/L ; corrected Ca^{++} > 2,65mmol/L ; gout	B9
	Loop diuretic	for hypertension, first line, unless concurrent heart failure	B7
		for hypertension with concurrent urinary incontinence	B10
		for dependant ankle oedema (no cardiac, liver, renal failure; no nephrotic syndrome)	B8
	Aldosterone antagonist	with potassium-conserving drug†† and no K^+ monitoring	B13
		with eGFR < 30ml/min	E7
	ACEI or ARB	with K^+ > 5.5mmol/L	B12
	SGLT2 inhibitor	with symptomatic hypotension	J4
	Antihypertensive drug	with severe symptomatic aortic stenosis	B20

Table 1 (continued)

	STOPP.v3 medication	Potentially Inappropriate Medication (PIM) : consider deprescribing	code
	Centrally-active antihypertensive	in any circumstances	B11
		with falls	K11
	Phosphodiesterase type-5 inhibitor	with severe heart failure (sBP < 90mmHg) or concurrent nitrate therapy	B14
	Vasodilator	with falls persistent postural tension drop [sBP ≥ 20 and/or dBP ≥ 10 mmHg]	K3
	α -blocker	with falls, as antihypertensive	K9
	Statin	for primary CV prevention with age ≥ 85 and frailty/life expectancy < 3 years	B16
ENDOCRINE	Metformin	with eGFR < 30 ml/min	E6
	Sulphonylurea	long half-time drug (glibenclamide, glimepiride, …)	J1
	Thiazolidenedione	with heart failure	J2
	SGLT2 inhibitor	with symptomatic hypotension	J4
	Levothyroxin	for subclinical hypothyroidism (normal free T4 and elevated TSH < 10 mU/L)	J9
	Vasopressin analogue	for urinary incontinence / frequency	J10
	Oestrogen, systemic	with history of venous thromboembolism	J6, C15
		with history of breast cancer	J5
		with intact uterus and no progestogen	J8
		with progestin and history of atherosclerotic disease	J7
	Androgen, systemic	with history of venous thromboembolism	C15
GASTRO.	Metoclopramide, prochlorperazine	with parkinsonism	F1
	PPI	full dosage > 8 weeks for uncomplicated peptic œsophagitis or gastric ulcer	F2
	Oral elemental iron	with chronic constipation	F3
		> 200 mg/day (fumarate > 600mg/day, sulphate > 600mg/day, gluconate > 1800 mg/day)	F4
	Aluminium antacid	with chronic constipation	F3
	Megestrol	for appetite increase	F8
MUSCULOSKELETAL	NSAID	with eGFR < 50 ml/min	E4
		with coronary, cerebral or peripheral vascular disease, systemic long-term	B17
		with heart failure requiring loop diuretic therapy	B19
		with severe hypertension (> 170 / 100 mmHg, consistently)	H2
		with OAC or antiplatelet agent without IPP	C10
		for osteoarthritis pain, > 3 months, first-line therapy (paracetamol not tried)	H3
		for osteoarthritis/rheumatism with concurrent corticosteroid	H7
		for gout, > 3 months, where no contraindication to allopurinol / febuxostat	H6
	Non-COX-2	with history of peptic ulcer or GI bleeding, unless PPI ou H2-antagonist	H1
	Bisphosphonate	with eGFR < 30 ml/min	E9
		with upper GI disease (oesophagitis, gastritis, peptic ulcer, bleeding..), oral	H8
	Colchicine	with eGFR < 10 ml/min	E5
		for gout, > 3 months, with no contraindication to allopurinol / febuxostat	H6
	Methotrexate	with eGFR < 30 ml/min	E10
	Corticosteroïd, systemic	with heart failure requiring loop diuretic	B19
		with history of peptic œsophagitis or gastric ulcer disease, unless PPI prescribed	F5
		for rheumatoid arthritis, monotherapy, > 3 months	H4
		for osteoarthritis (other than periodic mono-articular injections)	H5
URO.	Anticholinergic drug	systemic, with several conditions : see section below	I1-4
	Duloxetine	for urge incontinence	I7
	α-1 receptor antagonist (except silodosin)	with orthostatic hypotension or history of syncope	I5
		with falls	K10
	Mirabegron	with labile or severe hypertension	I6
	Antibiotic	for asymptomatic bacteriuria	I8
	Nitrofurantoin	with eGFR < 45 ml/min	E8
RESPI	Theophylline	for COPD, monotherapy	G1
	Corticosteroïd, systemic	for COPD moderate-severe, maintenance therapy (instead of inhaled)	G2
	LAMA	with narrow angle glaucoma or with bladder outflow obstruction	G3
PAIN	Opioid	with falls	K7
		with chronic constipation	F3
	Opioid, long term	for osteoarthritis	H9
	Opioid, strong	for mild pain, 1st line therapy	L1
	Opioid, long acting	for break-through pain (moderate-severe) without short-acting opioid	L3
	Opioid, regular use	without laxative	L2
	Lidocain, patch	for chronic osteoarthritis pain	L4
	Gabapentinoid	for non-neuropathic pain	L5
	Paracetamol > 3 g/day	with poor nutritional status (BMI < 18) or chronic liver disease	L6
ANTICHOL.	Bladder/intestine antispasmodic, antihistamine 1st generation, tricyclic antidepressant, antipsychotic, …	with prostatism / previous urinary retention	D4, I3
		with dementia and/or delirium	D1,D14, I1
		with narrow angle glaucoma	D1, I2
		with constipation	D1, F3, I4
		with falls	D1, K12
	≥ 2 drugs concomitantly		M1

Abbreviations: *ACEI* Angiotensin-converting-enzyme inhibitors, *ACS* Acute coronary syndrome, *AF* Atrial fibrillation, *ARB* Angiotensin II receptor blocker, *BMI* Body mass index, *BP* Blood pressure, *BPSD* Behavioral and psychological symptoms in dementia, *CKD* Chronic kidney disease,, *COPD* Chronic obstructive pulmonary disease, *COX-2* Cyclooxygenase-2, *CV* Cardiovascular, *dBP* diastolic blood pressure, *DMARD* Disease modifying activity rheumatic drug, *IV* Intravenous, *DOAC* Direct oral anticoagulant, *DVT* Deep venous thrombosis, *eGFR* estimated glomerular filtration rate, *GAVE* Gastric antral vascular ectasia, *GI* Gastro-intestinal, *HFpEF* Heart failure with preserved ejection fraction,

Table 1 (continued)

HFrEF Heart failure with reduced ejection fraction, *LABA* Long-acting beta-agonists, *LAMA* Long-acting muscarinic antagonists, *NSAID* Non-steroidal anti-inflammatory drugs, *NYHA* New York Heart Association, *OAC* Oral anticoagulant, *pCO2* partial pressure of carbon dioxide, *pO2* partial pressure of oxygen, *pa02* partial pressure of arterial oxygen, *PE* Pulmonary embolism, *PIM* Potentially inappropriate medication, *P-gp* P-glycoprotein, *PPI* Proton pump inhibitor, *PTH* Parathormone, *QTc* Corrected QT Interval, SaO2 arterial oxygen saturation, *SARS-CoV2* Severe acute respiratory syndrome coronavirus 2, *sBP* systolic blood pressure, *SGLT2* Sodium-glucose cotransporter 2, *SNRI* Serotonin–norepinephrine reuptake inhibitors, *SSRI* Selective Serotonin Reuptake Inhibitor, *T4* Thyroxine, *TSH* Thyroid stimulating hormone, *VKA* Vitamin K antagonist

[a]acepromazine, chlorpromazine, clozapine, flupenthixol, fluphenzine, levomepromazine, olanzapine, pipothiazine, promazine, thioridazine

[b]including Ginkgo Biloba, piracetam, pramiracetam, phenylpiracetam, aniracetam, phosphatidylserine, modafinil, L-theanine, omega-3 fatty acids, panax ginseng, rhodiola, creatine

[c]amiodarone, azithromycin, carvedilol, cyclosporin, dronedarone, itraconazole, ketoconazole (systemic), macrolides, quinine, ranolazine, tamoxifen, ticagrelor, verapamil

[d]rivaroxaban, apixaban, edoxaban

[e]quinolones, macrolides, ondansetron, citalopram (doses > 20 mg/day), escitalopram (doses > 10 mg/day), tricyclic antidepressants, lithium, haloperidol, digoxin, class 1A antiarrhythmics, class III antiarrhythmics, tizanidine, phenothiazines, astemizole, mirabegron

[f]ACEI's, ARB's, amiloride, triamterene

preserved or reduced ejection fraction, vaccination) which is a welcome development. Another notable feature of the version 3 criteria is the inclusion of geriatric syndromes both in STOPP (e.g. frailty, behavioural and psychological symptoms of dementia, delirium, dysphagia) and in START (frailty, functional impairment, chronic constipation) [5]. The clinically important fall-risk inducing drugs (FRIDs) criteria now include eight new medications.

The present work may be useful for experts to evaluate how the new and modified criteria align with recommendations in their country, region, or practice, and to discuss their validity and applicability. The clear identification of new and modified criteria is not only valuable for users of SS.v2 but also for those developing electronic clinical decision system (CDS) tool based on the STOPP/START criteria. The conversion of the list of criteria into a single-entry table is an intermediate step in preparing a CDS. The creation of rules requires identifying components relevant to operationalization [27], and the single-entry table aids in this process. Finally, the CDS results should be presented to users concisely. We believe that grouping the various reasons why a medication is inappropriate on a single screen would be an effective way to alert the prescriber.

We designed a user-friendly version of the criteria, featuring a single entry for each medication (STOPP) and clinical condition (START). Each START criterion is initiated with its corresponding medical condition, not the medication. This approach aligns with the clinical process, which examines medical conditions to identify instances where a medication may have been omitted.

This work aligns with recent efforts to enhance the usability of the Beers criteria [13]. The Beers criteria are also presented in a table format, with the order of the criteria related to the systems. The panel responsible for developing the latest Beers criteria focused on the order and wording of criteria to improve usability [13]. However, the Beers criteria consist of several lists, with the one linking medications and conditions presented with the condition first, as a single entry. In contrast, our presentation of the STOPP criteria prioritizes the drug first, as this approach was preferred during continuing education workshops we conducted on medication review.

Using a similar format facilitates the comparison of criteria from different sources. We believe that presenting criteria as a single-entry table should be promoted. We expect this paper to pave the way for greater uniformity in clinical decision support tools.

This tool represents an update and translation from French to English of our work on the SS.v2, published in 2015 [24]. Our clinical and teaching experiences since 2015 indicate that the single-entry format streamlines the medical review process. This is particularly true for frequently prescribed medications that belong to multiple sections. Initially, based on our research findings on SS.v1, we designed a list that collected, on a single line, all the PIMs associated with each of the 10 most frequent STOPP drugs and all the PPOs associated with each of the 10 most frequent START medical conditions. As mentioned above, these "single-entry" short lists were used in 2011 as the cornerstone of several workshops on medication review, gathering hundreds of Belgian general practitioners (GPs) in continuing medical education. The survey completed by these GPs after the training showed a high level of satisfaction with the "single-entry" approach.

In 2015, following the publication of SS.v2, we extended the single-entry tables to include all 115 criteria. We used the tool during continued education workshops on medication review, gathering more than 150 GPs in Belgium and Luxembourg, with positive feedback on this approach. Additionally, we tested its usability with 60 young Belgian physicians in GP training. Their satisfaction was very high (72%) and high (26%) regarding

Table 2 Single-entry START.v3 criteria

	START.v3: medical condition	Potentially inappropriate Prescribing Omission (PPO): consider prescribing	code
	Any drug indication	when appropriate	A1
MUSCULOSKELETAL	Vitamin D deficiency	when housebound, falls or osteopenia : vitamin D	H5
	Osteoporosis ± fragility fracture	vitamin D	H3
		when life expectancy > 1 year : bone antiresorptive/anabolic therapy	H4
	Denosumab	when discontinuation after ≥ 2 doses : anti-resorptive therapy	H6
	PTH analogue (-paratide)	when discontinuation : anti-resorptive therapy	H7
	Rheumatoïd arthritis	when active and disabling : DMARD (methotrexate, rituximab, etanercept...)	H1
	Corticosteroid, systemic	when > 3 months : vitamin D + calcium + bone antiresorptive/anabolic therapy	H2
	Methotrexate	folic acid	H9
	Gout	when recurrent : xanthine-oxydase inhibitor, long-term	H8
	NSAID therapy	PPI	F3
CARDIOVASCULAR	BP >140/90	antihypertensive therapy, unless moderate-severe frailty	B1
	Atrial fibrillation	oral anticoagulant	C1
		when uncontrolled heart rate : β-blocker	B10
	Atherosclerotic disease (coronary/cerebral/periph.)	antiplatelet agent	C2
		statin unless moderate-severe frailty	B2
	Coronary artery disease	ACEI	B3
	Ischaemic disease	when symptomatic ischaemia : β-blocker	B4
	Heart failure	when eGFR > 30ml/min : mineralocorticoid receptor antagonist	B7
		when symptomatic : SGLT2 inhibitor	B8
	HFrEF	ACEI	B5
		when stable : selective β-blocker (bisoprolol, metoprolol, carvedilol, ...)	B6
		when persistent symptoms : sacubitril/valsartan (to replace ACEI/ARB)	B9
		when symptomatic and iron deficiency : IV iron	B11
NEURO.	Anxiety	when severe : SSRI (if contraindicated : duloxetine, venlafaxine, pregabalin)	D5
	Depression	when major : antidepressant drug (non-tricyclic)	D2
	Parkinson disease		
	when disability	levodopa or dopamine agonist	D1
	when dementia	rivastigmine	D4
	Lewy Body dementia	rivastigmine	D4
	Alzheimer's dementia	when mild-moderate : acetylcholinesterase inhibitor	D3
	Restless legs syndrome	after exclusion of iron deficiency and severe renal disease : dopamine agonist	D6
	Essential tremor	when disabling: propranolol	D7
RENAL	eGFR < 30ml/min	when corrected Ca++ < 2.10 mmol/l and high PTH : calcitriol or 1α-OH-vitamin D	E1
		when persisting phosphatemia > 1.76 mmol/l (> 5.5 mg/dl) : phosphate binder	E2
		when symptomatic anemia (not due to deficiency) : erythropoietin analogue	E3
	eGFR < 60 ml/min	when albuminuria > 300 mg/24h : ARB or ACEI	E4
	Diabetic proteinuria	ACEI (or ARB if intolerance to ACEI)	J1
RESPI.	Asthma or COPD	when mild-moderate : LAMA or LABA	G1
		when moderate-severe[‡‡]: daily inhaled corticosteroid	G2
	Hypoxaemia, chronic	when pO_2 < 60 mmHg (or SaO_2 < 88%) : home continuous oxygen	G3
GASTRO.	Gastro-œsophagal reflux	when severe : PPI	F1
	Esophageal peptic stenosis	PPI	F1
	Oesophagitis / peptic ulcer	when aspirin or corticosteroid: PPI (see STOPP F5)	F2
	Peptic ulcer disease	when Helicobacter pylori: eradication	F7
	Constipation, chronic	osmotic laxative	F5
		when diverticulosis : fibre supplements	F4
	Antibiotics	probiotics, unless immunocompromised/debilitated (prevention of *Clostridium difficile* diarrhea)	F6
UROGEN.	Prostatism, symptomatic	when prostatectomy non-considered : α1-blocker ; 5α-reductase inhibitor	I1, I2
	Atrophic vaginitis	when symptomatic : local oestrogen	I3
	Urinary infections (woman)	when recurrent : local oestrogen	I4
	Erectile dysfunction	when persistence and distress : phosphodiesterase type-5 inhibitor	I5
PAIN	Non arthritis pain	when moderate-severe : high-potency opioids, after failure of lower potency	K1
	Break-through pain	short-acting opioids (see STOPP L3)	
	Opioids	when regular use : laxative	K2
	Lidocaine (5%) patch	for localized neuropathic pain (e.g. post herpetic)	K3
VACCINE	Annually	Trivalent influenza vaccine	L1
	At least once	Pneumococcal vaccine	L2
	National guidelines	Varicella-zoster vaccine	L3
		SARS-CoV2 vaccine	L4

Abbreviations: *ACEI* Angiotensin-converting-enzyme inhibitors, *ACS* Acute coronary syndrome, *AF* Atrial fibrillation, *ARB* Angiotensin II receptor blocker, *BMI* Body mass index, *BP* Blood pressure, *BPSD* Behavioral and psychological symptoms in dementia, *CKD* Chronic kidney disease,, *COPD* Chronic obstructive pulmonary disease, *COX-2* Cyclooxygenase-2, *CV* Cardiovascular, *dBP* diastolic blood pressure, *DMARD* Disease modifying activity rheumatic drug, *IV* Intravenous, *DOAC* Direct oral anticoagulant, *DVT* Deep venous thrombosis, *eGFR* estimated

Table 2 (continued)

glomerular filtration rate, *GAVE* Gastric antral vascular ectasia, *GI* Gastro-intestinal, *HFpEF* Heart failure with preserved ejection fraction, *HFrEF* Heart failure with reduced ejection fraction, *LABA* Long-acting beta-agonists, *LAMA* Long-acting muscarinic antagonists, *NSAID* Non-steroidal anti-inflammatory drugs, *NYHA* New York Heart Association, *OAC* Oral anticoagulant, *pCO2* partial pressure of carbon dioxide, *pO2* partial pressure of oxygen, *pa02* partial pressure of arterial oxygen, *PE* Pulmonary embolism, *PIM* Potentially inappropriate medication, *P-gp* P-glycoprotein, *PPI* Proton pump inhibitor, *PTH* Parathormone, *QTc* Corrected QT Interval, SaO2 arterial oxygen saturation, *SARS-CoV2* Severe acute respiratory syndrome coronavirus 2, *sBP* systolic blood pressure, *SGLT2* Sodium-glucose cotransporter 2, *SNRI* Serotonin–norepinephrine reuptake inhibitors, *SSRI* Selective Serotonin Reuptake Inhibitor, *T4* Thyroxine, *TSH* Thyroid stimulating hormone, *VKA* Vitamin K antagonist

[a]where FEV1 <50% of predicted value and repeated exacerbations requiring treatment with oral corticosteroids

its didactic value, and very high (84%) and high (16%) regarding its potential impact on daily practice (unpublished data).

We then published the single-entry table in French in Louvain Médical, the medical journal of UCLouvain [24]. Since then, it has been further disseminated nationnaly during symposiums, conferences, and meetings. The SS.v2 single-entry table is now part of the UCLouvain program for medical and pharmacy students. It is also part of our clinical practice as pharmacists and geriatricians, and we train our interns in its use.

The format is user-friendly for all users, and especially beneficial for new users of these criteria. The process of adopting new recommendations is extensive, and the emphasis on user-friendliness is crucial. We anticipate that researchers, clinicians, and students will embrace our formatted tool, thereby enhancing the positive impact of SS on the care of older patients. Conducting usability testing of this format could further promote its adoption. One could compare the performance of medication reviews using the original list versus the single-entry table tool in terms of inappropriate prescription (IP) detection, time efficiency, and user satisfaction. This could be carried out in primary and secondary care, by physicians, pharmacists and other healthcare professionals engaged in medication reviews.

In conclusion, this work might assist clinicians, students and researchers in more seamlessly adopting the new SS.v3 criteria. By presenting these criteria in an easily accessible single-entry table, we hope to facilitate their integration into daily clinical practice.

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Declarations

Conflict of interest Authors have no financial or non financial interests related to this work to disclose.

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