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Defining quality indicators for atherosclerotic cardiovascular diseases in primary care, extractable from the electronic health record: a RAND-modified Delphi method

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Abstract

Background Atherosclerotic cardiovascular diseases (ASCVD) account for 85% of all cardiovascular diseases and put a substantial burden on healthcare systems. General practitioners play an important role in managing ASCVD. The management of ASCVD could be improved by audit and feedback (A&F) based on quality indicators (QIs) derived from the electronic health record (EHR) of the general practitioner. This study aimed to define a set of validated and EHR extractable QIs for ASCVD to support A&F in primary care.

Methods A RAND-modified Delphi method was employed to define QIs. Recommendations were selected based on the SMART principle from international guidelines, selected following the AGREE II evaluation. After assessment by a multidisciplinary expert panel, the recommendations were analyzed using the median Likert Scale score, prioritization, and degree of agreement. They were preliminary classified as having high, uncertain or low potential to measure the quality of ASCVD care. These recommendations were further discussed in a consensus meeting. Upon final validation, high-potential recommendations were converted into QIs.

Results A questionnaire composed of 92 recommendations, selected from 12 international guidelines, were presented to the panel, resulting in a set of 50 high-potential recommendations. These were merged and modified into 41 recommendations after the consensus meeting. This resulted in a final set of 41 QIs classified into four categories: follow-up ($N=4$), pharmacological treatment ($N=22$), patient education ($N=10$), and referral ($N=5$).

Conclusions This study defines a set of 41 EHR extractable QIs for ASCVD in primary care, supporting A&F in primary care.

Keywords Quality indicators, Quality improvement, Feedback, Consensus, Delphi Technique, Population health management

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Background

Cardiovascular diseases (CVD) represent the foremost cause of mortality worldwide, with an estimated 17.9 million deaths attributed to CVD in 2019, accounting for 32% of all global deaths [1]. Atherosclerotic cardiovascular diseases (ASCVD), caused by a multitude of risk factors including hypertension, hyperlipidemia, elevated fasting plasma glucose, renal dysfunction, dietary risks, air pollution, lead exposure, suboptimal temperature, tobacco use, high body mass index, physical inactivity and excessive alcohol consumption, will result in plaque formation and arterial occlusion [2]. ASCVD account for approximately 85% of all cardiovascular disease cases [3, 4]. In Belgium, CVD are responsible for approximately 25% of annual deaths [5, 6]. It is estimated that around 750.000 individuals in Belgian are diagnosed with ASCVD, although this is likely underestimated due to slow disease progression [7].

Given the significant burden on both patient health and the healthcare system, a multidisciplinary, guideline-based approach is imperative, with general practitioners (GPs) playing an important role in the management and follow-up of ASCVD [8]. It is important that GPs deliver high-quality care to patients with ASCVD in accordance with national and international guidelines. However, evidence suggests that these guidelines are not being sufficiently implemented in clinical practice, with variability in physicians' knowledge being a major contributing factor to this non-adherence [9–11].

To enhance guideline adherence and the quality of care among GPs, audit and feedback (A&F) can be employed. A&F provides a summary of healthcare providers' performance over a specified period of time and evaluates their performance against established standards of excellence [12–15]. However, the implementation of A&F requires the availability of a set of validated quality indicators (QIs) to facilitate the measurement of care quality [16–20]. Previously, European QIs encompassing structure, process, and outcome measures for ASCVD have been developed [21]. Given the country-specific organization of ASCVD care, it is imperative to develop an updated set of QIs tailored for Belgium to guide the follow-up and management of ASCVD.

Furthermore, the electronic health record (EHR) can facilitate the efficiency of A&F and physician performance measurement through the use of EHR-extractable QIs. This approach offers a more accessible and cost-effective method for automated quality assessment, thereby assisting in improving quality of care [14–16, 22]. By leveraging EHR-extractable QIs, the number of ASCVD patients whose quality of care can be analyzed will increase substantially, potentially enhancing the overall quality of healthcare provided to these patients [23].

Consequently, the aim of our study was to develop evidence-based and EHR-extractable QIs for ASCVD, which will serve as a framework to evaluate and enhance the quality of primary care for ASCVD patients.

Methods

Design

The study was conducted between September 2024 and January 2025. In line with previous studies on QI development, we used the RAND-modified Delphi method to define QIs for ASCVD [17, 18, 24–27]. This method encompassed five steps: (a) Extraction of recommendations from international guidelines, evaluated by AGREE II, and inclusion in an online questionnaire, (b) Individual assessment of recommendations by the panel, followed by analysis and preparation of a feedback report (questionnaire round), (c) Online meeting with the panel to review the recommendations for eligibility (consensus round), (d) Final approval of the recommendations by all panel members, (e) Formulation of QIs.

Study population

The panel comprised 13 members: cardiologists ($N=2$), vascular surgeon ($N=1$), neurologist ($N=1$), GPs ($N=4$), pharmacist ($N=1$), dietician ($N=1$), nurse ($N=1$), EHR-developer ($N=1$), and a patient diagnosed with an ASCVD ($N=1$). All healthcare professionals worked in Belgium and were selected for their expertise in treating patients with ASCVD.

Data collection and analysis

Selection of guidelines and recommendations

The search for (inter)national guidelines related to ASCVD was conducted in September 2024. Guidelines pertaining to chronic coronary artery diseases (CCD), peripheral arterial diseases (PAD), stroke, transient ischaemic attacks (TIA), angina pectoris, acute coronary syndrome (ACS), and CVD were consulted from esteemed research institutions, including the American Heart Association, Scottish Intercollegiate Guidelines Network, National Institute for Health and Care Excellence, European Society of Cardiology, and Nederlands Huisartsen Genootschap. Additionally, we conducted a PubMed search using the terms ((chronic coronary disease) OR (peripheral arterial disease) OR (stroke) OR (transient ischaemic attack) OR (acute coronary syndrome) OR (cardiovascular disease)) AND ((guidelines) OR (recommendations)) AND (focused updates) AND ("2019/01/01"[Date - Publication] : "3000"[Date - Publication]). Only guidelines published from 2019 onwards and available in English or Dutch were included. The quality of the guidelines was ensured through a structured appraisal using the AGREE II assessment tool, independently conducted by three researchers (LC, LM

and MA) [28]. Only those deemed to be of high quality based on this tool were included.

Subsequently, all recommendations relevant to ASCVD were listed. The selection of these recommendations was guided by the SMART principle (Specific, Measurable, Acceptable, Realistic, Time-related), which was independently applied by two researchers (LC and MA) [25]. Recommendations that lacked specificity or acceptability for primary care were excluded, as they could not yield useful QIs (e.g. in patients with CCD, optimization of guideline-directed medical therapy is recommended to reduce major adverse cardiovascular events). Non-extractable but theoretically measurable recommendations were included to ensure that the development of QIs was not impeded by the current unavailability of data [29]. Disagreements were resolved through discussion, and if consensus could not be reached, a fourth researcher was consulted (SVdB).

All SMART recommendations were compiled into a questionnaire and categorized into four themes: follow-up, pharmacological treatment, patient education, and referral. (Supplemental material 1.1). Given the inclusion of a patient with ASCVD in our panel, an alternative questionnaire was created, omitting the recommendations that specifically applied to the expert panel members.

Written questionnaire

Completion The link to the online questionnaire in Lime Survey was provided to panel members via email [30]. Participants were instructed to evaluate each recommendation's usability for measuring the quality of ASCVD care provided by GPs, using a Likert scale ranging from one (indicating a poor recommendation for measuring quality of care) to nine (indicating an excellent recommendation for measuring quality of care). Panel members also had the option to mark recommendations as 'not assessable'. For each recommendation, panel members were asked to confirm its EHR-extractability. Additionally, each panel member ranked the recommendations in a top-five per category based on their relevance for measuring quality of care. Finally, participants were given the opportunity to provide remarks and suggest additional recommendations.

Analysis Prior to the consensus meeting, recommendations were classified based on the median Likert Scale scores, prioritization, and the degree of agreement ('agreement', 'disagreement', or 'no agreement' [to allow for a more refined interpretation]) among panel members (Table 1). Based on these criteria, the recommendations were categorized into three groups: high *(median Likert scale score '≥ 7' AND prioritization rate '≥ 20%' AND degree of agreement 'agreement')*, uncertain *([median Likert scale score '≥ 7' AND prioritization rate '1–20%' AND degree of agreement 'agreement'] OR [median Likert scale score '< 7' AND prioritization rate '≥ 20%' AND degree of agreement 'agreement or disagreement'])*, or low *(not fulfilling the defined criteria)* potential for measuring the quality of ASCVD primary care. (Table 1) [17, 24, 26, 27].

Table 1 Classification of recommendations as having a high/uncertain/low potential to measure the quality of care for atherosclerotic cardiovascular diseases

Step 1 – Median Likert scale score				
Determination of the median score, ranging from one to nine, for each recommendation based on the median of all panel members' scores				
Step 2 – Prioritization				
Order recommendations of each (sub)category into a top five (or 'not assessable') • Step a – The first ranked recommendation received five points. The second received four, etc. Remarks: (a) recommendations not in the top-five received zero points; (b) duplicate recommendations in the top five were only scored once. • Step b – Each recommendation's total prioritization points were divided by the maximum score, calculated as the product of the number of panel members who could prioritize that recommendation and the highest score a panel member could assign. The number of panelists indicating on the top-five assessment that it was not their expertise, were excluded in the determination of the denominator. *Example: In a panel of 13 members, if four panel members ranked a recommendation first, two ranked it second, six did not include it in their top five, and one was unable to assess it, the prioritization rate was 28/60 or ((4 × 5) + (2 × 4) + (6 × 0))/((13 − 1) x 5) or 46.6%.*				
Step 3 – Agreement				
Agreement	≥ 70% of the panel members assigned a Likert score of ≥ 7 for the recommendation			
Disagreement	≥ 30% of the panel members assigned a Likert score of ≥ 7 for the recommendation AND ≥ 30% of the panel members assigned a Likert score of ≤ 3 recommendation			
No agreement	Other recommendations			
Step 4 – Classification of recommendations				
	High potential	Uncertain potential	Uncertain potential	Low potential
Median Likert scale score	≥ 7	≥ 7	< 7	Other recommendations
Prioritization rate	≥ 20%	1–20%	≥ 20%	
Agreement	Agreement	Agreement	Agreement or Disagreement	

Consensus meeting

The results of the analysis were presented to panel members through an individual feedback report, detailing their scores on the 9-point Likert scale, the median scores of all panel members, the percentage of prioritization, and the level of agreement for each recommendation. These reports were supplemented with comments and color-coded recommendations indicating their potential for measuring the quality of care: high (green), uncertain (yellow) or low (red) potential.

Subsequently, a consensus meeting, led by one of the researchers (LC) and recorded for transcription, was held to discuss the inclusion or exclusion of the recommendations based on the feedback report. Recommendations with high potential were included unless objected by panel members, while those with low potential were excluded unless further deliberation was requested. Recommendations with uncertain potential were thoroughly discussed to reach consensus on their inclusion or exclusion. All accepted recommendations were then discussed, merged, or modified, considering the SMART principle and panel members' remarks.

Final appraisal

The final list of high-potential recommendations was sent to the panel members for their final evaluation. Although only nine panel members participated in the consensus meeting, all 13 members received a summary of the high-potential recommendations via email afterwards. This ensured that each member had the opportunity to review and evaluate the recommendations.

Translation into quality indicators

The approved high-potential recommendations were converted into QIs that could be expressed as percentages. For instance, the recommendation "Annual influenza vaccination is recommended as secondary prevention in patients with ACS, CCD, PAD and/or stroke" was converted into "The percentage of patients with ACS, CCD, PAD and/or stroke who received an annual influenza vaccine". The final set of QIs received approval from all authors.

Ethics

This study received approval from the Social and Societal Ethics Committee: G-2024-8020. Panel members provided written informed consent to participate in the study.

Results

Selection of recommendations

A total of 1932 recommendations were collected from 12 guidelines, each positively evaluated using the AGREE II assessment tool and selected based on their relevance to ASCVD, applicability in primary care, and publication date [28, 31–42]. After applying the SMART principle and merging similar recommendations, 92 recommendations were obtained. These were categorized into follow-up (N = 13), pharmacological treatment (N = 48), patient education (N = 18), and referral (N = 13) (Fig. 1). The patient questionnaire only included the recommendations related to patient education. (Supplemental material 1.2, 1.3 and 1.4).

Written questionnaire

All panel members (13/13) completed the questionnaire. Based on median Likert scale scores, prioritization rates and agreement, 46 recommendations were identified as high potential, 14 as uncertain and 32 as low potential.

Consensus meeting

Nine panel members, comprising three GPs, one cardiologist, one vascular surgeon, one dietitian, one nurse, one EHR-developer, and one patient, participated in the consensus meeting. During this meeting, 44 high-potential recommendations and six uncertain-potential recommendations were retained, while none of the low-potential recommendations were reclassified. This process resulted in the acceptance of 50 recommendations. Subsequent minor modifications and combinations of recommendations, based on panel feedback and adherence to the SMART criteria, aimed to improving applicability and measurability, culminated in a refined set of 41 recommendations (Fig. 1).

Final approval

All 13 panel members approved the 41 recommendations emailed to them after the consensus meeting.

Translation into quality indicators

The final set of recommendations was converted into 41 QIs: follow-up (N = 4), pharmacological treatment (N = 22), patient education (N = 10), and referral (N = 5) (Table 2).

Content of quality indicators

The panel concurred that recommendations specifically defined for one condition of ASCVD, such as PAD, CCD, or stroke, could be extrapolated to other conditions as deemed appropriate by the panel. Blood pressure targets were set at systolic blood pressure (SBP) < 130mmHg and diastolic blood pressure (DBP) < 80mmHg. For optimal dosing of statin therapy, fasting lipid profiles should be assessed at the initiation or adjustment of treatment, and subsequently on an annual basis. Independent of medication, comprehensive blood tests are recommended to refine risk stratification. No QI was selected for LDL cholesterol targets due to the potential adverse effects

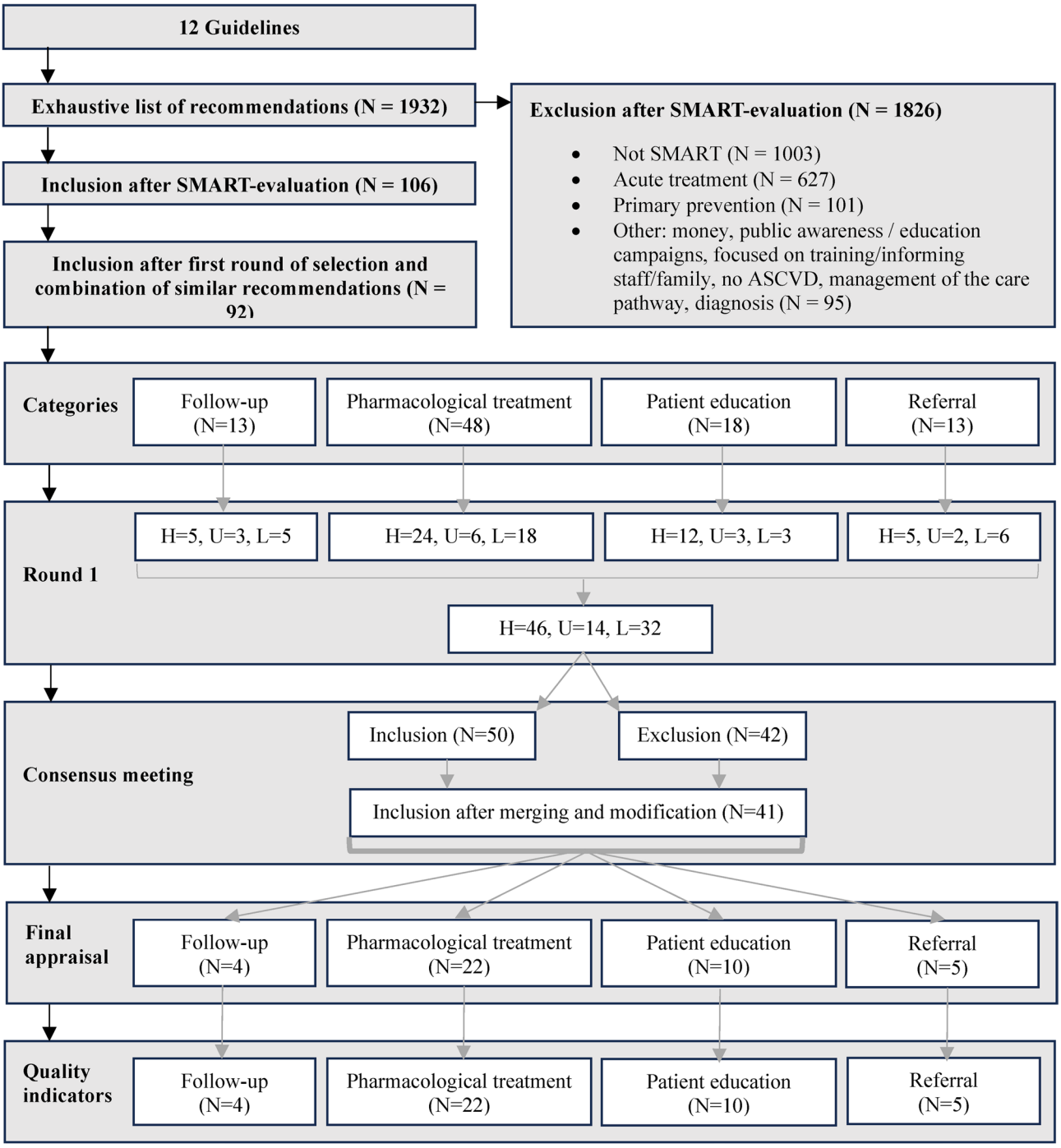

Fig. 1 Quality indicators for the treatment of atherosclerotic cardiovascular diseases by general practitioners using the RAND-modified Delphi method. N = number of recommendations; H = number of high-potential recommendations; U = number of uncertain-potential recommendations; L = number of low-potential recommendations

Table 2 Quality indicators for atherosclerotic cardiovascular disease care

Follow-up	
1	Percentage of patients with peripheral arterial disease (PAD), chronic coronary artery disease (CCD) or stroke with systolic blood pressure (SBP) < 130mmHg and diastolic blood pressure (DBP) < 80mmHg.
2	Percentage of patients with CCD, PAD and/or stroke in whom the effects of lipid-lowering medication are assessed by measuring fasting lipids within 4 to 12 weeks of starting statin treatment or after dose adjustment, and every 12 months thereafter to assess response to or compliance with therapy.
3	Percentage of patients with CCD, PAD and/or stroke in whom a statin was started, and in whom basic blood tests and a clinical assessment were performed prior to this, consisting of the assessment of: smoking status, alcohol consumption, blood pressure, body mass index or other measure of obesity, complete lipid profile, diabetes status, renal function, transaminase level (alanine aminotransferase or aspartate aminotransferase), thyroid-stimulating hormone level in those with symptoms of slow or overactive thyroid hormone.
4	Percentage of patients with CCD, PAD and/or stroke in whom renal function, sodium and potassium are determined 2 weeks after initiation of a renin-angiotensin system inhibitor (RASi) and/or diuretic in case of an abnormal laboratory result (eGFR < 60 mL/min/1.73 m^2, potassium < 3.8 mmol/l or potassium > 4.5 mmol/l), or when a combination of a RASi and a diuretic is prescribed.
Pharmacological treatment	
5	Percentage of patients who have had a myocardial infarction (MI) and to whom an angiotensin converting enzyme inhibitor (ACEi), angiotensin receptor blocker (ARB) or angiotensin receptor neprilysin inhibitor (ARNI) is prescribed.
6	Percentage of patients who had a MI more than 12 months ago to whom an aspirin is prescribed.
7	Percentage of patients with acute coronary syndrome (ACS) with a left ventricular ejection fraction (LVEF) ≤ 40% to whom beta-blockers are prescribed.
8	Percentage of patients with ACS with symptoms of heart failure, LVEF ≤ 40%, diabetes, hypertension (SBP ≥ 130mmHg and DBP ≥ 80mmHg) and/or chronic kidney disease to whom ACEi are prescribed.
9	Percentage of patients with ACS with a LVEF ≤ 40% and heart failure or diabetes to whom mineralocorticoid receptor antagonists are prescribed.
10	Percentage of patients with ACS, CCD, PAD and/or stroke to whom an annual influenza vaccine is prescribed.
11	Percentage of patients with CCD and heart failure to whom a sodium-glucose cotransporter-2 inhibitor is prescribed.
12	Percentage of patients with CCD and who were treated with percutaneous coronary intervention to whom dual antiplatelet therapy (consisting of aspirin and clopidogrel) is not prescribed for more than 12 months after that treatment.
13	Percentage of patients with CCD and LVEF ≤ 40% to whom beta-blocker therapy is prescribed.
14	Percentage of patients with CCD who also have hypertension (SBP ≥ 130mmHg and DBP ≥ 80mmHg), diabetes, LVEF ≤ 40% or chronic kidney disease, to whom ACEi, or ARBs (if ACEi intolerant) are prescribed.
15	Percentage of patients who have had coronary artery bypass grafting to whom 75–100 mg aspirin per day is prescribed for life.
16	Percentage of patients without prior MI or revascularization, but with evidence of significant obstructive coronary artery disease, to whom 75–100 mg aspirin per day is prescribed for life.
17	Percentage of patients with hypertension (SBP ≥ 130mmHg and DBP ≥ 80mmHg), and a stroke or transient ischaemic attack (TIA) or CCD or PAD, to whom a thiazide diuretic, an ACEi or an ARB is prescribed.
18	Percentage of patients with ischaemic stroke or with a TIA due to valve/rheumatic atrial fibrillation or mechanical heart valve replacement, and with contraindications or intolerance to direct oral anticoagulant therapy, should receive anticoagulation with an adjusted dose of warfarin (target international normalized ratio 2.5, range 2.0 to 3.0) with a target value of more than 72% in the therapeutic range.
19	Percentage of patients with carotid artery stenosis and a TIA, stroke, CCD, or PAD, to whom intensive medical treatment with antiplatelet therapy, lipid-lowering therapy and treatment of hypertension is prescribed.
20	Percentage of patients with (nonvalvular) atrial fibrillation and stroke or TIA, to whom oral anticoagulation (e.g., apixaban, dabigatran, edoxaban, rivaroxaban, or warfarin) is prescribed.
21	Percentage of patients to whom vitamin K antagonists or direct oral anticoagulants are prescribed after a TIA or cerebral infarction due to atrial fibrillation or another cardiac embolic source.
22	Percentage of patients with stable angina pectoris to whom acetylsalicylic acid 1dd 80 mg tablet is prescribed.
23	Percentage of patients with symptomatic PAD to whom single antiplatelet therapy is prescribed.
24	Percentage of patients with symptomatic PAD to whom antiplatelet therapy with aspirin (range, 75–325 mg daily) is prescribed.
25	Percentage of patients with PAD and hypertension (SBP ≥ 130mmHg and DBP ≥ 80mmHg) to whom antihypertensive therapy is prescribed.
26	Percentage of patients with PAD, CCD and/or stroke who received the vaccine series against severe respiratory syndrome-coronavirus-2, including the booster(s).
Patient education	
27	Percentage of patients with CCD, PAD and/or stroke who receive ongoing individualized education on medication adherence.

Table 2 (continued)

28	Percentage of patients with stroke, TIA, CCD and/or PAD receiving medication for secondary prevention who received the following information: 1. receive information about the reason for the medication, how and when to take it and common side effects; 2. receive verbal and written information about their medicines in an appropriate format; 3. be offered compliance aids such as large-print labels, non-childproof tops and dosette boxes according to their level of manual dexterity, cognitive impairment, personal preference and compatibility with safety in the home; 4. be aware of how to obtain further supplies of medication; 5. have their medication regularly reviewed; 6. have their capacity to take full responsibility for self-medication assessed (including cognition, manual dexterity and ability to swallow) by the multidisciplinary team as part of their rehabilitation prior to the transfer of their care out of hospital. The following medications should be discouraged: estrogen-containing contraceptives and hormone therapy due to menopause symptoms.
29	Percentage of patients with stroke, CCD and/or PAD to whom a statin is prescribed and who have received the following advice: (1) other drugs, some foods (for example, grapefruit juice) and some supplements may interfere with statins and (2) always consult the patient information leaflet, a pharmacist or prescriber for advice when starting other drugs or thinking about taking supplements.
30	Percentage of patients with CCD, PAD and/or stroke who are recommended a diet emphasizing vegetables, fruits, legumes, nuts, whole grains, fish and lean protein (and less meat; and replace butter and cheese with vegetable oil-based products).
31	Percentage of patients with CCD, PAD and/or stroke who have their tobacco use assessed at every health care visit.
32	Percentage of patients with stroke, TIA, CCD and/or PAD, who are overweight or obese, and who have received information to support weight loss including the adoption of a healthy diet and lifestyle, limiting alcohol intake and taking regular exercise.
33	Percentage of patients with CCD, PAD and/or stroke who are advised to limit their alcohol intake.
34	Percentage of patients with CCD, PAD and/or stroke who are advised to avoid stress.
35	Percentage of patients with stroke, TIA, CCD and/or PAD, who smoke, and who received the advice to stop smoking immediately, avoid second-hand smoke, and in whom smoking cessation is promoted in an individualized prevention plan using interventions that may include pharmacotherapy, psychosocial support, and referral to statutory stop smoking services.
36	Percentage of patients with CCD, PAD and/or stroke who are advised to: (1) be physically active for 20 to 30 min a day to the point of slight breathlessness (moderate-intensity exercise). (2) to increase their activity in a gradual, step-by-step way, aiming to increase their exercise capacity when they are not active. (3) start at a level that is comfortable, and increase the duration and intensity of activity as they gain fitness.
Referral	
37	Percentage of patients with stroke, as well as recurrent failure symptoms and complications referred to a neurologist.
38	Percentage of patients with stroke and limitations in somatic or social functioning referred to a specialist in geriatrics or a rehabilitation physician.
39	Percentage of patients with stroke with language, speech and/or swallowing problems referred to a speech therapist.
40	Percentage of patients with stroke with mobility problems referred to an exercise or physical therapist.
41	Percentage of patients with stroke with disabilities in general daily living activities and household operations and/or need for home adaptations and assistive devices, referred to an occupational therapist.

ACEi Angiotensin converting enzyme inhibitor, *ACS* Acute coronary syndrome, *ARB* Angiotensin receptor blocker, *ARNI* Angiotensin receptor neprilysin inhibitor, *CCD* Chronic coronary artery disease, DBP Diastolic blood pressure, *eGFR* Estimated glomerular filtration rate, *LVEF* Left ventricular ejection fraction, *MI* Myocardial infarction, *PAD* Peripheral arterial disease, *RASi* Renin-angiotensin system inhibitor, *SBP* Systolic blood pressure, *TIA* Transient ischaemic attack

of excessively low levels and the lack of evidence for improved outcomes. Medication-related QIs included influenza and COVID-19 vaccinations, antihypertensives (thiazide diuretics, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers), lipid-lowering therapy, and (dual) antiplatelet therapy. Despite current non-extractability, the panel emphasized the importance of QIs related to patient education, encompassing pharmacological treatment evaluation, medication adherence advice, lifestyle guidance on diet, discouraging tobacco and alcohol use, stress reduction, and gradual increase in moderate-intensity physical activity. For stroke patients, referrals to neurologists, geriatricians, rehabilitation physicians, speech therapists, physiotherapists, and occupational therapists were recommended.

Discussion

This study used a RAND-modified Delphi method to develop 41 EHR-extractable QIs for evaluating ASCVD primary care quality. These QIs encompass follow-up, pharmacological treatment, patient education, lifestyle management, and specialist referrals. Physicians suggested generalizing pathology-specific recommendations to CCD, PAD, and stroke.

Follow-up QIs emphasized the importance of monitoring clinical parameters and laboratory values during medication initiation and dosage adjustments, with annual re-evaluation identified as essential. During the Delphi process, three controversies were identified. First, although the patient proposed inclusion of lipoprotein(a) in basic blood tests for ASCVD patients, the panel

rejected this due to absence of guidelines and reimbursement in the Belgian health insurance system [43]. Second, blood pressure monitoring was recognized as an important QI in assessing the quality of follow-up. Unlike older QI sets which maintain less stringent blood pressure targets, such as SBP < 140 mmHg and DBP < 90 mmHg, the panel endorsed stricter thresholds of < 130/80 mmHg, aligning with recent and evidence-based American Heart Association guidelines [31, 44, 45]. Third, optimal targets for LDL- and non-HDL cholesterol remained contentious. While NICE guidelines recommend ≤ 2.0 mmol/L and ≤ 2.6 mmol/L respectively, participating cardiologists and vascular surgeons favored more stringent targets, whereas GPs advocated for individualized approaches, citing limited evidence for improved outcomes and concerns about overtreatment [34]. Due to lack of consensus and the need for individualized targets, the recommendation was not adopted.

Compared to existing QI sets, which often address both primary and secondary prevention, this study focused exclusively on developing QIs to enhance the quality of secondary prevention for ASCVD patients. To enable determination of those QIs, the ASCVD patient population must be delineated in the EHR based on their diagnosis of CCD, PAD, and/or stroke [21, 45]. Our set also included QIs on referral to secondary care, alongside existing QIs related to follow-up, pharmacological treatment, and patient education and lifestyle management, highlighting multidisciplinary ASCVD management and timely specialist referral. Also, differences were noted in target values for SBP and DBP. Unlike other sets, it excludes QIs on medical record registration quality, concentrating instead on care processes [44, 45]. Although not all panel members attended the consensus meeting, each had the opportunity to review and approve the final set of indicators during the third round, ensuring their expertise was fully incorporated.

A key strength of this study lies in its foundation on 12 AGREE II-endorsed international guidelines published since 2019, ensuring methodological rigor and cross-national applicability [28, 31–42, 46]. Recommendations were selected using the SMART principle, including theoretically measurable but currently non-extractable recommendations [25, 47]. This approach ensures that QI development is not hindered by current data unavailability and highlights the need for enhanced EHR data entry and interoperability across care teams. Automated EHR data extraction will enhance QIs applicability and facilitate automated A&F, facilitating evidence-based practice [14–16, 22]. Achieving this requires converting unstructured data into standardized formats, necessitating innovative EHR integration strategies [20]. Prior to implementation, QIs must be tested on operational validity and EHR-extractability, considering the Belgian healthcare context [46, 48]. Given international variability in EHR systems, extractability must be revalidated in other countries [49]. In future work, the QIs will be piloted using data from INTEGO, a general practice morbidity registry in Flanders (Belgium), which systematically collects patient data from EHR systems used by GPs [50]. This includes evaluating whether the indicators can be reliably extracted from both structured and unstructured EHR data, and whether they reflect actual clinical performance. Following the pilot test using INTEGO data, the QIs may be scaled up for national implementation. Given the heterogeneity of EHR systems internationally, the extractability of QIs will need to be revalidated in other contexts. This will require collaboration with international partners to test the indicators across divers data architectures and coding standards, thereby supporting generalizability and scalability of the QIs. Furthermore, challenges related to data quality and potential biases in secondary data use must be addressed, although existing feedback tools can mitigate these issues [51–53]. Social determinants of health (SDoH) were not included due to their absence in the guidelines and non-extractability from EHRs [54, 55]. However, this omission represents a limitation, especially in light of growing international consensus on the importance of SDoH in ASCVD risk stratification [55, 56]. Future iterations of the QIs should explore ways to incorporate these factors, which may require updates to clinical guidelines and improvements in EHR infrastructure to enable structured documentation and extraction of relevant SDoH data. In contrast to many comparable studies, this research engaged a multidisciplinary panel – including primary and secondary care providers, a patient, and an EHR developer – to ensure diverse perspectives and minimize discordance between patient and provider priorities [21, 44–46, 57, 58]. Recognizing that panel composition can influence QI selection, deliberate efforts were made to balance stakeholder representation and reduce groupthink, thereby enhancing the robustness and relevance of the final QI set [59–61].

Conclusions

This study used a RAND-modified Delphi method to develop a set of 41 electronic health record extractable quality indicators designed to assess the quality of primary care for patients with ASCVD. These quality indicators cover various aspects of care, including follow-up, pharmacological treatment, patient education and lifestyle management, and referrals to other healthcare professionals. They can be used in automated quality assessments via audit and feedback to measure and enhance the quality of ASCVD primary care.

Abbreviations

A&F	Audit and Feedback
ACEi	Angiotensin converting enzyme inhibitor
ACS	Acute coronary syndrome
ARB	Angiotensin receptor blocker
ARNI	Angiotensin receptor neprilysin inhibitor
ASCVD	Atherosclerotic cardiovascular diseases
CCD	Chronic coronary artery disease
CVD	Cardiovascular diseases
DBP	Diastolic blood pressure
eGFR	Estimated glomerular filtration rate
EHR	Electronic health record
GP	General practitioner
LVEF	Left ventricular ejection fraction
MI	Myocardial infarction
PAD	Peripheral arterial disease
QI	Quality indicator
RASi	Renin-angiotensin system inhibitor
SBP	Systolic blood pressure
SDoH	Social Determinants of Health
SMART	Specific – Measurable – Acceptable – Realistic – Time-related
TIA	Transient Ischaemic Attack

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12875-025-03087-3.

Supplementary Material 1.

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Transparency statement

The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Authors' contributions

LC, WR, BV and SVDB contributed to the design and conceptualization of the study. LC, LM, MA and SVDB performed the AGREE II and SMART evaluation. LC, WR, BV and SVDB researched data and wrote the manuscript. LC chaired the consensus meeting. LC wrote the first draft of the manuscript. LC, WR, MA, MVDP, BV and SVDB reviewed and edited the manuscript. All authors read and approved the final manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Data availability

The data generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical approval and consent to participate

This study, conducted in accordance with the ICH GCP guidelines, received approval from the Social and Societal Ethics Committee: G-2024-8020. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki, as approved by the World Medical Association. Prior to the study, all participants received an Informed Consent Form outlining the research details. Panel members provided written informed consent to participate in the study. Participants were assured that no potentially identifying details would be reported, all data would be kept confidential, and they could withdraw at any time or decline to answer any question without any negative consequences. No electronic health record data were accessed or reviewed during the development of the quality indicators.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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